FPM & H_2SO_4 on the Trimer Control System

at Guardian Industries Corp. 14600 Romine Rd Carleton, MI 48117

Test Dates: July 13th, 2017

Project 17-272

Prepared by:
Empire Stack Testing, LLC. (AETB)
1090 Cain Road
Angola, New York 14006

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Michael T. Karter, QSTI (V)
General Manager
August 18, 2017

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Table 1-1: FPM Results Summary

Site	Date	Run	Stack Parameters					
			O_2	CO_2	Moisture	Temperature	Flow Rate	
			(%)	(%)	(%)	(F)	(ACFM)	(DSCFM)
RM 05 Outlet	7/13/2017	1	11.0	9.3	15.0	523	64632	28928
	7/13/2017	2	10.8	9.3	14.3	492	63684	29668
	7/13/2017	3	10.3	9.8	14.6	515	62817	28507
		Average	10.7	9.5	14.63	510	63711	29034

Site	Date	Run	FPM Emissions		
			gr/DSCF	(lbs/hr)	(lbs/ton glass)
RM 05 Outlet	7/13/2017	1	0.0043	1.07	0.06
	7/13/2017	2	0.0041	1.05	0.06
	7/13/2017	3	0.0059	1.43	0.09
		Average	**0.0048**	**1.18**	**0.07**
Permit Limit			**n/a**	**n/a**	**0.45**

Table 1-2: Production Data Summary

Production Data Summary					
			Production Rate		Pressure Drop
Method	Date	Time	Tons/Day	Tons/hr	in. WC
RM 05 Outlet	7/13/2017	0934-1048	401	16.71	3.1
	7/13/2017	1143-1254	401	16.71	3.2
	7/13/2017	1421-1527	401	16.71	3.2
CTM 13 Outlet	7/13/2017	0935-1005	401	16.71	3.1
	7/13/2017	1254-1324	401	16.71	3.2
	7/13/2017	1422-1452	401	16.71	3.2

Table 1-3: CTM 13 Results Summary

			Stack Parameters					
			O_2	CO_2	Moisture	Temperature	Flow Rate	
Site	Date	Run	(%)	(%)	(%)	(F)	(ACFM)	(DSCFM)
CTM 13 Outlet	7/13/2017	1 (4)	11.0	9.3	16.1	538	59167	25656
	7/13/2017	2 (5)	10.8	9.3	16.1	538	63805	27672
	7/13/2017	3 (6)	10.3	9.8	16.8	540	64995	27923
		Average	10.7	9.5	16.33	539	62656	27084

			Emissions					
			H2SO4			SO2		
Site	Date	Run	(lbs/ton glass)	(lbs/hr)	(ppmvd)	(lbs/ton glass)	(lbs/hr)	(ppmvd)
CTM 13 Outlet	7/13/2017	1 (4)	0.11	1.86	4.75	0.74	12.44	48.6
	7/13/2017	2 (5)	0.10	1.65	3.91	0.86	14.42	52.3
	7/13/2017	3 (6)	0.07	1.21	2.85	0.96	15.97	57.4
		Average	**0.09**	***1.57***	**3.84**	***0.85***	**14.28**	**52.7**
Permit Limit			**n/a**	***1.6***	**n/a**	***1.2***	**n/a**	**n/a**

Table 1-4: Summary of Analytical QA/QC Results

Test Method	Parameter	QA/QC Criteria	Ground Site QA/QC Status	Outlet Site QA/QC Status	Within QC Criteria?
RM 2	Pitot Leak Check	Δ 0.0" H_2O / 15 seconds		0.0 @ 4.3" (max)	Yes
RM 5	Sample Train Leak Check (post test)	<0.02 cfm		0.01 cfm @ 5.0" H_2O (max)	Yes
RM5	Isokinetics	100% +/- 10%		102.9%-106.2%	Yes
CTM013	Sample Train Leak Check (post test)	<0.02 cfm	0.003 cfm @ 6.0" H_2O (max)		Yes
	Probe Temperature	> 350 °F	377°F (avg.)		Yes
	Thimble Temperature	> 500 °F	524°F (avg.)		Yes

2. **FACILITY INFORMATION & STATEMENT OF CERTIFICATION**

Facility Information

Name of Source Operator: Guardian Industries Corp.

Name of Source Owner: Guardian Industries Corp.

Address of Owner: 14600 Romine Road, Carleton, MI 4811 7

Source Identification: Glass Manufacturing

Location of Source: 14600 Romine Road, Carleton, MI 4811 7

Owners Representative: Michael Smolenski

STATEMENT OF CERTIFICATION

I certify that "to the best of my knowledge" the state and federal regulations, operating permits, or plan approvals applicable to this source and/or control device to be tested have been reviewed and that all testing requirements therein have been incorporated into the test plan.

Signature

EHS MANAGER
Title

8/22/2017
Date

Source owner/operator

Signature

General Manager
Title

8/18/17
Date

On-site supervisor for the test team

3. INTRODUCTION

3.1 Introduction

Guardian Industries Corp. (Guardian) has contracted Empire Stack Testing, LLC. (Empire) to perform Filterable Particulate Matter (FPM), Sulfur Dioxide (SO_2), and Sulfuric Acid (H_2SO_4) testing on their glass furnace in Carleton, Michigan. Testing used RM5 at the Trimer outlet stack, and CTM-13 at both the inlet and outlet of the Trimer control system.

Section 5 of this report contains the sampling and analytical procedures used to perform the test program. Section 6 details the quality assurance/quality control (QA/QC) procedures for the test program.

3.2 Test Program Objective

This test program is required annually to quantify the FPM, SO_2, and H_2SO_4 emissions from the outlet of the Trimer control system. All testing followed applicable methodologies of the Environmental Protection Agency (EPA), and as defined in Table 3-1, below.

