EMISSION TEST REPORT

FPM & Sulfuric Acid Mist Emissions
on the
Line-1
Trimer Control System

at
Guardian Industries, LLC
14600 Romine Rd
Carleton, MI 48117

Test Date: October 29th, 2019

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14600 Romine Rd
Carleton, MI 48117
(Line-1)

Test Date: October 29th, 2019

Project 19-412

Prepared by:
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1090 Cain Road
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Michael Karter Digitally signed by Michael Karter
Date: 2019.12.18 20:07:28 -05'00'

Michael T. Karter, QSTI
General Manager

December 18, 2019

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Table 1-1: FPM Results Summary

Site	Date	Run	Stack Parameters O_2 (%)	CO_2 (%)	Moisture (%)	Temperature (F)	Flow Rate (DSCFM)
RM 05 Outlet		1	11.8	5.3	11.7	562	40773
		2	12.0	5.3	11.6	565	37714
		3	12.0	4.5	11.3	564.0	41042
		Average	11.9	5.0	11.5	564	39843

Site	Date	Run	FPM Emissions (lbs/ton glass)	(lbs/hr)	(gr/DSCF)
RM 05 Outlet		1	0.45	7.48	0.0214
		2	0.06	1.02	0.0032
		3	0.03	0.48	0.0014
		Average	**0.18**	**2.99**	**0.009**
Permit Limit			**0.45**	**n/a**	**n/a**

Table 1-2: CTM 013 Results Summary

Date	Run	Stack Parameters O_2 (%)	CO_2 (%)	Moisture (%)	Temperature (F)	Flow Rate (DSCFM)
10/29/2019	1	11.8	5.3	11.1	568	40773
	2	12.0	5.3	11.9	576	37714
	3	12.0	4.5	11.8	580	41042
	Average	11.9	5.0	11.60	575	39843

Date	Run	Emissions H2SO4 (lbs/ton glass)	(lbs/hr)	(ppmvd)
	1	0.04	0.67	1.08
	2	<0.04	0.75	1.29
	3	<0.03	0.54	0.86
	Average	**<0.04**	**0.65**	**1.08**
Permit Limit		**n/a**	***1.6***	**n/a**

Table 1-3: Production Data Summary

Production Data Summary					
			Production Rate		Pressure Drop
Date	Run	Time	Tons/Day	Tons/hr	in. WC
10/29/2019	1	0955 - 1137	401.63	16.73	7.5
10/29/2019	2	1315 - 1500	401.63	16.73	7.5
10/29/2019	3	1558 - 1743	401.63	16.73	7.8

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

Test Method	Parameter	QA/QC Criteria	QA/QC Status	Within QC Criteria?
RM 2	Pitot Leak Check	Δ 0.0" H_2O / 15 seconds	0.0 @ 4.9" (max)	Yes
	Cyclonic Flow	<20°	9.8°	Yes
RM 5	Sample Train Leak Check (post test)	<0.02 cfm	0.001 cfm @ 7.0" H_2O (max)	Yes
RM5	Isokinetics	100% +/- 10%	956.4%-100.9%	Yes
CTM013	Sample Train Leak Check (post test)	<0.02 cfm	0.003 cfm @ 7.0" H_2O (max)	Yes
	Probe Temperature	> 350 °F	357°F (avg.)	Yes
	Thimble Temperature	> 500 °F	522°F (avg.)	Yes

2. **Facility Information & Statement of Certification**

Facility Information

Name of Source Operator: Guardian Industries, LLC.

Name of Source Owner: Guardian Industries, LLC.

Address of Owner: 14600 Romine Road, Carleton, MI 48117

Source Identification: Glass Manufacturing

Location of Source: 14600 Romine Road, Carleton, MI 48117

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

12/17/2019
Date
Source owner/operator

Signature

General Manager
Title

12-17-19
Date
On-site supervisor for the test team

3. INTRODUCTION

3.1 Introduction

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

Section 3 of this protocol contains the sampling and analytical procedures used to perform the test program. Section 4 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 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, LLC.
(734)-654-4283

Ancy Sebastian
ALS Environmental
(905)-331-3111

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

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 3-1 below.

