

FINAL REPORT

**EMISSIONS EVALUATION
OF
COAL-FIRED GENERATING STATION**

**GRAND HAVEN BOARD OF LIGHT & POWER
SIM GENERATING STATION
GRAND HAVEN, MICHIGAN**

LEMOS LABS PROJECT 0153

December 14, 2015

**PREPARED BY
ALEX KEFFALAS
GENERAL MANAGER**

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**6017-B ENTERPRISE DRIVE
EXPORT, PENNSYLVANIA 15632**

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Appendix C	Laboratory Analyses
Appendix D	Calculations
Appendix E	Field Equipment Calibrations

1.0 EXECUTIVE SUMMARY

Grand Haven Board of Light & Power (Grand Haven) contracted Lemos Labs, LLC (Lemos) to perform an evaluation of particulate emissions from Boiler 3 (ID: EU-UNIT-3_BLR), associated wet lime scrubber, electrostatic precipitator and Selective Non-Catalytic Reduction (SNCR) located at the Sims Generating Station facility. Testing and analyses were conducted using the principles of U.S. Environmental Protection Agency (EPA) Methods as described in 40 CFR, Part 60, Appendix A, Subpart Da. The particulate emission results demonstrate compliance with MIDEQ emission regulations.

The performance testing was conducted at normal load based on demand during the time of testing.

Permit Number: MIROP-B1976-2011

SRN: B1976

The tests results are in compliance with the permit. Table 1 presents a test results summary.

TABLE 1

**GRAND HAVEN BOARD OF LIGHT AND POWER
BOILER 3 (ID: EU-UNIT-3_BLR)**

PERMIT NUMBER MI-ROP-B1976-2011

TEST RESULTS SUMMARY

Parameter	Measured Average	Compliance Limit	Compliance Determination
Total Particulate Matter Emissions:			
lb/hr	6.26		
ton/yr	27		
lb/mmBtu	0.009	0.03	in compliance

2.0 SCOPE AND OBJECTIVES

The scope of this project was to determine the particulate from Boiler 3 using the principles of EPA Method 5B. The particulate results are to demonstrate compliance with MIDEQ emission regulations.

Permit Number: MIROP-B1976-2011

SRN: B1976

The following parameters were determined at a minimum for each of three test runs:

- Gas Flow acfm¹ and dscfm²
- Gas Temperature °F³
- Gas Moisture % by volume
- Sample Gas Volume dscf⁴
- Isokinetic Ratio %
- Particulate Emission gr/dscf⁵, lb/hr⁶ and lb/mmBtu⁷

Lemos Labs Contact:
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- ¹acfm actual cubic feet per minute
²dscfm dry standard cubic feet per minute
³°F degrees Fahrenheit
⁴dscf dry standard cubic feet
⁵gr/dscf grains per dry standard cubic feet
⁶lb/hr pounds per hour
⁷lb/mmBtu pounds per million British thermal unit

3.0 PROCESS DESCRIPTION

The Sims Generating facility operates Boiler 3 (EU-UNIT-3_BLR) fueled by pulverized sub-bituminous coal. The boiler is rated at 993 mmBtu/hr of heat input with an out-put approximately 80 MW. The facility includes a wet lime scrubber for flue gas desulfurization and an electrostatic precipitator. Additionally, this unit is equipped with low-NO_x burners and Non-Catalytic Reduction (SCNR) for NO_x emissions control.

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4.0 PROCEDURES

4.1 FIELD WORK

4.1.1 Field Data Sheets

Copies of all field data sheets are included in Appendix A.

4.1.2 Emission Testing Station and Traverse Locations

The sampling station for the collection of particulate matter were located at the exhaust stack. The inside diameter of the stack at the sampling ports is 167 inches. The nearest downstream disturbance is the stack exit which is approximately 199 feet or 14 diameters from the test location. The nearest upstream disturbance is the inlet plenum which is approximately 26 feet or 2 diameters from the test location. EPA Method 1 - Sample and Velocity Traverses for Stationary Sources was used to determine the number and location of the traverse points. Twenty-four sampling points were used, twelve on each diameter, six at each of the four test ports located 90 degrees to center. The following are the distances from the inner wall to each traverse point: 3.6, 11.2, 19.7, 29.6, 41.8, and 59.4 inches. A drawing of the outlet stack sampling location and a table of the traverse points is in Figure 1.