3.3 Test Personnel

Coordinating the test program were:

Michael Smolenski
Guardian Industries Corp.
(734)-654-4283

David Patterson
MDEQ
(517)-284-6782

Michael T. Karter, QSTI
Empire Stack Testing, LLC.
(716)-481-6749

Ancy Sebastian
ALS Environmental
(905)- 331-3111

3.4 Test Plan

Testing for all parameters was completed in triplicate following Reference Methods (RMs). The test program incorporates reference methods outlined in the United States Environmental Protection Agency (USEPA) Code of Federal Regulations Title 40, Part 60 (40CFR60), Appendix A. See Table 2-1 below.

3.5 Test Schedule

Day 1 (July 10): Mobilize to Guardian & Setup Inlet RATAs
Day 2 (July 11): Inlet RATA and complete setup for Outlet RATAs
Day 3 (July 12): Complete Outlet RATAs and setup for FPM, H2SO4, and SO_2
Day 4 (July 13): Complete testing for FPM, H_2SO_4, and SO_2
Day 5 (July 14): Demobilize from site

Table 3-1: Summary of Test Plan

PARAMETER	METHOD	ANALYSIS	SAMPLE DURATION (MINUTES)	TEST LOCATION(S)	PERMIT LIMIT (OUTLET)
Flow Rate	RM 1 & 2	S-Type Pitot Tube / Manometer	various	Outlet	n/a
Dry Molecular Weight	RM 3	O_2 and CO_2 Fyrites	various	Outlet	n/a
Moisture	RM 4	Gravimetric	30	Outlet	n/a
FPM	RM 5	Gravimetric	60	Outlet	0.45 lbs / ton of glass
H_2SO_4 & SO_2	CTM 013	Ion Chromatography	30	Outlet Ground Site	1.6 lbs H_2SO_4 / hr 1.2 lbs SO_2 / ton of glass

NOTES:

CTM:	Conditional Test Method
FPM:	Filterable Particulate Matter
H_2SO_4:	Sulfuric Acid
RM:	United States Environmental Protection Agency Reference Method
SO_2:	Sulfur Dioxide

3.6 Process Description

Flat glass manufacturing Line #2 consisting of a raw material melting Furnace, glass forming and finishing, and glass cutting. Line #2 produces flat glass using the float method. Materials are weighed and mixed with water in the batch house before entering the natural gas fired Furnace. Glass then enters the tin bath to be formed and drawn. Next, it enters a lehr to reduce its temperature. The emission unit is controlled by a new (Trimer ECS) Control Device consisting of a Dry Scrubber, Particulate Filter, and Selective Catalytic Reduction (SCR).

3.7 Plant data

The plant's SCADA system continuously records the operating data included in the test report. The plant provided and summarized pertinent operating data to represent plant operation. These data and summaries were provided electronically (MS Excel).

4. PRESENTATION OF RESULTS / EXECUTIVE SUMMARY

This Executive Summary discusses, in detail, the test results and any anomalies, their resolution, and any effect on the results quality or usability.

4.1 Discussion of Results

Testing was completed on July 13th, 2017 for FPM, H_2SO_4, and SO_2. During this test program, the facility operated at a production rate of 401 tpd (16.71 tph).

The results indicate that the measured emissions are compliant with their permit limits. All field and lab data are included in the appendices of this report.

4.1.1 Isokinetics

Each RM 5 sample run for FPM met the isokinetic limit of 100 % ± 10%. These and other QAQC criteria are summarized in Table 1-4.

4.1.2 FPM Test Result

The average FPM emissions were measured to be 0.07 lbs/ton; which is compliant with limit of 0.45 lbs/ton. See Summary Table 1-1.

4.1.3 H_2SO_4 Test Result (CTM 13)

The average emission rate of sulfuric acid was 1.57 lbs/hr and 0.09 lbs/ton of glass. The unit demonstrated compliance with the emission limit of 1.6 lbs/hr. See Table 1-3.

4.1.4 SO_2 Test Results (CTM 13)

The sulfur dioxide emission rate was quantified as 14.28 lbs/hr and/or 0.85 lbs/ton of glass of glass. The unit demonstrated compliance with the emission limit of 1.2 lbs/ton of glass. See Table 1-3.

4.2 Anomalies

4.2.1 CTM 13 Runs 5 & 7

The post-leak check at the end of the second CTM 13 run (R5) did not pass on the 0.02 cfm criteria. All contents from the R5 train were discarded and the run was repeated. As a result, the CTM 13 runs were labeled R4, R6, and R7.

No other anomalies were recorded during testing nor report production.

5. SAMPLING AND ANALYTICAL PROCEDURES

This section provides a brief overview of the specific test methods that were used to determine the Sulfuric Acid emissions from each the glass furnace. All test method procedures were performed in accordance with the USEPA Reference Methods given in 40CFR60, Appendix A. The details of each method are given in the following sections.

5.1 Reference Method Test Location

The emission point exhausts the gases from the furnace that produces float glass. Emissions were discharged to atmosphere after passing through the Trimer control system. The inlet test location was a horizontal duct with an internal diameter (ID) of 6'-3". The vertical exhaust stack has an ID of 6'-6.5".

The inlet duct was fixed with a single 6-inch diameter port. The test ports were located approximately 5 equivalent diameters downstream of a disturbance and 1 equivalent diameters upstream of another disturbance. See Figure 5-1.

The exhaust stack was fixed with two 10-inch diameter ports. The test ports were located approximately 13 equivalent diameters downstream of a disturbance and 2.3 equivalent diameters upstream of another disturbance. See Figure 5-2.

The ground site of the exhaust stack was fixed with two 6-inch diameter ports. The test ports were located approximately 8 equivalent diameters downstream of a disturbance and 1 equivalent diameter upstream of another disturbance. See Figure 5-3.