3.5 Test Schedule

Day 1: Mobilize to Guardian and finish setup for FPM & H2SO4 Testing
Day 2: Complete FPM & H2SO4 Testing (~ 8 hours)
Day 3: Demobilize from site

Table 3-1: Summary of Test Plan

PARAMETER	METHOD	ANALYSIS	SAMPLE DURATION (MINUTES)
Flow Rate	RM 1 & 2	S-Type Pitot Tube / Manometer	various
Dry Molecular Weight	RM 3	O_2 and CO_2 Fyrites	various
Moisture	RM 4	Gravimetric	60
FPM	RM 5	Gravimetric	60
H_2SO_4	CTM 013	Titration	60

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

3.6 Process Description

Flat glass manufacturing Line #1 consisting of a raw material melting furnace, glass forming and finishing, and glass cutting. Line #1 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 shall provide plant operation and summarize pertinent operating data to represent plant operation. These data and summaries are provided both electronically (MS Excel) and in paper copies.

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 October 29th, 2019 for FPM and H_2SO_4. During this test program, the facility operated at an average production rate of 401.63 tpd.

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 1-1.

4.1.2 FPM Test Result (RM 5)

The average FPM emissions were measured to be 0.18 lbs/ton; which is compliant with limit of 0.45 lbs/ton. See Summary Table 4-1.

4.1.3 H_2SO4 Test Result (CTM 013)

The average emission rate of sulfuric acid was 0.65 lbs/hr; which is compliant with limit of 1.6 lbs/hr. See Table 1-2.

4.1.4 Cyclonic Flow Check

The cyclonic flow check was performed during this testing and demonstrated non-cyclonic, laminar flow. These data are included in the test report. This data remains acceptable as long as the stack and duct configurations remain unchanged. These data are included in Appendix A of this test report.

4.2 Anomalies

4.2.1 Audit Sample (CTM 013)

Although not required or included in the test protocol, Empire obtained certified H_2SO_4 audit material from a certified vendor and supplied this material to the laboratory along with the samples. Initial analysis resulted in an audit concentration of 48.5 ppm (the limits were 39.6-48.4). Subsequent re-analysis yielded a result of 46.3 ppm. The test

results are calculated with the original lab results, and both sets of lab data are included in Appendix D.

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 exhaust stack is fixed with four 10-inch diameter ports. The test ports are located approximately 7 equivalent diameters downstream of a disturbance and 11 equivalent diameters upstream of another disturbance. See Figure 5-1.

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 3.3.1, below.

According to Reference Method 1, the cross section of the stack is divided into equal areas and a traverse point is 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 this stack has a diameter >24 inches the outermost traverse points were at least 1 inch from the stack walls. Sampling were 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 were determined from the average velocity head with a type S Pitot tube, gas density, stack temperature, and stack pressure.

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

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

5.6.2 Sampling

An isokinetic sample were 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 is a Greenburg-Smith design; the remaining impingers are 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 were 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 were tightened and the height of the fluid level marked.

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

5.6.4 Analysis

The samples were shipped to ALS Global (ALS) for analysis following RM 5. The filters are 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 are obtained.

ALS 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 ALS to perform this analysis with the modification listed.

The procedure used is as follows:

- The vials are kept in the balance room at all times prior to use. Lab numbers are put on the vials with a black magic marker and the vial is 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 are complete a second analyst must select and reweigh 1 of every 10 vials (the vial is 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 are 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 is extracted from the sampling point in the recovery furnace stack. The sulfuric acid vapor or mist (including sulfur trioxide) and the sulfur dioxide are separated, and both fractions are measured separately by **barium-thorin titration.**

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 were also maintained at the temperature of >500 °F. The thimble holder was constructed of quartz with a quartz thimble filter.

Sampling were performed for a minimum of 60 minutes at a constant rate (±10%) of ~10.0 lpm (~0.35 cfm).

A condenser connects the thimble to the train. The condenser is filled with water and its temperature is 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 are 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) were performed at the same rate at the test run, as required by the method.

5.7.4 Sample Recovery

Recovery were 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 were tightened and the height of the fluid level marked. The thimble was discarded.

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

Container 3:
The water from the third impinger were 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 were marked.

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

5.7.5 Analysis

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

Figure 5-1: Test Port Location (Outlet)

