STACK EMISSIONS STUDY
FOR THE
KILNS 19, 20, 21 AND WET GAS SCRUBBER
PREPARED FOR
HOLCIM (US) INC. D/B/A LAFARGE, SRN B1477
AT THE
ALPENA PLANT
ALPENA, MICHIGAN
OCTOBER 16-26, 2018

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certify that this testing was conducted and this report was created in conformance with the requirements of ASTM D7036

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Stack Emissions Study
Kilns 19, 20, 21 and Wet Gas Scrubber
Holcim (US) Inc. d/b/a Lafarge, SRN B1477
Alpena Plant
Alpena, Michigan
October 16-26, 2018

1.0 INTRODUCTION

Air Hygiene International, Inc. (Air Hygiene) has completed the Stack Emissions Study for nitrogen oxides (NOx), sulfur dioxide (SO_2), flow, carbon dioxide (CO_2), oxygen (O_2), moisture (H_2O), particulate matter (PM), dioxins, and metals [Cadmium (Cd) and Lead (Pb)] from the exhaust of the Kilns 19, 20, 21 and Wet Gas Scrubber for Holcim (US) Inc. d/b/a Lafarge, SRN B1477 at the Alpena Plant near Alpena, Michigan. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on October 16-26, 2018.

1.1 TEST PURPOSE AND OBJECTIVES

The purpose of the test was to conduct a periodic compliance emission test to document levels of selected pollutants at greater than 50 percent load (>50%). The information will be used to confirm compliance with the operating permit issued by the Michigan Department of Environmental Quality (MDEQ). The specific objective was to determine the emission concentration of NOx, SO_2, flow, CO_2, O_2, H_2O, PM, dioxins, and metals from the exhaust of Holcim (US) Inc. d/b/a Lafarge, SRN B1477's Kilns 19, 20, 21 and Wet Gas Scrubber.

1.2 SUMMARY OF TEST PROGRAM

The following list details pertinent information related to this specific project:

1.2.1 Participating Organizations
- Michigan Department of Environmental Quality (MDEQ)
- Holcim (US) Inc. d/b/a Lafarge, SRN B1477
- Air Hygiene

1.2.2 Industry
- Cement

1.2.3 Air Permit Requirements
- Permit Number: MI-ROP-B1477-2012
- EPA Facility ID: MID005379607

1.2.4 Plant Location
- Alpena Plant near Alpena, Michigan
  - 1435 Ford Avenue, Alpena, Michigan 49707
  - Federal Registry System / Facility Registry Service (FRS) No. – 110015742605
  - Source Classification Codes (SCC) – 30501120, 30500699, and 30500613

1.2.5 Equipment Tested
- Kilns 19, 20, 21 and Wet Gas Scrubber

1.2.6 Emission Points

- Exhaust from the Kilns 19, 20, 21 and Wet Gas Scrubber
- For all molecular weight gases, a single sample points in the exhaust stack for each unit
- For all wet chemistry testing, 24 sampling points in the exhaust duct from the Kilns 19, 20, 21 and Wet Gas Scrubber

1.2.7 Emission Parameters Measured

- NOx
- SO_2
- Flow
- O_2
- CO_2
- H_2O
- PM
- Dioxins
- Metals [Cadmium (Cd) and Lead (Pb)]

1.2.8 Dates of Emission Test

- October 16-26, 2018

1.2.9 Federal Certifications

- Stack Testing Accreditation Council AETB Certificate No. 3796.02
- International Standard ISO/IEC 17025:2005 Certificate No. 3796.01

1.3 KEY PERSONNEL

Holcim (US) Inc. d/b/a Lafarge, SRN B1477:		
	Travis Weide (travis.weide@lafargeholcim.com)	989-358-3321
MDEQ:	Jeremy Howe	231-878-6687
Air Hygiene:	Cole McBride (cmcbride@airhygiene.com)	918-307-8865
Air Hygiene:	Matt McBride (mmcbride@airhygiene.com)	918-307-8865

2.0 SUMMARY OF TEST RESULTS

Results from the sampling conducted on Holcim (US) Inc. d/b/a Lafarge, SRN B1477's Kilns 19, 20, 21 and Wet Gas Scrubber located at the Alpena Plant on October 16-26, 2018 are summarized in the following tables and relate only to the items tested.