5.2 Sampling Point Location

5.2.1 Volumetric Flow

Representative measurement of pollutant emissions and total volumetric flow rate from a stationary source requires a measurement site where the effluent stream is flowing in a known direction and cyclonic flow is not present. See section 5.3.1, below.

According to Reference Method 1, the cross section of the stack was divided into equal areas and a traverse point was then located within each of these areas. The number of duct diameters upstream and downstream from the test location to a flow disturbance determines the number of traverse points in a cross section.

As these stacks have diameters >24 inches the outermost traverse points were at least 1 inch from the stack walls.

Sampling was performed at 12 traverse points per traverse for a total of 24 sampling points, as set forth by RM 1. See Figures 5-3 and 5-4.

5.3 Stack Gas Velocity and Volumetric Flow Rate

According to Reference Method 2, the gas velocity in a stack was determined from the average velocity head with a type S Pitot tube, gas density, stack temperature, and stack pressure.

The average velocity head was determined by using an inclined manometer and a type S Pitot tube with a known coefficient of 0.84 that was determined geometrically by standards set forth in Reference Method 2. Stack temperature was taken at each traverse point using a type K thermocouple. Static pressure was determined by using a straight tap and an inclined manometer.

5.3.1 Cyclonic Flow Check

The cyclonic flow check was performed during previous testing in 2016 and demonstrated non-cyclonic, laminar flow. This data remains acceptable as the stack and duct configurations remain unchanged. These data were included in the test report.

5.4 Oxygen & Carbon Dioxide Concentration (RM 3)

The Oxygen and Carbon Dioxide concentrations used in the calculation of the stack gases molecular weight were measured according to RM-3 with grab samples and Fyrite gas analyzers.

5.5 Moisture Determination (RM 4)

The determination of effluent moisture was performed as part of the wet-chemistry sampling, as detailed below in RM 5 and CTM013.

5.6 Filterable Particulate Matter (RM 5)

5.6.1 Background

Reference Method 5 was used to determine the FPM concentrations. An integrated sample was drawn from the stack. The filterable particulate was quantified from the probe and filter catch.

5.6.2 Sampling

An isokinetic sample was collected at a rate of approximately 0.7 cubic feet per minute (cfm) for 60 minutes. A heated glass probe, heated glass filter, and standard full-size impingers were used. The first two impingers each contained 100 ml each of distilled water. The third impinger remained empty. The last impinger contained a known amount of silica gel. The second impinger was a Greenburg-Smith design; the remaining impingers were modified Greenburg-Smith designed. A schematic of the sampling train is presented in Figure 5-7. Both the probe and filter were maintained at 250 °F, ±50 °F as required by the method.

5.6.3 Sample Recovery

Recovery of all sample train components was performed in Empire's Mobile Laboratory.

Container 1:
The filter was carefully removed from the filter holder with the use of tweezers and disposable surgical gloves, and placed into its Petri dish labeled with the filter ID number and identified as "Container No. 1" for the proper run and location. Any particulate matter and/or fiber filters that adhered to the filter holder or filter holder gasket were carefully transferred to the Petri dish with the use of a dry nylon bristle brush or a sharp edged blade. The Petri dish was then sealed with parafilm. The probe nozzle, probe liner, and front half of the filter holder were rinsed at least three times with acetone, and the rinses collected in a sample jar labeled "Container No. 2". The container was then sealed and the fluid level marked.

Container 2:
The particulate matter was recovered from the probe nozzle, union, probe liner, front half of the filter holder, and (if applicable) the cyclone, as follows;

a. The nozzle was rinsed with acetone, brushed with a non-metallic bristle brush, and rinsed with acetone until no visible particles remained. A final acetone rinse was performed.
b. The probe liner was rinsed and brushed at least three times, followed by a final rinse of the brush with acetone.
c. After completing the rinses, the lid on the sample container was tightened and the height of the fluid level marked.

Acetone Blank:
An acetone blank with a volume roughly equal to the rinse volume was saved as a blank.

5.6.4 Analysis

The samples were shipped to Maxxam Analytical for analysis following RM 5. The filters were desiccated to a constant weight. The gravimetric analysis of the filters and acetone samples were repeated every six to twenty-four hours until stable analyses were obtained.

Maxxam uses a 40 mL vial to analyze the acetone rinses, in lieu of evaporation in a 250 mL beaker. This minimizes the tare weight of the vessel; as the vials have a tare weight of approximately 21g compared to a tare weight of approximately 100g with a 250 mL glass beaker. The 250 mL glass beaker has a greater chance of variability; also the NJ-DEP (the primary NELAC accreditor) has certified Maxxam to perform this analysis with the modification listed.

The procedure used was as follows:

- The vials were kept in the balance room at all times prior to use. Lab numbers were put on the vials with a black magic marker and the vial was then desiccated for one hour prior to doing the pre-weight
- Place bottle of solvent onto Navigator balance, enter the weight into the "Bottle and Solvent Weight" column
- Place a ribbed watch glass on the sample container and set in a fume to evaporate to <10 mL
- Transfer the remaining solvent to a pre-cleaned, pre-weighed and pre-numbered 40 mL glass vial
- Place the empty bottle of solvent onto Navigator balance, enter weight into the "Empty Bottle Weight" column
- Reduce to dryness with a gentle stream of N2 using the N-Evap system
- Place vials in desiccators for 24 hours minimum and record the time in the spreadsheet
- Note the appearance of the residue on the worksheet, (light, dark, minimal, copious as l/d/m/c)
- Proceed to 7.4 (Balance use and weighing samples)
- When all weightings were complete a second analyst must select and reweigh 1 of every 10 vials (the vial was to be selected at random)
  Second analyst's result must be ±2 mg of the first analyst's result.