4.1.3 Determination of Gas Flow and Gas Temperature

The gas flow rate and temperature profiles for the gas stream were measured by conducting simultaneous velocity and temperature traverses concurrently with the particulate emission sampling. The gas flow rates were used to calculate the emission rates for each parameter. Gas velocity head was measured with a calibrated "S"-type Pitot tube that was connected to an inclined manometer. A chrome-alumel thermocouple attached to a digital indicator was used to measure the gas temperature at each of the traverse points. The gas flow and gas temperature measurements followed the principles of EPA Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube).

An angular flow test was conducted. The angle of flow ranged from 5 to 14 degrees and the average angle of flow was 8.33 degrees.

4.1.4 Determination of Dry Molecular Weight

Carbon dioxide (CO₂) and oxygen (O₂) in the exhaust gas stream were continuously measured for the calculation of dry molecular weight using EPA Method 3A - Gas Determination of Oxygen and Carbon Dioxide Concentration in Emissions From Stationary Sources. The O₂ and CO₂ data was collected simultaneously with the particulate emission data.

4.1.5 Determination of Moisture Content

Moisture sampling was conducted using the principles presented in EPA Method 4 - Determination of Moisture Content In Stack Gases concurrently with the particulate emissions sampling. Parameters evaluated in order to determine the gas stream moisture content were: sample gas volume, sample gas temperature, sample gas pressure, impinger moisture gain and silica gel moisture gain.

4.1.6 Determination of Particulate Emissions

EPA Method 5B - Determination of Nonsulfuric Acid Particulate Matter Emissions From Stationary Sources was used to measure particulate emissions. Particulate matter was withdrawn isokinetically from the gas stream and collected in a stainless steel nozzle, heated stainless steel lined probe and on a glass-fiber filter. A series of glass impingers containing distilled water and silica gel was used to collect water vapor. The impinger train consisted of two impingers each containing 100 milliliters of distilled water. The third impinger was empty and the fourth impinger contained at least 200 grams of silica gel. The average of three 120-minute sampling runs constituted the test. A schematic of the Method 5B sampling train is included in Figure 2.

4.1.7 Process Data

The process information was recorded by Grand Haven during each testing period and is included in Appendix B.

The process parameters include:

- Electric generation rate (MW)
- Heat input rate of coal (mmBtu/hr)
- Scrubber liquor pH
- Scrubber differential pressure (in. water)
- Continuous opacity monitor values during the test run periods

4.1.8 Test Parameters and Methods

The compliance emission testing was performed for the parameters listed in Table 3. All test methods conducted for this compliance test conform to Title 40, Code of Federal Regulations, Part 60 Subpart Da. The test methods followed the current reference methods and no variations were conducted.

TABLE 3

TEST PARAMETERS AND METHODS

Parameter	EPA Method #	Sampling and Analytical Procedure	Variations
Sample and Velocity Traverses	1	Sample and Velocity Traverses for Stationary Sources	None
Gas Flow	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)	None
O ₂ , CO ₂	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources	None
Moisture	4	Determination of Moisture Content in Stack Gases	None
Particulate	5B	Determination of Nonsulfuric Acid Particulate Matter Emissions From Stationary Sources	None

4.1.9 Sample Recovery Procedures

All samples were recovered according to the appropriate methodology without deviation.

4.2 LABORATORY ANALYSES

Lemos Labs conducted all gravimetric analyses of the particulate catches in accordance with EPA Method 5B procedures. Summaries of the analytical results are included in Appendix C.

4.3 CALCULATIONS

Emission calculations were completed using a computer spreadsheet format. The results of each pertinent parameter are detailed on the spreadsheet. The spreadsheet and Run 1 calculations are included in Appendix C.

