STACK EMISSIONS STUDY
FOR THE
CLINKER COOLER 22 AND WET GAS SCRUBBER
PREPARED FOR
HOLCIM (US) INC. D/B/A LAFARGE, SRN B1477
AT THE
ALPENA PLANT
ALPENA, MICHIGAN
DECEMBER 12-14, 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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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), and dioxins from the exhaust of the Clinker Cooler 22 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 December 12-14, 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, and dioxins from the exhaust of Holcim (US) Inc. d/b/a Lafarge, SRN B1477's Clinker Cooler 22 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
- Clinker Cooler 22 and Wet Gas Scrubber

1.2.6 Emission Points

- Exhaust from the Clinker Cooler 22 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 Clinker Cooler 22 and Wet Gas Scrubber

1.2.7 Emission Parameters Measured

- NOx
- SO_2
- Flow
- O_2
- CO_2
- H_2O
- PM
- Dioxins

1.2.8 Dates of Emission Test

- December 12-14, 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:	Michael Stockwell (mstockwell@airhygiene.com)	918-307-8865
Air Hygiene:	James Reynolds	918-307-8865
Air Hygiene:	Axel Martinez	918-307-8865
Air Hygiene:	Zach Van Ness	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 Clinker Cooler 22 and Wet Gas Scrubber located at the Alpena Plant on December 12-14, 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 2.3 represents the Clinker Cooler PM-CPMS Operating limits. The clinker coolers must comply with PC MACT Regulation 40 CFR 63, Subpart LLL. The PM-CPMS Operating Limit was calculated using the following equations.

$$Ol = z+((0.75*L)/R)$$

Ol = Operating limit for PM CPMS on a 30 day rolling average (mA)

L = Source emission limit (lb/ton clinker)

z = instrument zero (mA)

R = Relative lb/ton clinker per mA

$R=Y_1 /(X_1 - z)$

Y_1 = three run avg lb/ton clinker Pm conc.

X_1 = three run avg mA

Z = instrument zero (mA)

TABLE 2.1
CLINKER COOLER 22 DATA SUMMARY

Parameter	Run 1	Run 2	Run 3	Average
Total PM_{10} (mg)	7.38	6.28	13.97	9.21
Total PM_{10} (g/dscf)	1.08E-04	9.74E-05	2.15E-04	1.40E-04
Total PM_{10} (gr/dscf)	1.67E-03	1.50E-03	3.31E-03	2.16E-03
Total PM_{10} (kg/hr)	0.37	0.33	0.73	0.48
Total PM_{10} (lb/hr)	0.81	0.73	1.61	1.05
Total PM_{10} (ton/year) at 8760 hr/year	3.53	3.21	7.04	4.59
Total PM_{10} (lb/ton)	0.012	0.011	0.024	0.016

TABLE 2.2
SUMMARY OF WET GAS SCRUBBER RESULTS

Parameter	Run 1	Run 2	Run 3	Average
NOx (ppmvd)	451.80	314.07	301.17	382.9
SO_2 (ppmvd)	25.49	60.05	135.74	42.8
Dioxins / Furans (mg) [TEF NATO]	1.20E-09	5.40E-10	4.45E-09	8.70E-10
Dioxins / Furans (g/dscf) [TEF NATO]	8.34E-15	3.68E-15	3.07E-14	6.01E-15
Dioxins / Furans (ngTEQ/dscm@7%O_2)	3.39E-04	1.44E-04	1.23E-03	2.42E-04
Dioxins / Furans (lb/hr) [TEF NATO]	2.58E-10	1.16E-10	9.76E-10	1.87E-10
Dioxins / Furans (mg) [total mass]	1.73E-07	1.32E-07	3.87E-07	1.53E-07
Dioxins / Furans (ng/dscm) [total mass]	4.25E-02	3.18E-02	9.41E-02	3.71E-02
Dioxins / Furans (ng/dscm@7%O_2)	4.90E-02	3.53E-02	1.07E-01	4.22E-02
Dioxins / Furans (lb/hr) [total mass]	3.73E-08	2.84E-08	8.48E-08	3.28E-08

