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St Marys Cement

Air Quality Test Report

SMC-15-100

CERMS RATA Testing Services for:

St. Marys Cment
Charlevoix, MI

Main and Bypass Stacks

Tested Sept. 16th-18th, 2015

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EXECUTIVE SUMMARY

On September 16th, 17th and 18th, 2015, AccuAir, LLC (AccuAir) was at St. Mary's Cement (St. Marys) to perform air testing at their facility located in Charlevoix, Michigan. AccuAir was contracted to perform relative accuracy test audits (RATAs) on two Continuous Emission Rate Monitoring Systems (CERMS) on the Main and Bypass stacks. The constituents tested for were; sulfur dioxide (SO2) and oxides of nitrogen (NOx), oxygen (O2) and carbon dioxide (CO2) for molecular weight. The test was conducted in accordance with all appropriate United States Environmental Protection Agency (USEPA) Methodologies as well as the requirements outlined in the Michigan Department of Environmental Quality (MDEQ) Permit for the facility.

The purpose of these tests was to provide RATA results for demonstrating compliance of the CERMS with the applicable regulations, 40 CFR 60 Appendix B, Performance Specifications 2, 3 and 6. See Table 1-1 below for a list of St. Marys CERMS equipment.

Source	CEMS	Make	Model	Serial No.	Range
Bypass Stack	NO_x	ABB	Limas	400004743706	0-1,000 ppm
	SO_2	ABB	Limas	400004743706	0-1,000 ppm
	CO	ABB	URAS	400004701606	0-2,000 ppm
	O_2 - Wet	Thermox	2000	C131530B	0-25%
	O_2 - Dry	ABB	Magnos	400004747706	0-25%
	CO_2	ABB	URAS 26	01400300661307G	0-30%
Main Stack	NO_x	ABB	Limas	400004745306	0-1,000 ppm
	SO_2	ABB	Limas	400004745806	0-1,000 ppm
	CO	ABB	URAS	400004697806	0-3,000 ppm
	O_2 - Wet	Thermox	2000	C131530A	0-25%
	O_2 - Dry	ABB	Magnos	400004731606	0-25%
	CO_2	ABB	URAS 26	01400300662707G	0-30%

Table 1-1. St. Marys CERMS Analyzers

The Relative Accuracy (RA) for each compound was based on data calculated from nine (9) twenty-one (21) minute test runs. A total of ten (10) runs were performed on each source, with the results of the run with the highest deviation being discarded.

The calculated RA results for each component and each source are presented in Table 1-2.

Source	Test Date	Compound	Average RM	Average Source	Allowable	Calculated RA	Alternate RA	Pass
Main Stack	**9/16/2015**	SO2 lbs/hr	702.5	582.4	10% App. Std.	23.67	5.94	YES
		NOx lbs/hr	554.3	481.7	20% RM	17.81	N/A	YES
Bypass Stack	**9/17-18/2015**	SO2 ppm	.4	3.1	5 ppm	793.16	2.8	YES
		NOx lbs/hr	20.4	22.1	20% RM	12	N/A	YES
		Flow	60814	55211	20% RM	11.03	N/A	YES

Table 1-2. RATA and Analysis Results vs. Allowable

The allowable alternative RA is 10% of the applicable standard for NOx and SO2. The applicable standard for NOx is 6.5 lbs/ton and 2800 lbs/hr for SO2. Due to low SO2 concentrations on the Bypass Stack, an absolute mean difference of no more than 5 ppm was used with the previous approval of the onsite state auditor and modeled after PS4A.

Based on the results shown in this report, both the Main and Bypass CERMS are operating within the limits applicable.

INTRODUCTION

Purpose of Test

The objective of the program was to demonstrate compliance of the sources according to the requirements of the facility's Permit NO. **MI-ROP-B1559-2014**. The sources were tested to determine the specific pollutants outlined in this report. Mr. Geoff Resney was the onsite project manager, and was assisted by Mr. Mark Carlson and Nathan Fitterer. Mr. Cortney Schmidt of St. Mary's coordinated the test and Mr. David Patterson observed the testing for MDEQ.