The results of all measured pollutant emissions were below the required limits. All testing was performed without any real or apparent errors. All testing was conducted according to the approved testing protocol.

TABLE 2.1
SUMMARY OF KILN, UNIT #19 RESULTS

Parameter	Run 1	Run 2	Run 3	Average
NOx (ppmvd)	45.17	12.32	135.67	64.4
SO_2 (ppmvd)	363.55	144.62	11.40	173.2
Filterable PM_{10} (mg)	3.58	4.22	5.45	4.42
Filterable PM_{10} (g/dscf)	3.89E-05	3.71E-05	5.22E-05	4.27E-05
Filterable PM_{10} (mg/dscm)	1.37	1.31	1.84	1.51
Filterable PM_{10} (gr/dscf)	6.01E-04	5.72E-04	8.06E-04	6.60E-04
Filterable PM_{10} (kg/hr)	0.21	0.21	0.28	0.23
Filterable PM_{10} (lb/hr)	0.46	0.47	0.61	0.51
Filterable PM_{10} (ton/year) at 8760 hr/year	2.00	2.05	2.68	2.24
Cadmium (mg)	1.80E-04	1.80E-04	1.80E-04	1.80E-04
Cadmium (g/dscf)	1.95E-09	1.58E-09	1.73E-09	1.75E-09
Cadmium (mg/dscm)	6.90E-05	5.59E-05	6.09E-05	6.19E-05
Cadmium (gr/dscf)	3.02E-08	2.44E-08	2.66E-08	2.71E-08
Cadmium (kg/hr)	1.04E-05	9.08E-06	9.16E-06	9.54E-06
Cadmium (lb/hr)	2.29E-05	2.00E-05	2.02E-05	2.10E-05
Cadmium (ton/year) at 8760 hr/year	1.00E-04	8.76E-05	8.84E-05	9.21E-05
Lead (mg)	2.00E-05	2.01E-03	0.00E+00	6.77E-04
Lead (g/dscf)	2.17E-10	1.77E-08	0.00E+00	5.96E-09
Lead (mg/dscm)	7.67E-06	6.24E-04	0.00E+00	2.11E-04
Lead (gr/dscf)	3.35E-09	2.73E-07	0.00E+00	9.20E-08
Lead (kg/hr)	1.15E-06	1.01E-04	0.00E+00	3.42E-05
Lead (lb/hr)	2.54E-06	2.23E-04	0.00E+00	7.53E-05
Lead (ton/year) at 8760 hr/year	1.11E-05	9.79E-04	0.00E+00	3.30E-04
Dioxins / Furans (mg) [TEF NATO]	3.73E-09	8.00E-10	3.73E-09	2.75E-09
Dioxins / Furans (g/dscf) [TEF NATO]	2.35E-14	5.43E-15	2.43E-14	1.77E-14
Dioxins / Furans (ngTEQ/dscm@7%O_2)	1.14E-03	2.64E-04	9.69E-04	8.15E-04
Dioxins / Furans (lb/hr) [TEF NATO]	4.37E-11	1.05E-11	4.35E-11	3.26E-11
Dioxins / Furans (mg) [total mass]	4.52E-07	2.47E-07	3.70E-07	3.56E-07
Dioxins / Furans (ng/dscm) [total mass]	1.01E-01	5.92E-02	8.51E-02	8.16E-02
Dioxins / Furans (ng/dscm@7%O_2)	1.38E-01	8.15E-02	9.61E-02	1.05E-01
Dioxins / Furans (lb/hr) [total mass]	5.30E-09	3.23E-09	4.32E-09	4.28E-09