4.4 FIELD EQUIPMENT CALIBRATIONS

The following field equipment calibration data are included in Appendix D:

- Pitot tube;
- Thermocouple;
- Dry gas meters and orifices;
- Analyzers; and
- Calibration gas certificates.

5.0 SUMMARY OF RESULTS

Table 2 presents the summary of emissions and testing parameters.

The particulate concentration ranged from 0.0034 to 0.0040 gr/dscf and the average was 0.0038 gr/dscf. The particulate emission rate ranged from 5.55 to 6.66 lb/hr and the average was 6.26 lb/hr. The particulate emission rate ranged from 24 to 29 ton/yr and the average was 27 ton/yr. The particulate emission rate ranged from 0.008 to 0.010 lb/mmBtu and the average was 0.009 lb/mmBtu.

TABLES

TABLE 1

**GRAND HAVEN BOARD OF LIGHT AND POWER
BOILER 3 (ID: EU-UNIT-3_BLR)**

PERMIT NUMBER MI-ROP-B1976-2011

TEST RESULTS SUMMARY

Parameter	Measured Average	Compliance Limit	Compliance Determination
Total Particulate Matter Emissions:			
lb/hr	6.26		
ton/yr	27		
lb/mmBtu	0.009	0.03	in compliance

TABLE 2
GRAND HAVEN BOARD OF LIGHT AND POWER
UNIT 3

November 18, 2015

LEMOS LABS PROJECT 0153

SUMMARY OF EMISSIONS AND TESTING PARAMETERS

Parameter	Run 1	Run 2	Run 3	Average
Gas flow, acfm	281067	272606	276711	276795
Gas flow, dscfm	194354	191329	190458	192047
Gas temperature, °F	177.3	175.9	175.8	176.3
Gas moisture, % by volume	13.8	12.7	14.4	13.6
Oxygen content, % by volume	6.0	6.4	6.5	6.3
Carbon dioxide content, % by volume	12.4	12.4	12.4	12.4
Sample volume, dscf	101.024	101.302	103.766	102.031
Isokinetic ratio, %	99.5	101.3	104.3	101.7
Particulate Emissions:				
gr/dscf	0.0040	0.0040	0.0034	0.0038
lb/hr	6.66	6.56	5.55	6.26
ton/yr	29	29	24	27
lb/mmBtu	0.010	0.010	0.008	0.009

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TABLE 3

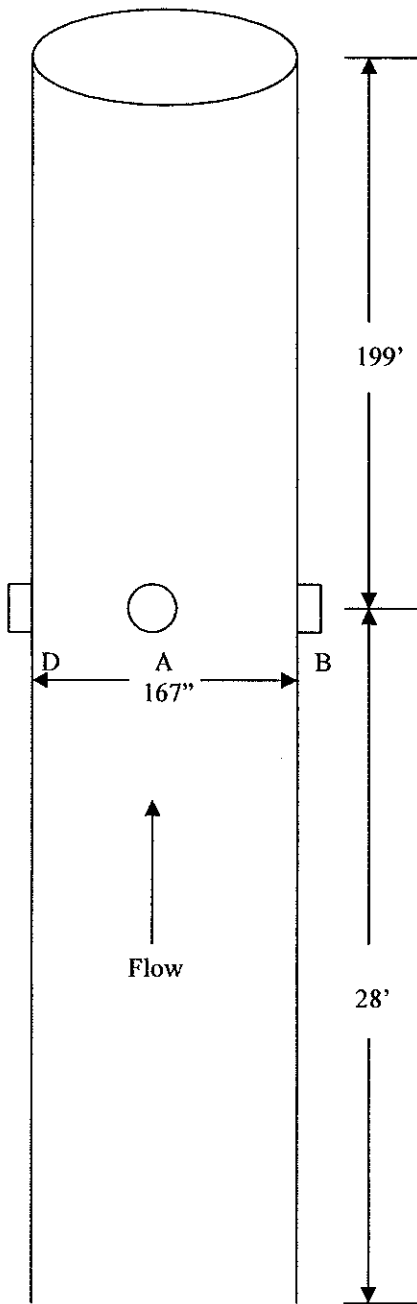
TEST PARAMETERS AND METHODS

Parameter	EPA Method #	Sampling and Analytical Procedure	Variations
Sample and Velocity Traverses	1	Sample and Velocity Traverses for Stationary Sources	None
Gas Flow	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)	None
O ₂ , CO ₂	3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources	None
Moisture	4	Determination of Moisture Content in Stack Gases	None
Particulate	5B	Determination of Nonsulfuric Acid Particulate Matter Emissions From Stationary Sources	None