5.7 Sulfuric Acid (CTM-013)

5.7.1 Background

This method was developed as an alternative to EPA Method 8 for determining sulfuric acid emissions from Kraft recovery furnaces. When testing recovery furnaces, EPA Method 8 is subject to significant interference from sulfates, which were present in the particulate matter, and sulfur dioxide. The alternative method uses a quartz in-line thimble to remove particulate matter from the gas stream prior to capturing sulfuric acid. The use of a controlled condensation technique eliminates the potential for interference from sulfur dioxide.

A gas sample was extracted from the sampling point in the recovery furnace stack. The sulfuric acid vapor or mist (including sulfur trioxide) and the sulfur dioxide were separated, and both fractions were measured separately by either the barium-thorin titration method or Ion Chromatography (IC).

5.7.2 Sampling

The sampling train consists of a glass nozzle and heated glass probe, which were maintained at the temperature of >177°C (350°F). The probe was then connected to the thimble holder housed in an oven box that was also maintained at the temperature of >500 °F. The thimble holder was constructed of quartz with a quartz thimble filter.

Sampling was performed for a minimum of 30 minutes at a constant rate (±10%) of ~10.0 lpm (~0.35 cfm).

A condenser connects the thimble to the train. The condenser was filled with water and its temperature was maintained between 75 and 85°C (167 to 185°F). The condenser was connected to the impinger train with a minimal length of unheated Teflon tubing. The first and third impingers consist of Greenburg-Smith design, the remaining impingers were modified Greenburg-Smith designed impingers. The first two impingers contained 100 ml of 3% hydrogen peroxide (H_2O_2). The third impinger contained 100 ml of distilled deionized water (RODI). The fourth impinger contained approximately 500 g of silica gel desiccant.

A vacuum line connects the outlet of the last impinger to the control module. The control module consists of a vacuum gauge, rotary pump, by-pass and main valve, dry gas meter, orifice, and an inclined manometer. The sample train is illustrated in Figure 5-8.

Coinciding with the sampling were velocity, moisture, and dry molecular weight determinations.

5.7.3 Sample Purge

At the completion of the test run, the probe was separated from the thimble, and a 15-minute purge with clean air (ambient) was performed at the same rate at the test run, as required by the method.

5.7.4 Sample Recovery

Recovery was performed onsite in Empire's mobile laboratory at the completion of each test run.

Container 1
Rinse separately the probe, quartz thimble holder and the H_2SO_4 condenser with deionized water using multiple rinse. After completing the rinses, the lid on the sample container was tightened and the height of the fluid level marked. The thimble was discarded.

Container 2:
The liquid from the first two impingers was quantitatively transferred into a clean sample bottle (glass or plastic).

Container 3
The water from the third impinger was weighed in the field, and then discarded.

Blank H_2O_2
Take ~100 ml of H_2O_2 and place it in a recovery bottle. The liquid level on the bottle was marked.

Blank H_2O
Take ~100 ml of H_2O and place it in a recovery bottle. The liquid level on the bottle was marked.

5.7.5 Analysis

The samples were shipped to ALS Environmental of Mississauga, Ontario, Canada for analysis for either IC or titration. The impinger solutions were also analyzed for SO_2.

Figure 5-1: Test Port Location (Inlet)

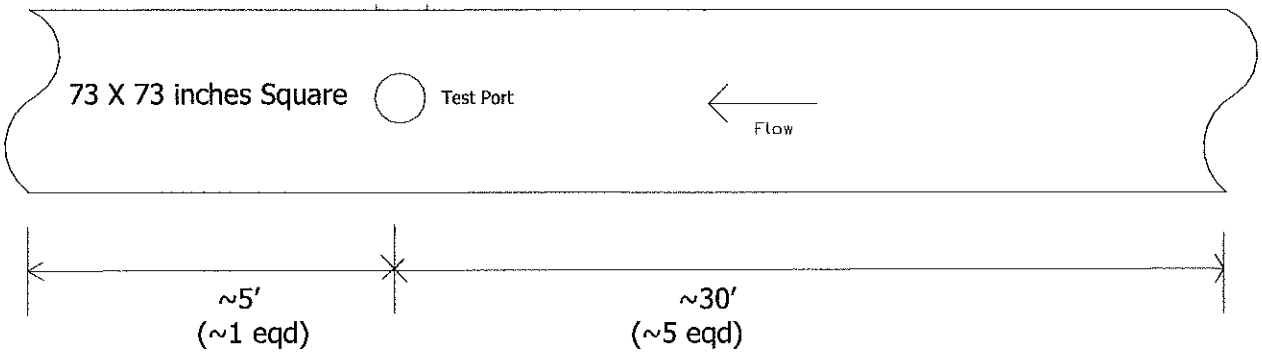


Figure 5-2: Test Port Location (Outlet)