TABLE 2.2
SUMMARY OF KILN, UNIT #20 RESULTS

Parameter	Run 1	Run 2	Run 3	Average
NOx (ppmvd)	396.89	511.96	402.51	437.1
SO_2 (ppmvd)	66.88	37.08	68.15	57.4
Filterable PM_{10} (mg)	7.95	1.29	2.18	3.81
Filterable PM_{10} (g/dscf)	8.48E-05	1.29E-05	2.31E-05	4.03E-05
Filterable PM_{10} (mg/dscm)	2.99	0.45	0.82	1.42
Filterable PM_{10} (gr/dscf)	1.31E-03	1.99E-04	3.57E-04	6.21E-04
Filterable PM_{10} (kg/hr)	0.35	0.06	0.10	0.17
Filterable PM_{10} (lb/hr)	0.78	0.13	0.22	0.37
Filterable PM_{10} (ton/year) at 8760 hr/year	3.40	0.55	0.95	1.64
Cadmium (mg)	4.50E-04	4.50E-04	1.80E-04	3.60E-04
Cadmium (g/dscf)	4.80E-09	4.48E-09	1.90E-09	3.73E-09
Cadmium (mg/dscm)	1.69E-04	1.58E-04	6.72E-05	1.32E-04
Cadmium (gr/dscf)	7.40E-08	6.92E-08	2.94E-08	5.75E-08
Cadmium (kg/hr)	1.99E-05	2.00E-05	8.12E-06	1.60E-05
Cadmium (lb/hr)	4.39E-05	4.40E-05	1.79E-05	3.53E-05
Cadmium (ton/year) at 8760 hr/year	1.92E-04	1.93E-04	7.84E-05	1.55E-04
Lead (mg)	1.05E-03	4.50E-04	0.00E+00	5.00E-04
Lead (g/dscf)	1.12E-08	4.48E-09	0.00E+00	5.23E-09
Lead (mg/dscm)	3.95E-04	1.58E-04	0.00E+00	1.85E-04
Lead (gr/dscf)	1.73E-07	6.92E-08	0.00E+00	8.06E-08
Lead (kg/hr)	4.65E-05	2.00E-05	0.00E+00	2.22E-05
Lead (lb/hr)	1.03E-04	4.40E-05	0.00E+00	4.89E-05
Lead (ton/year) at 8760 hr/year	4.49E-04	1.93E-04	0.00E+00	2.14E-04
Dioxins / Furans (mg) [TEF NATO]	1.50E-08	1.28E-08	4.08E-08	2.29E-08
Dioxins / Furans (g/dscf) [TEF NATO]	8.56E-14	8.61E-14	2.59E-13	1.44E-13
Dioxins / Furans (ngTEQ/dscm@7%O_2)	3.02E-03	3.15E-03	9.56E-03	5.25E-03
Dioxins / Furans (lb/hr) [TEF NATO]	9.32E-10	8.54E-10	2.62E-09	1.47E-09
Dioxins / Furans (mg) [total mass]	3.28E-07	3.96E-07	2.10E-06	9.41E-07
Dioxins / Furans (ng/dscm) [total mass]	6.59E-02	9.38E-02	4.70E-01	2.10E-01
Dioxins / Furans (ng/dscm@7%O_2)	6.59E-02	9.73E-02	4.92E-01	2.12E-01
Dioxins / Furans (lb/hr) [total mass]	2.03E-08	2.64E-08	1.35E-07	6.05E-08