TABLE 2.3
CLINKER COOLER PM-CPMS

Unit	PM Emissions (lb/ton)	PM Limit (lb/ton clinker)	PM-CPMS (mA)	PM-CPMS Operating Limit (mA)
CC 22	0.016	0.07	4.16	4.55

Note: z = 4.00 mA

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 6:

Kiln Group 6 at the Lafarge Alpena plant consists of two rotary kilns (#22 and #23). Specific components of Kiln Group 6 are:

- Coal/petroleum coke and combustion air delivery;
- Raw mix preparation and delivery;
- Two rotary kilns;
- Kiln burners; and
- Air pollution control system, consisting of the following components:
  - Boiler;
  - SNCR (mid-kiln);
  - Multiclone dust collectors;
  - Baghouses;
  - Induced draft (ID) fans; and
  - Wet gas Scrubber (WGS);
  - Common exhaust stack.

The pulverized coal/coke is pneumatically conveyed by heated air, recycled from the clinker cooler, through the outer ring of a concentric burner torch. Both rotary kilns in KilnGroup 6 were manufactured by Fuller Co. and are identical in design and operation. The kilns are 500 feet long and have a 19.5-foot outer diameter. The kilns are lined with high-temperature refractory brick. The kiln design is based on a throughput of 4.8 million Btu per ton of clinker. An induced draft fan pulls combustion gases from each kiln. After exiting the kiln, the gases pass through a set of multicyclones and then enter a fabric filter baghouse. After exiting the baghouse, the gases are routed through a breeching duct that connects the baghouse to a common reinforced concrete stack and exhaust to a wet FDG (scrubber).

The kilns rotate at a rate up to 80 revolutions per hour using two 350-hp motors. The kilns' associated air pollution control systems (APCS) are identical to one another in all aspects of design, operation, and maintenance. The

APCS for Kilns 22 and 23 are identical ten-compartment baghouses. Each baghouse, manufactured by Wheelbrator-Frye, consists of two parallel sets of five chambers and has design airflow of 285,000 cfm at 400°F. Figure 2-2 provides a process flow diagram of Kiln Group 6.

Kiln Process Instrumentation:

Instruments used to monitor kiln operating parameters are located throughout the kiln system. Parameters that will be recorded during testing are the baghouse inlet temperature, production rate, and baghouse change in pressure (delta P). Each kiln system is equipped with a differential pressure indicator system, with measurement points located in the duct prior to and exiting the baghouse. The differential pressure devices are used to monitor the pressure drop across the baghouse.

Clinker Coolers:

A Clinker Cooler cools the clinker, reclaims the hot air for return to the kilns, and moves clinker to FG CLINKER SYS. As the clinker is conveyed toward the clinker storage building, the recovered heat from Clinker Cooler (92) and (93) is re-circulated back to Kiln Group 5 (KG 5), the recovered heat from Clinker Cooler 22 is re-circulated back to Kiln 22, and the recovered heat from Clinker Cooler 23 is re-circulated back to Kiln 23. Figure 2-1 portrays the location of the clinker coolers within the process line.

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.

CLINKER COOLER SAMPLING LOCATIONS:

The existing test ports from both KG5 and KG6 clinker coolers will be used to measure manual PM with EPA Method 5 during the annual re-certification test period. A total of 3 EPA Method 5 test runs with full particulate traverses will be conducted on each of the four clinker coolers. The signal output (mA) from each PCMS (PM monitor) will be recorded every minute during the corresponding Method 5 test runs from PM monitor from the Lafarge DHAS system. The average signal output will be used to confirm the value established for the CPMS per the PC MACT regulation.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

The emission test on the Clinker Cooler 22 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 December 12-14, 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

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, and 23.

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, 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.