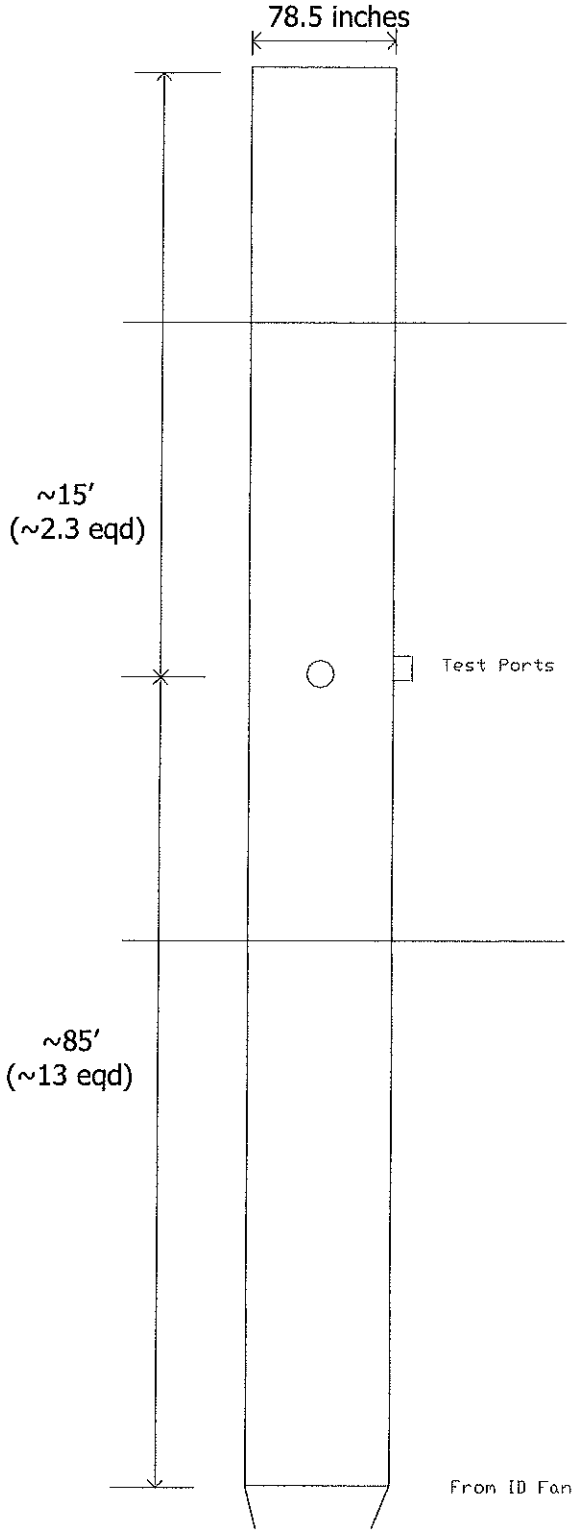


Figure 5-3: Test Port Location (Outlet Ground Site)

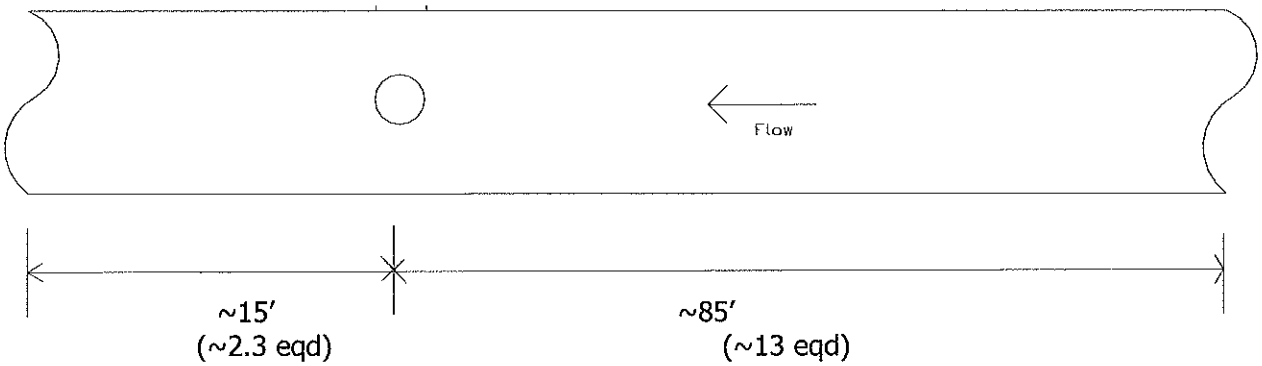
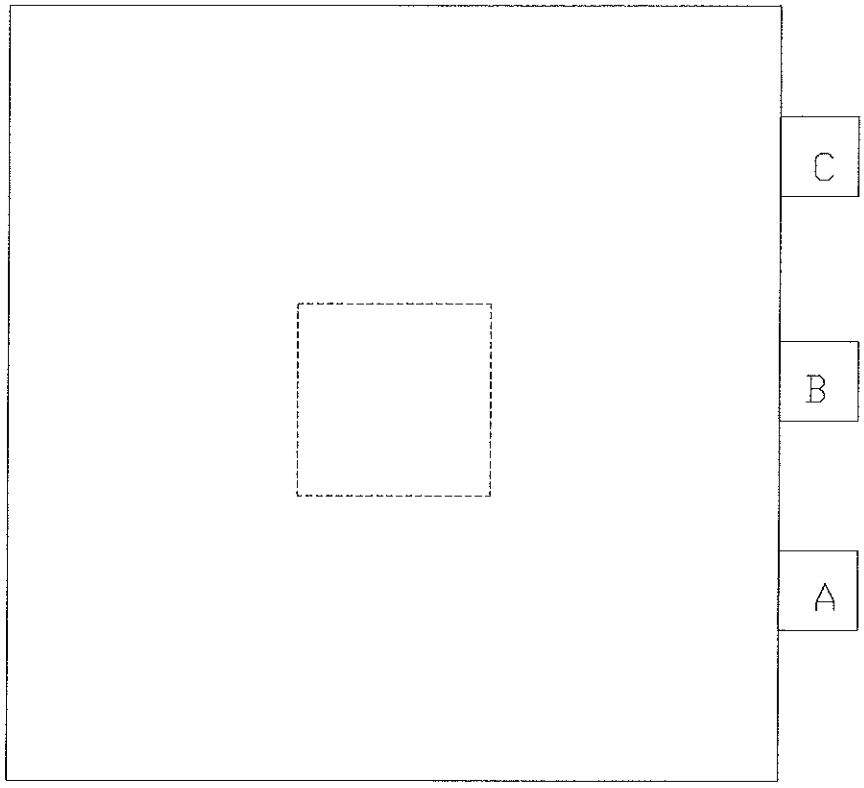