For this test program, gas concentrations were measured with reference method (RM) analyzers. The concentrations of each gas were measured on a dry basis and the emissions rates were calculated in pounds per hour using the measured airflow.

Relative Accuracy Test Audit (RATA)

During the RATA performance tests, the exhaust gas stream was analyzed for the targeted pollutant and diluent gas concentrations. This sampling was conducted according to USEPA Reference Methods 3A, 6C, and 7E, for determination of O_2, CO_2, SO_2, and NO_x, respectively. These methods utilize instrument analysis to determine the gaseous concentrations for the required constituents within the stack. The reference methods are discussed in greater detail in the Performance Test Procedures section of this report.

The RATA testing consisted of drawing a representative sample of the exhaust gas stream into a conditioning system for removal of moisture. The sample was then allowed to pass into a set of reference method (RM) analyzers, where the concentrations of the targeted pollutant and diluent gas concentrations were measured. These instantaneous readings were compiled in a data acquisition system (DAS) data based on a one-minute-average basis for comparison to the CERMS data. Reference methods employed for each of the targeted gases are described in the Performance Test Procedures section of this report.

The CERMS provides a record of the pollutant and diluent gas concentration and emission rate data from the subject flue gas stream. These data were subsequently compared to the RM data for determination of the relative accuracy (RA) of the CERM system. The RA calculations are discussed in greater detail in the Sample Calculations section of this report.

Problems, Deviations and/or Exceptions

SO2 concentration on the Bypass Stack was very low. The low concentrations made standard RA calculations irrelevant and the applicable limit doesn't fit Bypass emissions well. Therefore, under instruction and from Mr. Gasloli of MDEQ and with precedence from previous testing, the absolute mean difference in ppm was used for compliance of the SO2 monitor. For this reason a flow RA was included in the Bypass Stack results to demonstrate overall system compliance.

Note that the bypass RATA was not started until early evening on the 17th because of plant operational issues. Also note, that due to hazardous weather, the bypass RATA had to be paused for the evening and resumed on the 18th at Run 4 the following morning. Calibration Error tests were repeated as required by the method.

PERFORMANCE TEST PROCEDURES

USEPA Reference Methods

This section provides a detailed description of the individual USEPA Reference Methods employed in this test (40 CFR 60, Appendix A). Schematics of the various sampling systems used to perform the test program on the sources can be found in Figures 1-1 and 1-2. Specifics for the test equipment utilized in this program are presented in Appendix A.

USEPA Method 1: Sample and Velocity Traverses for Stationary Sources

Sampling traverse points were determined based on the ratio of the stack diameter to the upstream and downstream distances of the sampling plane to the closest disturbances. The minimum number of traverse points on the sampling plane is determined from Figure 1-2 and Table 1-2 of 40CFR60, Appendix A, Method 1.

USEPA Method 2: Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

Velocity and volumetric flow rates were determined from the measurement of the stack gas velocity head with a Type-S Pitot tube and inclined manometer. The Pitot tube was constructed per USEPA Method 2 design specifications. Based on the face opening alignments, external tubing diameter, and base-to-opening plane distances, a coefficient value of 0.84 was assigned to the Pitot tube.

USEPA Method 3A: Gas Analysis for the determination of Oxygen and Carbon Dioxide

This method was employed to determine the concentrations of O_2 and CO_2 in the flue gas stream with the use of analytical instruments. A sample was continuously extracted from the stack and introduced to a RM analyzer for determination of concentration. The minimum detection limit for this instrument is one-hundredth of one percent (0.01%). The instrument is connected to a DAS computer via an analog-to-digital converter for recording resulting values, and the data was recorded in one-minute averages. and USEPA Protocol-1 calibration standards were used to calibrate the analytical instrument. The general guidelines for the calibration of a RM analyzer are described above, with the specifics pertaining to the calibration of an O_2 and CO_2 analyzer being set forth in USEPA Method 3A (40 CFR Part 60, Appendix A).