TABLE 2.3
SUMMARY OF KILN, UNIT #21 RESULTS

Parameter	Run 1	Run 2	Run 3	Average
NOx (ppmvd)	132.44	95.59	147.29	125.1
SO_2 (ppmvd)	24.74	150.17	429.31	201.4
Filterable PM_{10} (mg)	15.92	28.48	10.15	18.18
Filterable PM_{10} (g/dscf)	1.47E-04	3.21E-04	8.63E-05	1.85E-04
Filterable PM_{10} (mg/dscm)	5.18	11.34	3.05	6.52
Filterable PM_{10} (gr/dscf)	2.26E-03	4.95E-03	1.33E-03	2.85E-03
Filterable PM_{10} (kg/hr)	0.71	1.54	0.46	0.90
Filterable PM_{10} (lb/hr)	1.57	3.40	1.01	1.99
Filterable PM_{10} (ton/year) at 8760 hr/year	6.89	14.90	4.42	8.73
Cadmium (mg)	5.40E-04	4.50E-04	4.50E-04	4.80E-04
Cadmium (g/dscf)	4.97E-09	5.07E-09	3.83E-09	4.62E-09
Cadmium (mg/dscm)	1.76E-04	1.79E-04	1.35E-04	1.63E-04
Cadmium (gr/dscf)	7.67E-08	7.83E-08	5.90E-08	7.13E-08
Cadmium (kg/hr)	2.42E-05	2.44E-05	2.03E-05	2.30E-05
Cadmium (lb/hr)	5.33E-05	5.37E-05	4.47E-05	5.06E-05
Cadmium (ton/year) at 8760 hr/year	2.34E-04	2.35E-04	1.96E-04	2.22E-04
Lead (mg)	1.25E-03	4.35E-03	1.05E-03	2.22E-03
Lead (g/dscf)	1.15E-08	4.90E-08	8.93E-09	2.32E-08
Lead (mg/dscm)	4.06E-04	1.73E-03	3.15E-04	8.18E-04
Lead (gr/dscf)	1.78E-07	7.57E-07	1.38E-07	3.57E-07
Lead (kg/hr)	5.60E-05	2.36E-04	4.73E-05	1.13E-04
Lead (lb/hr)	1.23E-04	5.19E-04	1.04E-04	2.49E-04
Lead (ton/year) at 8760 hr/year	5.41E-04	2.28E-03	4.57E-04	1.09E-03
Dioxins / Furans (mg) [TEF NATO]	5.33E-09	3.07E-09	3.63E-09	4.01E-09
Dioxins / Furans (g/dscf) [TEF NATO]	3.31E-14	1.98E-14	2.36E-14	2.55E-14
Dioxins / Furans (ngTEQ/dscm@7%O_2)	1.47E-03	8.22E-04	9.81E-04	1.09E-03
Dioxins / Furans (lb/hr) [TEF NATO]	4.35E-10	2.62E-10	3.02E-10	3.33E-10
Dioxins / Furans (mg) [total mass]	1.87E-07	2.06E-07	1.91E-07	1.94E-07
Dioxins / Furans (ng/dscm) [total mass]	4.10E-02	4.67E-02	4.38E-02	4.38E-02
Dioxins / Furans (ng/dscm@7%O_2)	5.14E-02	5.50E-02	5.15E-02	5.26E-02
Dioxins / Furans (lb/hr) [total mass]	1.52E-08	1.75E-08	1.59E-08	1.62E-08

TABLE 2.4

SUMMARY OF WET GAS SCRUBBER PM AND METALS RESULTS

Emission Rate Data	Run - 1	Run - 2	Run - 3	Average	Units
Filterable PM Mass	12.22	8.55	8.78	9.85	mg
Filterable PM Concentration	8.47E-05	6.15E-05	5.97E-05	6.86E-05	g/dscf
	2.99	2.17	2.11	2.42	mg/dscm
	1.31E-03	9.49E-04	9.21E-04	1.06E-03	gr/dscf
Filterable PM Emission Rate	2.12	1.43	1.47	1.67	kg/hr
	4.67	3.14	3.25	3.69	lb/hr
	20.44	13.77	14.23	16.14	tpy
Cadmium Mass	4.40E-04	1.80E-04	1.80E-04	2.67E-04	mg
Cadmium Concentration	3.05E-09	1.29E-09	1.22E-09	1.86E-09	g/dscf
	1.08E-04	4.57E-05	4.32E-05	6.55E-05	mg/dscm
	4.71E-08	2.00E-08	1.89E-08	2.86E-08	gr/dscf
Cadmium Emission Rate	7.62E-05	3.00E-05	3.02E-05	4.55E-05	kg/hr
	1.68E-04	6.61E-05	6.66E-05	1.00E-04	lb/hr
	7.36E-04	2.90E-04	2.92E-04	4.39E-04	tpy
Lead Mass	2.05E-03	0.00E+00	2.65E-03	1.57E-03	mg
Lead Concentration	1.42E-08	0.00E+00	1.80E-08	1.07E-08	g/dscf
	5.02E-04	0.00E+00	6.36E-04	3.79E-04	mg/dscm
	2.19E-07	0.00E+00	2.78E-07	1.66E-07	gr/dscf
Lead Emission Rate	3.55E-04	0.00E+00	4.44E-04	2.67E-04	kg/hr
	7.83E-04	0.00E+00	9.80E-04	5.88E-04	lb/hr
	3.43E-03	0.00E+00	4.29E-03	2.57E-03	tpy