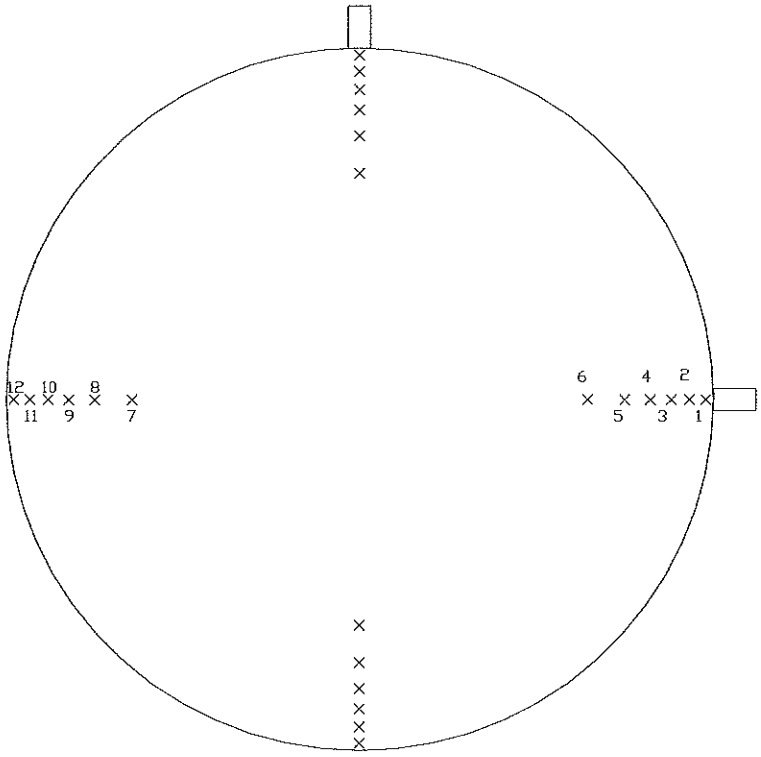
Figure 5-4: Sampling Point Locations (Inlet)



Note: Only a single port was present

Traverse Point Number	Distance from Port Edge (inches)
Centroid:	27.4 – 45.6″
Internal Dimensions:	73 X 73″
Port Length:	7″

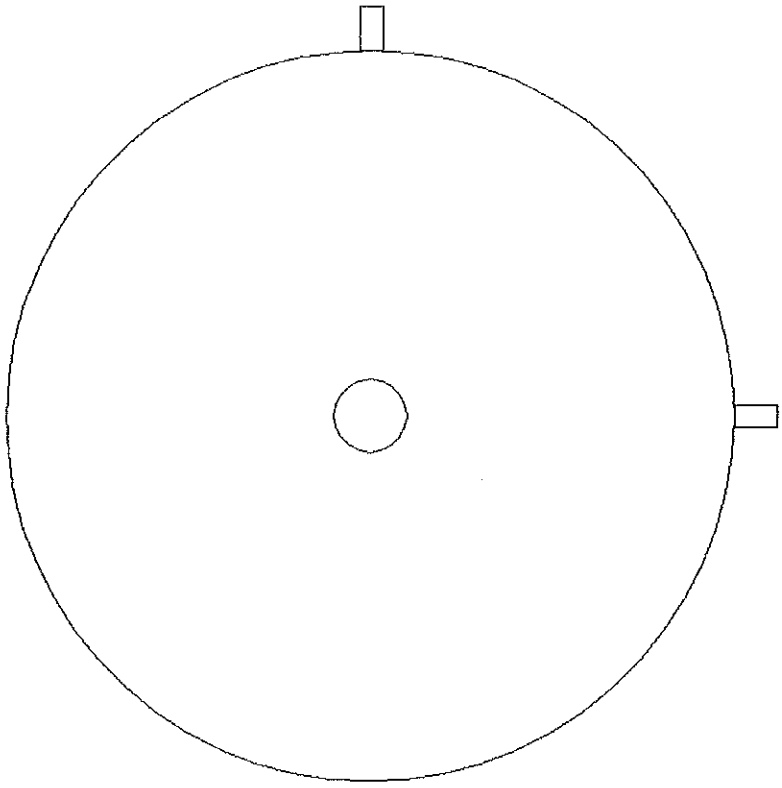
Figure 5-5: Sampling Point Locations (Outlet)



Traverse Point Number	Distance from Inner Wall (%)	Distance from Port Edge (inches)
1	4.5	13.5
2	14.6	21.5
3	29.6	33.2
4	70.4	65.3
5	85.4	77.0
6	95.5	85.0

Diameter: 78.5″
Nipple: 10″

Figure 5-6: Sampling Point Locations (Outlet Ground Site)



Note: Only a single port was present

Traverse Point Number	Distance from Port Edge (inches)
Centroid:	26.8 – 51.7″
Internal Dimensions:	78.5″
Port Length:	6″