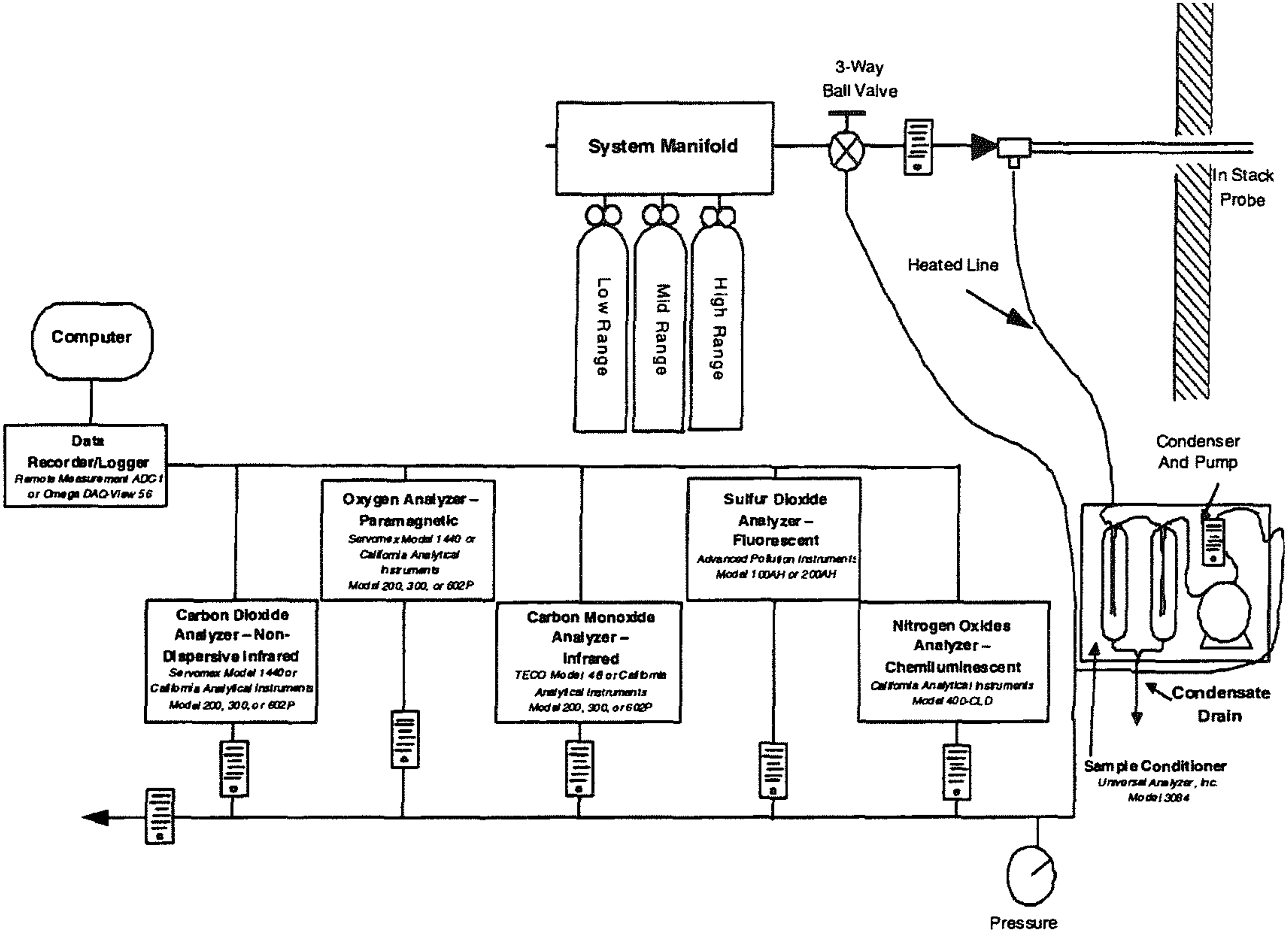


Figure 1-1. Sampling System Schematic

USEPA Method 4: Determination of Moisture Content

The stack gas moisture content was determined in accordance with USEPA Method 4 as shown in Figure 1-2. Specifically, stack gas was extracted at a constant rate through a glass condenser train consisting of four impingers connected in series with leak free, glass U-tube connections. The extracted stack gas sample temperature was maintained at a temperature below 68°F by use of an ice bath surrounding the glass impingers. The gas sample was extracted through the impinger train using a rotary vane vacuum pump, and the amount of gas sampled was measured with a calibrated dry gas meter. The pump flow was adjusted to maintain flow rate through the dry gas meter in order to obtain at least 21.0 dry, standard cubic feet (dscf) of sample gas during the test run. At the end of each run, the pump was turned