3.0 SOURCE OPERATION

3.1 PROCESS DESCRIPTION

The Lafarge Cement facility is located in Alpena, MI. The Raw Mill System mixes and grinds the raw materials (limestone, sand, bauxite, Bell shale, gypsum) and alternate raw materials (slag, iron ore, fly ash, and CKD) then sends the materials to the kilns.

Lafarge operates five rotary kilns, which manufacture Portland cement clinker using the dry process. A mixture of pulverized bituminous coal and petroleum coke, with a heating value of approximately 11,750 Btu per pound, serves as the primary fuel fed to the kilns. Coal and coke are fed to a Raymond bowl mill and ground to a fineness of approximately 95% passing a 200-mesh sieve.

Kiln Group 5:

Kiln Group 5 at the Lafarge Alpena plant consists of three rotary kilns (#19, #20, and #21). Specific components of Kiln Group 5 are:

- Coal/petroleum coke and combustion air delivery;
- Raw mix preparation and delivery;
- Three rotary kilns;
- Kiln burners; and
- Air pollution control system, consisting of the following components:
  - Boiler;
  - Multiclone dust collectors;
  - Baghouses;
  - SNCR;
  - Induced draft (ID) fans; and
  - Exhaust stacks.

Allis Chalmers manufactured all kilns identified as #19, #20, and #21. Each kiln is 460.5 feet long. Each kiln shell has an inside diameter of 15 feet at the feed end and 13 feet at the firing end. The kilns in Kiln Group 5 rotate at speeds of greater than 40 revolutions per hour and are driven by an electric motor.

Dracco manufactured the baghouse for Kiln 19. The baghouse has two parallel sets of six chambers and a design airflow of 175,000 cubic feet per minute (cfm) at 400°F. The maximum operating temperature is 550°F. The baghouses for kilns 20 and 21, manufactured by Wheelbrator-Frye are identical in design and construction, with two parallel sets of six chambers. Each baghouse has a design air flow of 166,000 cfm at 400°F. The maximum operating temperature is 550°F.

3.2 SAMPLING LOCATION

KILN SAMPLING LOCATIONS:

The baghouse breeching ducts have been demonstrated as acceptable locations to conduct EPA reference method testing on all kilns. For each location the stack sampling location is in the breaching duct between each kiln's baghouse and discharge stack. Ductwork geometry is adequate for collecting a representative sample of gaseous constituents at this point. Further descriptions of all sampling locations for this test program are provided in Appendix B.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

The emission test on the Kilns 19, 20, 21 and Wet Gas Scrubber at the Alpena Plant was performed following United States Environmental Protection Agency (EPA) methods described by the Code of Federal Regulations (CFR). Table 4.1 outlines the specific methods performed on October 16-26, 2018.