Figure 5-7: RM 5 Sampling Train

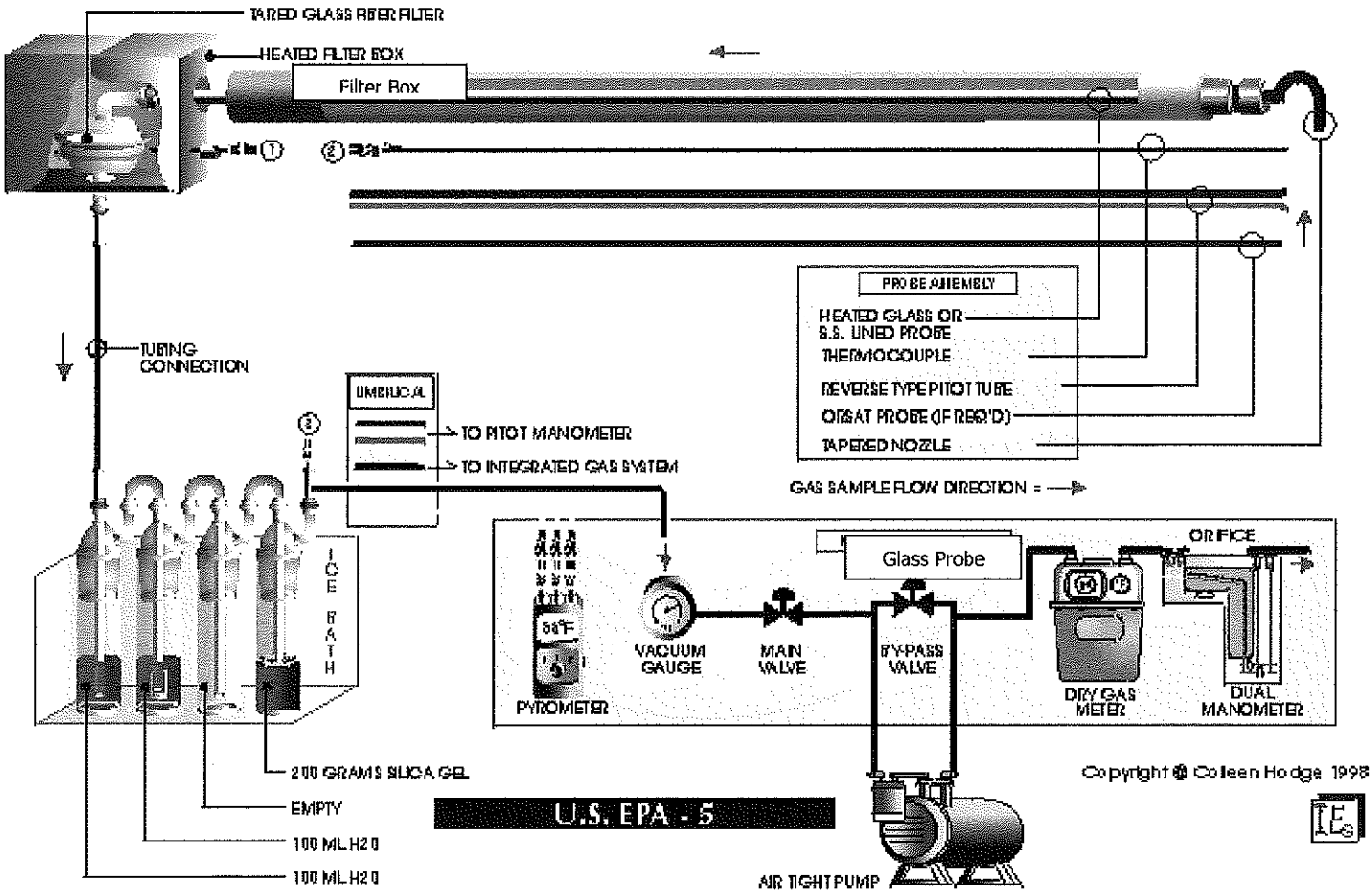
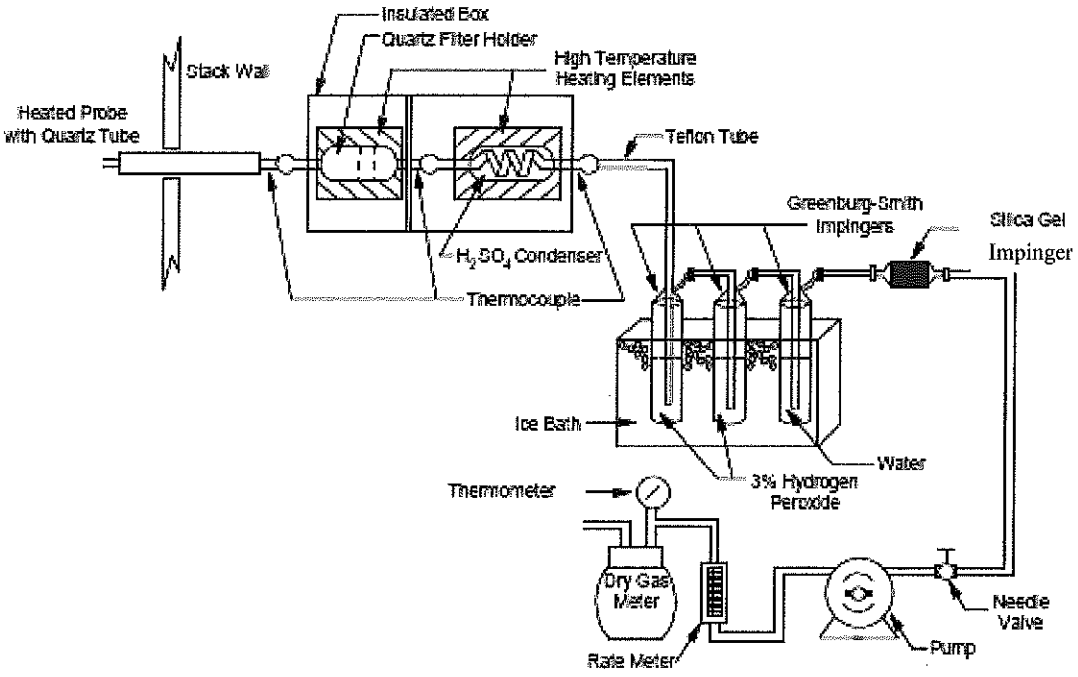


Figure 5-8: CTM 013 Sampling Train



6. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

Quality control procedures for all aspects of field sampling, sample preservation and holding time, reagent quality, analytical methods, analyst training and safety, instrument cleaning, calibration, and safety were followed. These procedures were consistent with EPA Guidelines documented in:

EPA 600/9-76-005, Quality assurance Handbook for Air Pollution Measurement Systems, Volume I
EPA 454/R-98-004, Quality assurance Handbook for Air Pollution Measurement Systems, Volume II
EPA 600/R-94-038c, Quality assurance Handbook for Air Pollution Measurement Systems, Volume III

6.1 Chain of Custody

Documentation of the Chain-of-Custody of samples and data obtained during the test program was essential for insuring the validity of the test program results. Chain-of-Custody procedures were followed during sampling, sample and data transport, sample preparation and analysis, storage of data, as well as with archived samples and reported results. Empire follows the protocol listed in SW 846, Section 1.3 during field sampling and in-house laboratory analysis.