FIGURES

Figure 1

Grand Haven Board of Light & Power
Sims Generating Station Boiler Stack
Grand Haven, Michigan



4 Ports, 6 points each port

Traverse Points	Inner Distance (inches)
1	3.6
2	11.2
3	19.7
4	29.6
5	41.8
6	59.4

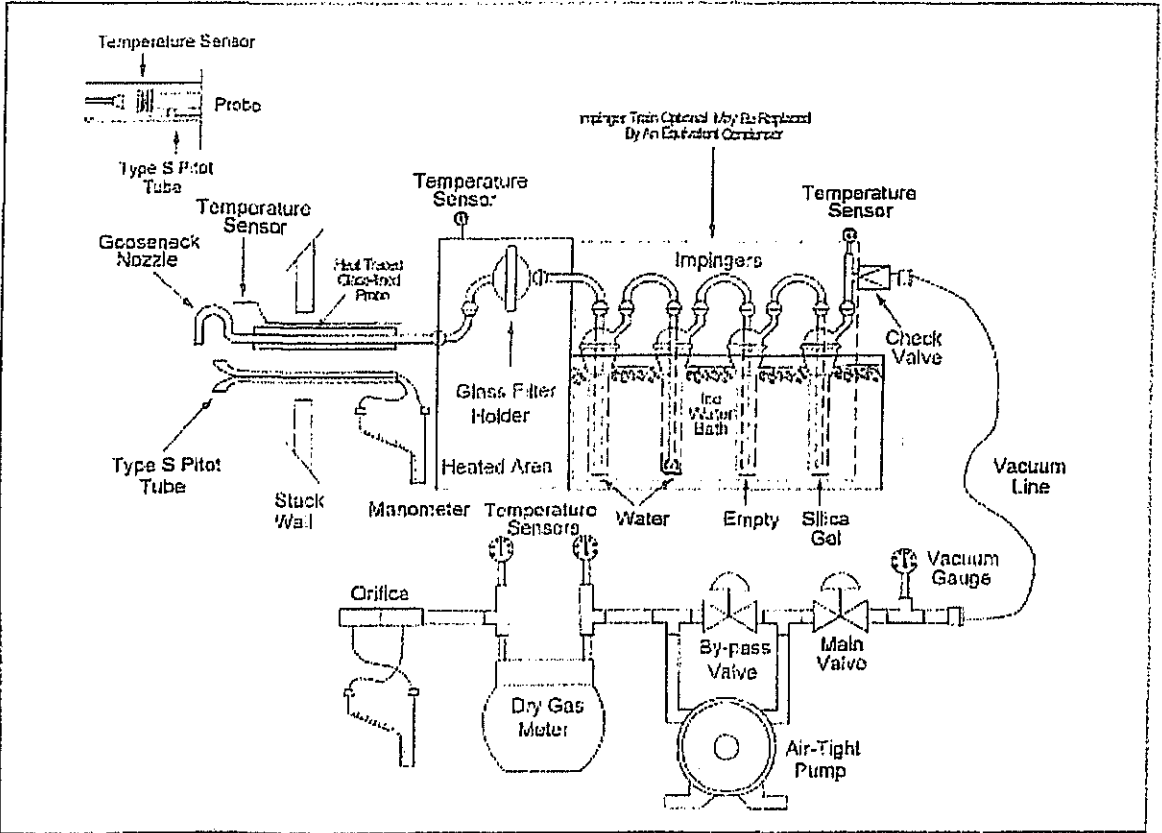


FIGURE 2

EPA Method 5B Sampling Train Schematic