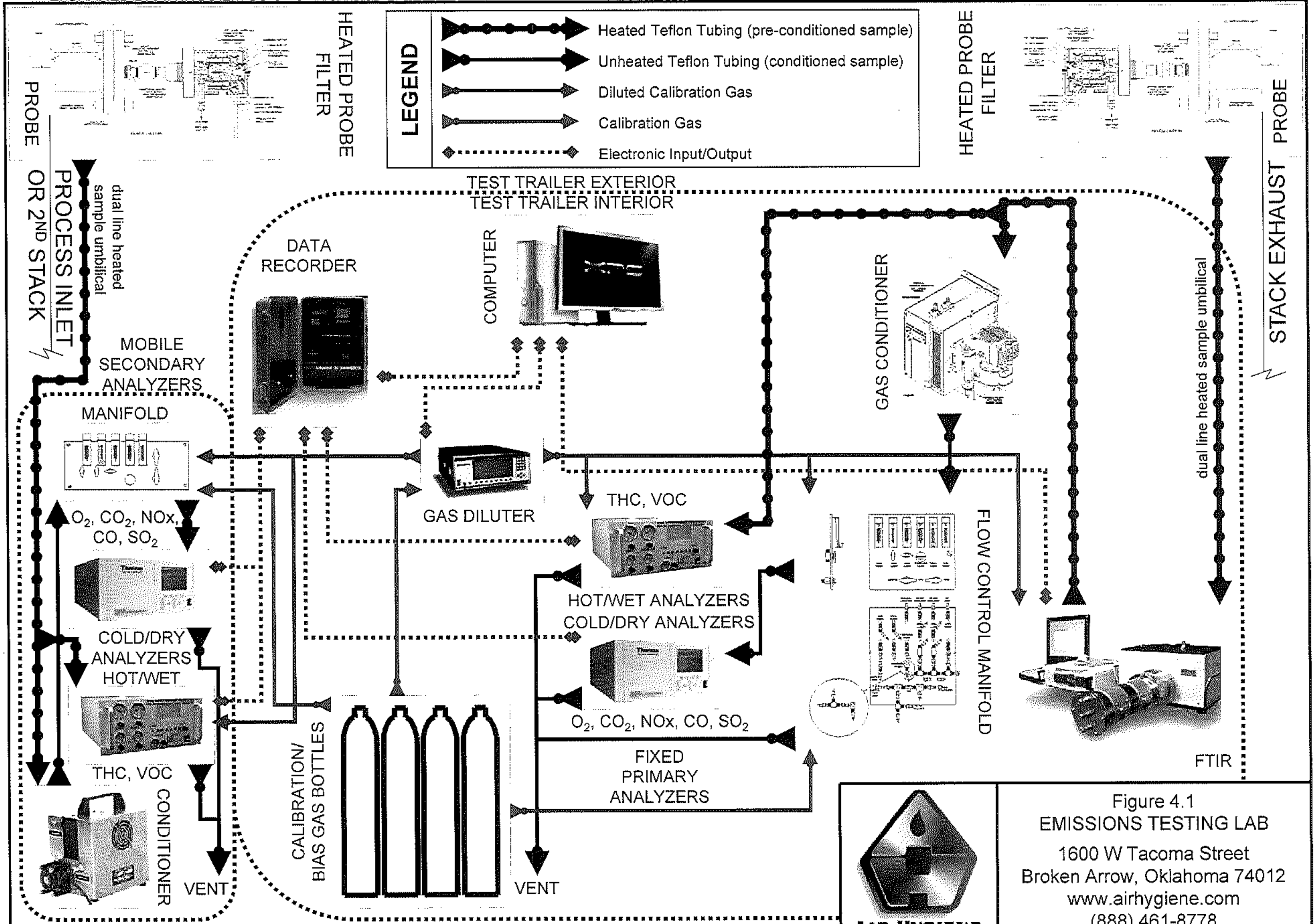

Figure 4.1
EMISSIONS TESTING LAB

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Broken Arrow, Oklahoma 74012
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(888) 461-8778

Shown fully equipped. Some labs may not contain these features and others may contain additional features specific to certain scopes.