off and the final readings were recorded. The amount of moisture in the gas stream was determined by measuring the volume of condensed moisture in impingers one through three and weighing the silica gel impinger to calculate percent moisture in the stack flue gas stream.

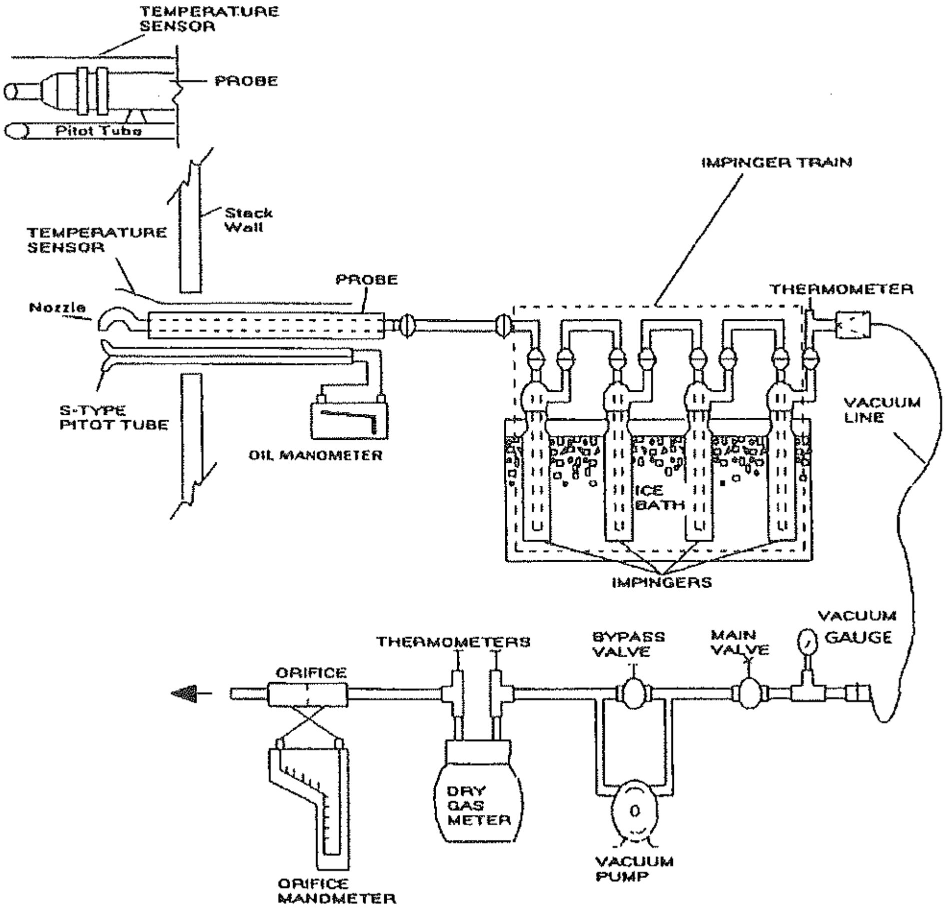


Figure 1-2. USEPA Method 4 Sampling Train

USEPA Method 6C: Sulfur Dioxide Analysis (Instrumental Procedure)

USEPA Method 6C was performed to quantify emissions of sulfur dioxide (SO_2) using an ultraviolet (UV) analyzer. SO_2 concentrations were recorded in dry parts per million (ppmvd) at least once per minute using a data acquisition system and averaged. Prior to testing, a calibration error check was performed using low, mid, and high-range calibration gases. Before and after each test run, a system calibration bias and drift test was performed to check the drift of the analyzer and biases correct the data.