6.2 Equipment and Sampling Preparation

Sampling equipment was cleaned, checked, and calibrated prior to use in the field. Each parameter's sampling method requires specific cleaning methods of the glassware, train components, and recovery containers. These materials were then sealed prior to shipment to the field.

6.3 Calibrations

6.3.1 Pitot Calibration

Pitot tubes were calibrated according to Reference Method 2, Section 10.1. Pitot tubes were given a baseline coefficient of 0.84 when they meet certain geometrically measured angles and dimensions as set forth in the method.

6.3.2 Thermocouple Display Calibration

Following Method 2, Section 10.3, an NIST Traceable Electronic Thermocouple Calibrator/Simulator (ALTEK) for post-test calibrations was used. If the display being calibrated and the ALTEK were within +/-1°F and/or +/-2% of the reference temperature, the calibration was acceptable, else the display was re-calibrated.

6.3.3 Thermocouple Calibration

According to EMTIC GD-28, a single point (at ambient temperature) check of the thermocouple was made prior to and following each test program. If the thermocouple being calibrated and the certified thermometer were within +/- 2.0 °F of each other, the calibration was acceptable. The thermocouple must also respond appropriately to a change in temperature. Thermocouples that fail either of these criteria were repaired or discarded.

6.3.4 Barometer Calibration

Empire's barometer was compared prior to and following testing with the barometer from the National Weather Service (NWS) located at the Buffalo International Airport. If the barometer disagrees from the Airport's absolute station pressure reading by more than +/- 2.3 millimeters (mm) (0.1 inch) of Hg, the barometer was adjusted. Elevation corrections were performed if the barometer and NWS elevations differ by more than 10 feet (elevation) of each other.

If necessary, readings taken in the field were corrected based on the degree of error between the Empire barometer and the NWS.

Alternatively, during testing, the barometric station pressure can be obtained online from the nearest NOAA or FAA weather station.

6.4 Leak Checks

6.4.1 Sample Trains (CTM013)

A leak-check prior to the sample run was optional; however, a leak-check after the sampling run was mandatory. The leak check was conducted in accordance with the procedures outlined in Reference Method 5, Section 8.5.9, except that it was conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate was found to be no greater than 0.02 cfm, the results were acceptable and no correction was applied to the total volume of dry gas metered.

6.4.2 Sample Trains (FPM)

Both pre- and post-run leak checks were conducted. A pre-test leak check was performed to verify integrity of the vacuum system. A leak check was mandatory at the conclusion of each isokinetic sampling run. The leak check was conducted in accordance with the procedures outlined in Reference Method 5, Section 8.5.9, except that it was conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate was found to be no greater than 0.02 cfm, the results were acceptable and no correction was applied to the total volume of dry gas metered.

6.4.3 Pitot Leak Check

The pitot tubes used during the test program were leak checked prior to the test series and following each traverse set, as prescribed in RM 2, Section 8.1. The leak check was performed by pressurizing the positive side of the pitot to at least 3 inches of water. No loss of pressure for 15 seconds indicates a successful leak check. This procedure was repeated with a vacuum applied to the negative side of the Pitot tube as well.

6.5 Sample Recovery

All sample volumes and reagent volumes were measured and recorded on Empire's recovery data sheets and included in the report. All recovery procedures were intended to meet the requirements of the methods.

6.6 Data Reduction

The QA/QC procedures for data reduction include using computer programs to generate tables of results. Results for at least one test run were double-checked and re-calculated by hand. These pages were included in the report.

The data was logged directly to a laptop hard drive, where calculations were performed using MS-Excel spreadsheets. These data were archived nightly to flash media or compact disks (CDs). Copies of these data were available in the field electronically or in print form, upon request.

6.7 Sample Recovery

All sample volumes and reagent volumes were measured and recorded on Empire's recovery data sheets and included in the report. All recovery procedures were intended to meet the requirements of the methods.

6.8 Data Reduction

The QA/QC procedures for data reduction include using computer programs to generate tables of results. Results for at least one test run were double-checked and re-calculated by hand. These pages were included in the report.

The wet-chemistry data was logged directly to a separate laptop hard drive, where calculations were performed using MS-Excel spreadsheets. These data were archived nightly to flash media. Copies of these data were available in the field electronically or in print form, upon request. Paper datasheets were available, only to be used in an emergency.

6.9 Safety

These methods involved hazardous materials, operations, and equipment. Empire established appropriate safety and health practices and determined the applicability of regulatory limitations before performing this test program.

The test site met the criteria of RM 1. Test ports (loosened and cleaned), safe access, and suitable power were provided by the client. The above items were ready upon arrival of the test crew.

Delay or Lost Time (delays) of the field crew due to causes beyond the control of Empire Stack Testing, LLC. (Empire) may include (but were not limited to weather, cyclonic flow conditions, process upsets or failure, or the facility's inability to maintain the desired test conditions). Inclement weather includes (but was not limited to) lightning, strong rains, blizzards, high winds (≥30 mph), high humidity, and/or working temperatures below 20 °F or above 90 °F. Empire's field leader retained the right of final refusal to stop testing for any unsafe condition.