TABLE 4.1
SUMMARY OF SAMPLING METHODS

Pollutant or Parameter	Sampling Method	Analysis Method
Sample Point Location	EPA Method 1	Equal Area Method
Stack Flow Rate	EPA Method 2	S-Type Pitot Tube
Oxygen	EPA Method 3A	Paramagnetic Cell
Carbon Dioxide	EPA Method 3A	Nondispersive Infrared Analyzer
Stack Moisture Content	EPA Method 4	Gravimetric Analysis
Particulate Matter	EPA Method 5	Front Half Filterables
Sulfur Dioxide	EPA Method 6C	Ultraviolet
Nitrogen Oxides	EPA Method 7E	Chemiluminescent Analyzer
Dioxins	EPA Method 23	Digestion
Metals	EPA Method 29	Digestion

4.2 INSTRUMENT CONFIGURATION AND OPERATIONS FOR GAS ANALYSIS

The sampling and analysis procedures used during these tests conform with the methods outlined in the Code of Federal Regulations (CFR), Title 40, Part 60, Appendix A, Methods 1, 2, 3A, 4, 5, 6C, 7E, 23, and 29.

Figure 4.1 depicts the sample system used for the real-time gas analyzer tests. The gas sample was continuously pulled through the probe and transported, via heat-traced Teflon® tubing, to a stainless steel minimum-contact condenser designed to dry the sample. Transportation of the sample, through Teflon® tubing, continued into the sample manifold within the mobile laboratory via a stainless steel/Teflon® diaphragm pump. From the manifold, the sample was partitioned to the real-time analyzers through rotameters that controlled the flow rate of the sample.

Figure 4.1 shows that the sample system was also equipped with a separate path through which a calibration gas could be delivered to the probe and back through the entire sampling system. This allowed for convenient performance of system bias checks as required by the testing methods.

All instruments were housed in an air-conditioned, trailer-mounted mobile laboratory. Gaseous calibration standards were provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 was used to determine the cylinder concentrations where applicable (i.e. NOx calibration gases).

Table 4.2 provides a description of the analyzers used for the instrument portion of the tests. All data from the continuous monitoring instruments were recorded on a Logic Beach Portable Data Logging System which retrieves calibrated electronic data from each instrument every one second and reports an average of the collected data every 30 seconds.

Figure 4.2 represents the sample system used for the wet chemistry tests (PM, dioxins, metals, H_2O, flow, etc.). A heated stainless steel probe with a glass liner and nozzle was inserted into the sample ports of the stack to extract

gas measurements from the emission stream through a filter and glass impinger train. Flow rates are monitored with oil filled manometers and total sample volumes are measured with a dry gas meter.

The stack gas analysis for O_2 and CO_2 concentrations was performed in accordance with procedures set forth in EPA Method 3A. The O_2 analyzer uses a paramagnetic cell detector and the CO_2 analyzer uses a continuous nondispersive infrared analyzer.

EPA Method 6C was used to determine the concentrations of SO_2. An ultraviolet analyzer was used to determine the sulfur dioxide concentrations in the gas stream.

EPA Method 7E was used to determine concentrations of NOx. A chemiluminescent analyzer was used to determine the nitrogen oxides concentration in the gas stream. A NO_2 in nitrogen certified gas cylinder was used to verify at least a 90 percent NO_2 conversion on the day of the test.

TABLE 4.2
ANALYTICAL INSTRUMENTATION

Parameter	Manufacturer and Model	Range	Sensitivity	Detection Principle
NOx	THERMO 42 series	User may select up to 5,000 ppm	0.1 ppm	Thermal reduction of NO_2 to NO. Chemiluminescence of reaction of NO with O_3. Detection by PMT. Inherently linear for listed ranges.
SO_2	AMETEK 721M	User may select up to 10,000 ppm	0.1 ppm	Ultraviolet
CO_2	SERVOMEX 1440	0-20%	0.1%	Nondispersive infrared
O_2	SERVOMEX 1440	0-25%	0.1%	Paramagnetic cell, inherently linear.