USEPA Method 7E: Nitrogen Oxides - Instrumental Method

This method was employed to determine the concentration of total NO_x present in the exhaust gas stream. A gas sample was continuously extracted from the stack, and a portion of the sample was introduced to a RM analyzer for analysis.

A NO_2 to NO converter efficiency test was performed utilizing the Tedlar Bag Procedure (Section 16.2.2 of Method 7E). The converter test applicable to this test program is provided in Appendix C.

The instrument is connected to a DAS computer via an analog-to-digital converter for recording the resulting values, and the concentration in dry parts per million were recorded in one-minute averages. USEPA Protocol-1 calibration standards were used to calibrate the analytical instrument. The general guidelines for the calibration of a RM analyzer are described above, with the specifics pertaining to the calibration of a NO_x analyzer being set forth in USEPA Method 7E (40 CFR 60, Appendix A).

The analyzers used to perform this compliance test have been in use prior to 2006. Based on a presentation by Mr. Foston Curtis with the USEPA, the analyzers are "grandfathered", and are not required to comply with the current full requirements of the interference checks. An interference check was conducted by the manufacturer and can be provided upon request.

Instrumental Analyzer Procedure

Stack gas concentrations of O_2, CO_2, SO_2, NO_x, and CO from the sources were measured with RM analyzers. These tests were performed in accordance with the applicable regulations, as outlined in Title 40, Part 60, Appendix A of the Code of Federal Regulations. All field data collected during the testing and photocopies of the actual O_2, CO_2, SO_2, NO_x, and CO one-minute averaging are provided in this report.

Sampling System

A gas sample was continuously extracted from the source with a Teflon® probe and channeled through a heated sample line to a gas sample conditioner. The entire sample extraction and delivery system was maintained at a temperature above 225°F to the point the sample enters the sample conditioner. The sample conditioner was employed to decrease the dewpoint of the combustion gases to a repeatable, stable, low dew point. Condensed moisture was continuously removed from the sample conditioner by peristaltic pump and drained. The conditioned gas then traveled through a network of ¼-inch Teflon® tubing to a manifold in the mobile laboratory. From the manifold, the sample was directed to a set of rotometers, where the flow of the sample gas into the analyzers was maintained at approximately 1 liter per minute (L/min).

Analyzer Calibration

The calibration of the instruments was performed using Protocol certified gas standards composed of a known concentration of the given component in zero-grade nitrogen. A copy of the certification standards for each of the certified calibration standards used during the testing is included in Subpart A of each Appendix. All of the values obtained during the calibration process, including analyzer calibration, system bias analysis, and drift values, can be found in Subpart A of each Appendix of this report. The analyzer calibration procedures are identical, regardless of the constituent being evaluated by each analyzer. The range used for each analyzer was determined based on the expected concentration levels of the flue gas stream.

The first step in the analyzer calibration was to set the zero point on the analyzer using zero-grade nitrogen. The nitrogen from an opposing span gas is introduced directly to the back of each analyzer, and the zero potentiometer on the analyzer is adjusted until the proper output from the analyzer is realized. Next, a high-range calibration gas is introduced to each analyzer, with a concentration within the appropriate range of the instrument. The span potentiometer on each analyzer is then adjusted until the output from the analyzer corresponds to the value of the calibration standard. Finally, a mid-range calibration standard with a concentration approximately one-half of the high-range calibration standard is used to determine the linearity of the analyzer within the given range. For certain constituents, more than one mid-range value is required. The specific requirements for each constituent are discussed later in this section.