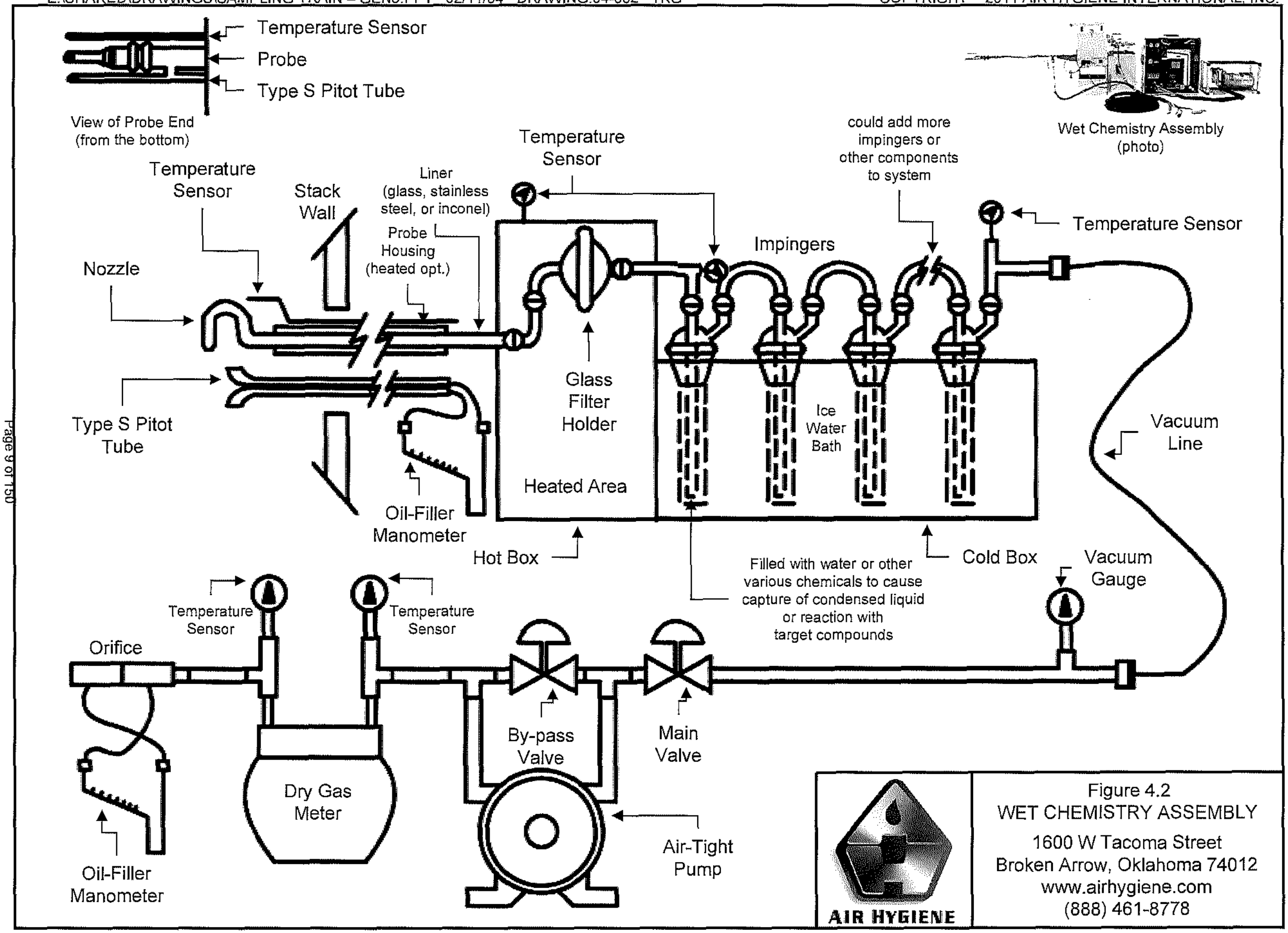

Figure 4.2
WET CHEMISTRY ASSEMBLY

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