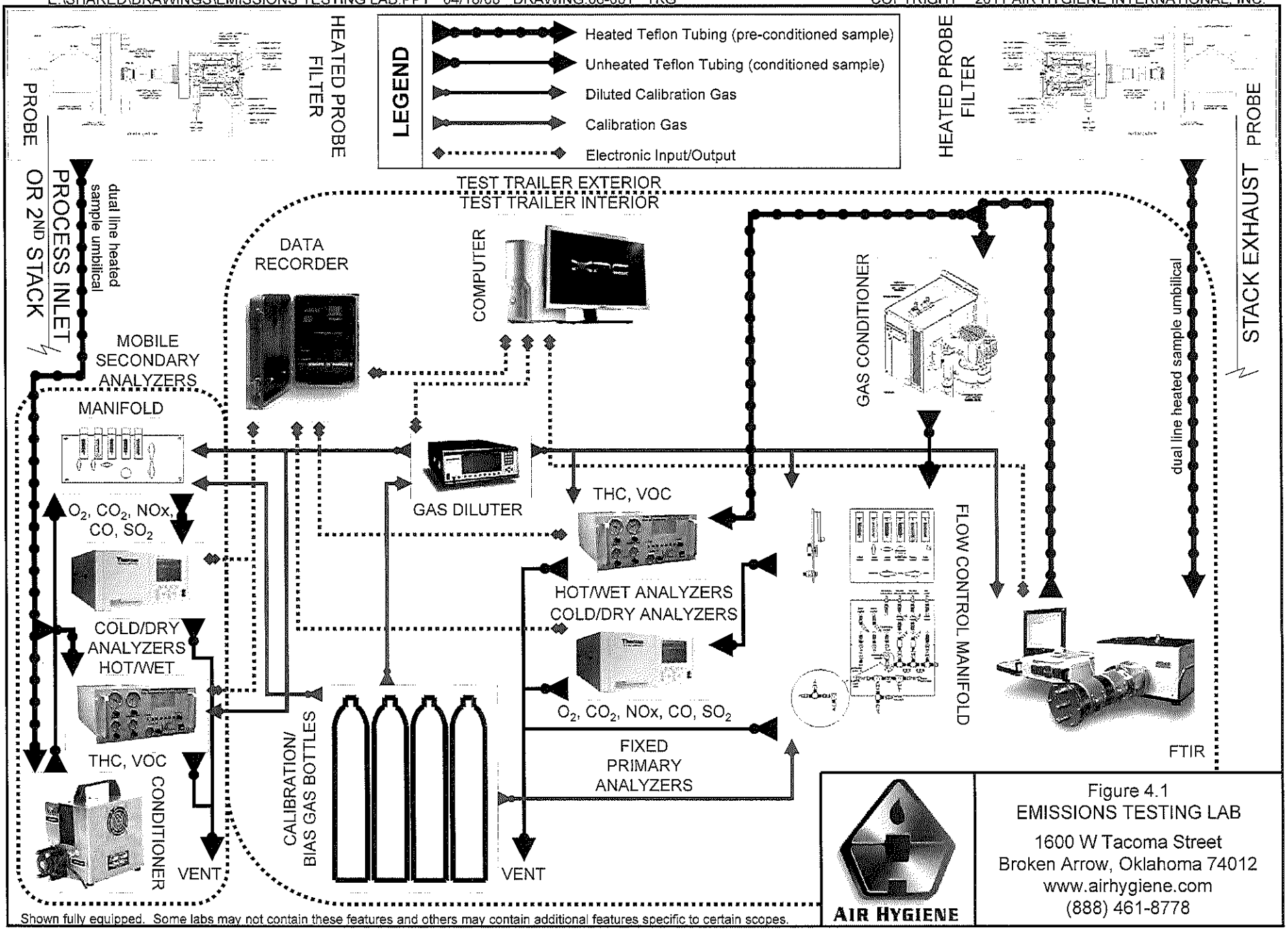
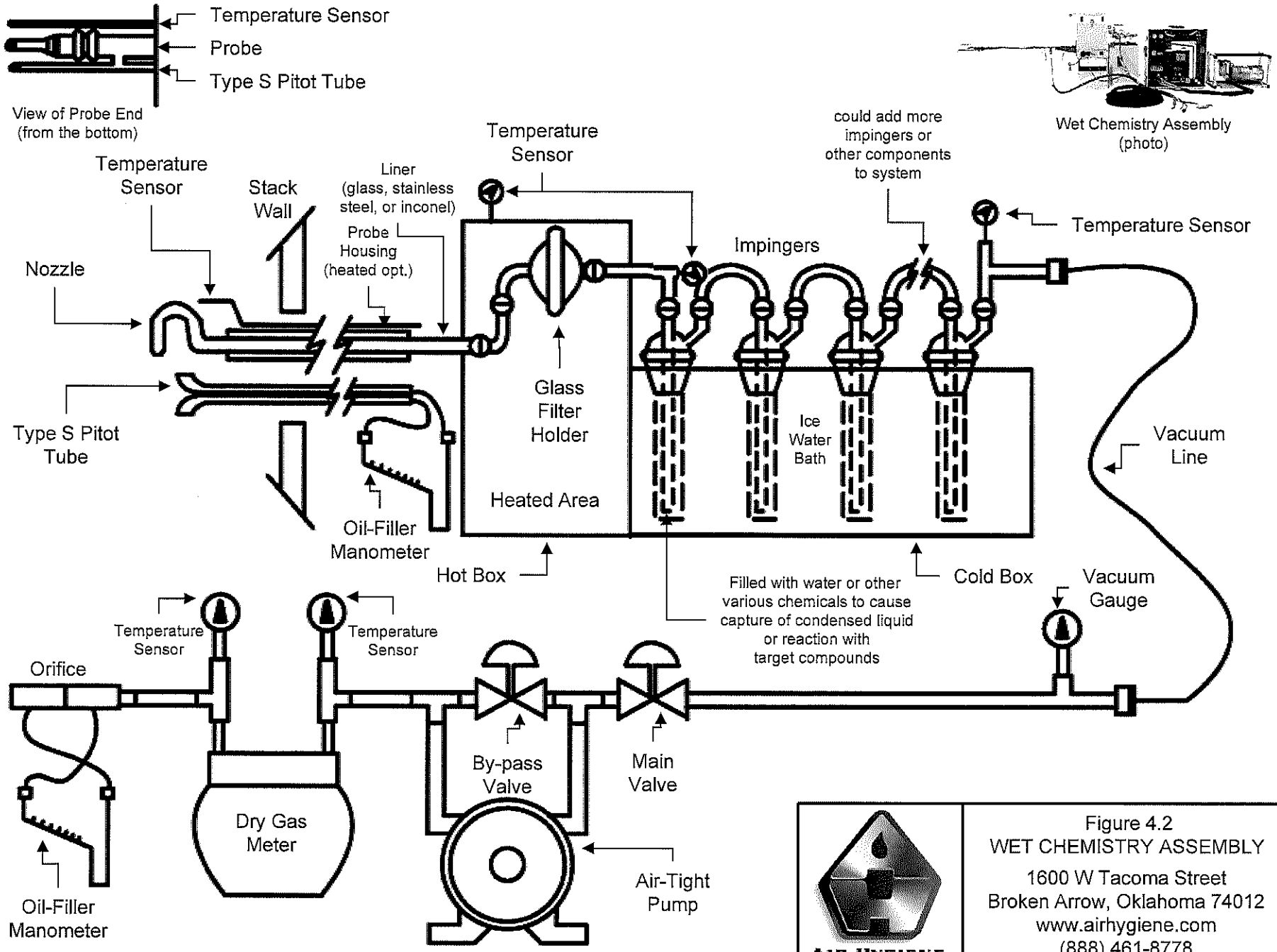


Figure 4.1
EMISSIONS TESTING LAB

1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
www.airhygiene.com
(888) 461-8778



AIR HYGIENE

Figure 4.2
WET CHEMISTRY ASSEMBLY

1600 W Tacoma Street
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(888) 461-8778