Analyzer Calibration Error

The Analyzer Calibration Error (ACE) is the difference between the gas concentration exhibited by the gas analyzer and the concentration of the calibration gas when introduced directly to the analyzer. The maximum allowable variance for the zero, mid-range, and high-range calibration gases is ± 2% of the calibration span. The calibration values and corresponding percent errors associated with this project can be found in Subpart A of each Appendix of this report, and is determined by the following equation.

$$ACE = \left(\frac{Analyzer\,Response - Cylinder\,Value}{Calibration\,Span}\right)x100$$

System Bias Check

Following the analyzer calibration procedure, a second test is required to determine the amount of bias the sampling system has on the calibration standard concentrations. In this procedure, the same calibration standards that were used to perform the analyzer calibration error test are introduced to the sampling system via a separate network of ¼-inch Teflon® tubing. The calibration gases are allowed to flood the system via a "t" connection at the end of the sample probe at a rate of approximately 2 L/min higher than the sample rate. The excess calibration gas flows out the tip of the probe, preventing stack gas from being drawn into the sampling system during calibrations. The gas is then drawn back through the system by the conditioning pumps, and is introduced to the analyzers. The output from the analyzers is recorded, without adjusting the zero or span potentiometers. The bias created by the sampling system is then determined by the following equation.

$$Bias = \left(\frac{System\,Response - Calibration\,Error\,Response}{Calibration\,Span}\right)x100$$

The maximum allowable system bias for any one analyzer is ±5% of the corresponding span value. The values determined for this portion of the calibration procedure can be found in Appendix C of this report.

Analyzer Drift

Utilizing the data obtained during the post-test bias check, a third test is performed to determine the amount of drift experienced during the test run. The analyzer response from the post-test system bias check is compared to the pre-test response for the same calibration standard for drift determinations. If the drift value is greater than the allowable value, the test run is considered invalid and the analyzers must be re-calibrated before continuing the test. The drift for each constituent is determined using the equation below.

$$Drift = \left(\frac{\left|Final\,System\,Calibration\,Response - Initial\,System\,Calibration\,Response\right|}{Calibration\,Span}\right)x100$$

The maximum allowable calibration drift for any one analyzer is 3% of the span over the period of each run. The values determined for this portion of the calibration procedure can be found in Appendix C of this report.

Response Time

System response times for each analyzer were determined during the initial pretest bias prior to run number 1. The response time is determined by the length of time it takes the analyzer response to be within 95% or 0.5 ppm (whichever is less restrictive) of the certified gas concentration. The start of each run was a minimum of twice the response time following the completion of calibration checks.

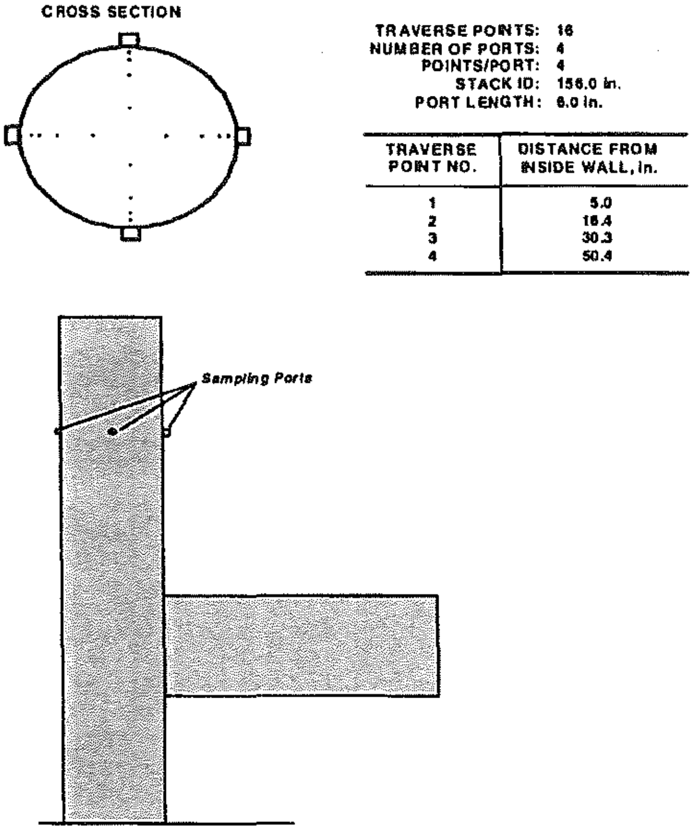
SOURCE INFORMATION

St. Marys currently owns and operates a limestone quarry and Portland cement manufacturing facility in Charlevoix, Michigan. The St. Marys facility is considered a dry cement manufacturing process.

The typical Portland cement raw materials used at the facility include limestone, shale, sand, and iron, containing materials; the fuels consumed during the test consisted entirely of coal. Small amounts of additional cement raw materials are utilized as necessary to produce the desired cement characteristics.

The raw materials are converted to Portland cement through both pyro-processing and mechanical processing techniques. These processes take place in the kiln and raw mill areas of the facility. The raw materials are dried by being fed countercurrent to hot exhaust gasses that are exiting the kiln and flash furnace. This type of kiln and raw mill configuration is referred to as an in-line kiln/raw mill. After leaving the kiln and raw mill area, the materials are in the form of Portland cement clinker. The clinker is mixed with additional constituents and further processed into Portland cement.

Figure 1-3 presents the sampling location on the Bypass Stack. The location on the 156.0-inch ID stack, consisted of four (4) sampling ports.

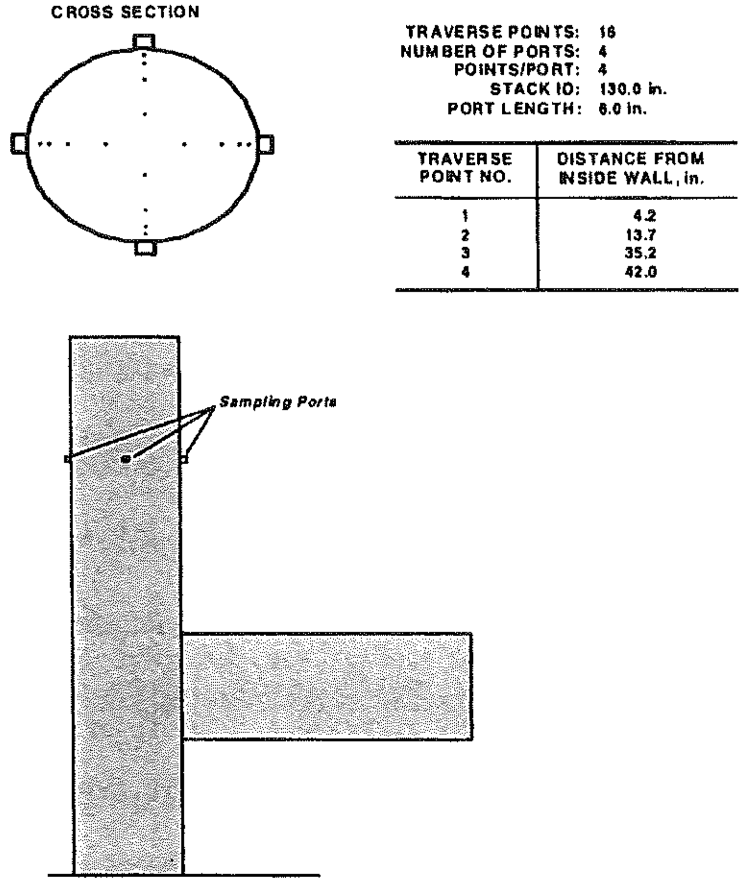


TRAVERSE POINTS: 16
NUMBER OF PORTS: 4
POINTS/PORT: 4
STACK ID: 156.0 in.
PORT LENGTH: 6.0 in.

TRAVERSE POINT NO.	DISTANCE FROM INSIDE WALL, in.
1	5.0
2	16.4
3	30.3
4	50.4

Figure 1-3. Diagram of Testing Location for the Bypass Stack

Figure 1-4 presents the sampling location on the Main Stack. The location on the 130.0-inch ID stack, consisted of four (4) sampling ports.



TRAVERSE POINTS: 16
NUMBER OF PORTS: 4
POINTS/PORT: 4
STACK ID: 130.0 in.
PORT LENGTH: 6.0 in.

TRAVERSE POINT NO.	DISTANCE FROM INSIDE WALL, in.
1	4.2
2	13.7
3	35.2
4	42.0

Figure 1-4. Diagram of Testing Location for the Main Stack