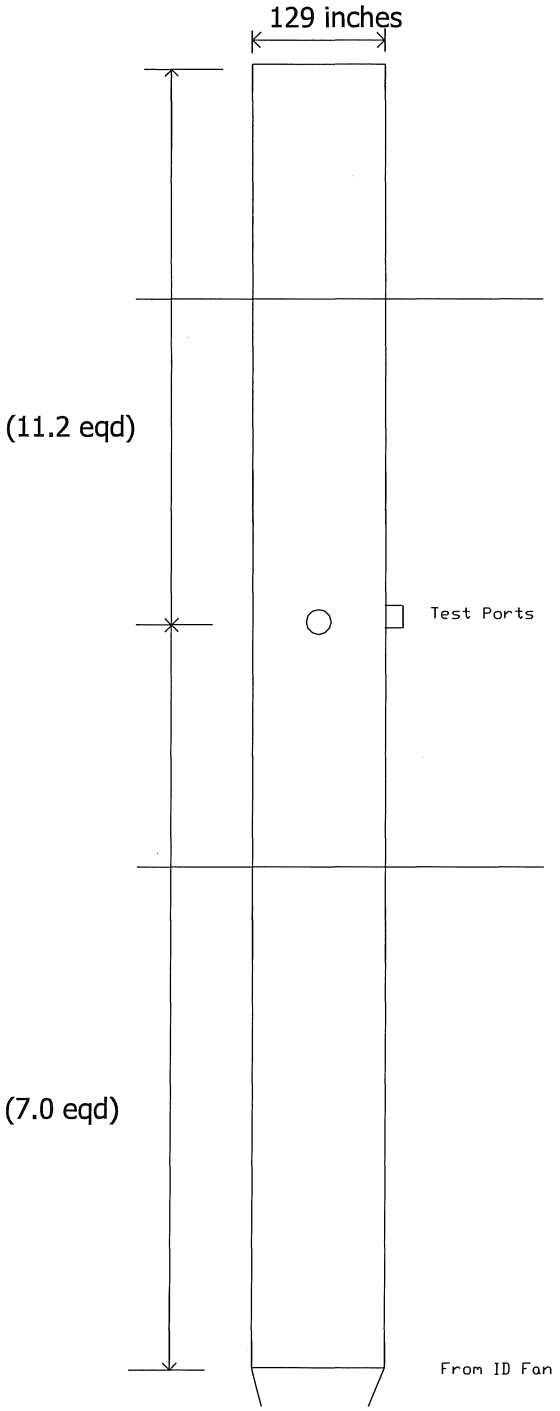
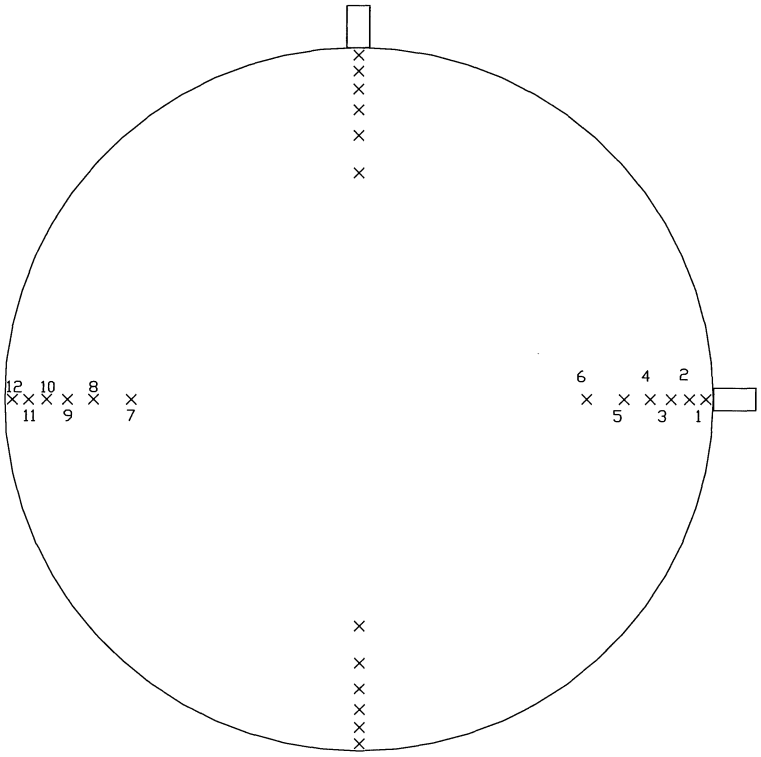


Figure 5-2: Sampling Point Locations (Outlet)



Traverse Point Number	Distance from Inner Wall (%)	Distance from Port Edge (inches)
1	2.1	48.7
2	6.7	54.6
3	11.8	61.2
4	17.7	68.8
5	25.0	78.3
6	35.6	91.9
7	64.4	129.1
8	75.0	142.8
9	82.3	152.2
10	88.2	159.8
11	93.3	166.4
12	97.9	172.3

Diameter: 129″
Nipple: 46″

Figure 5-3: RM 5 Sampling Train

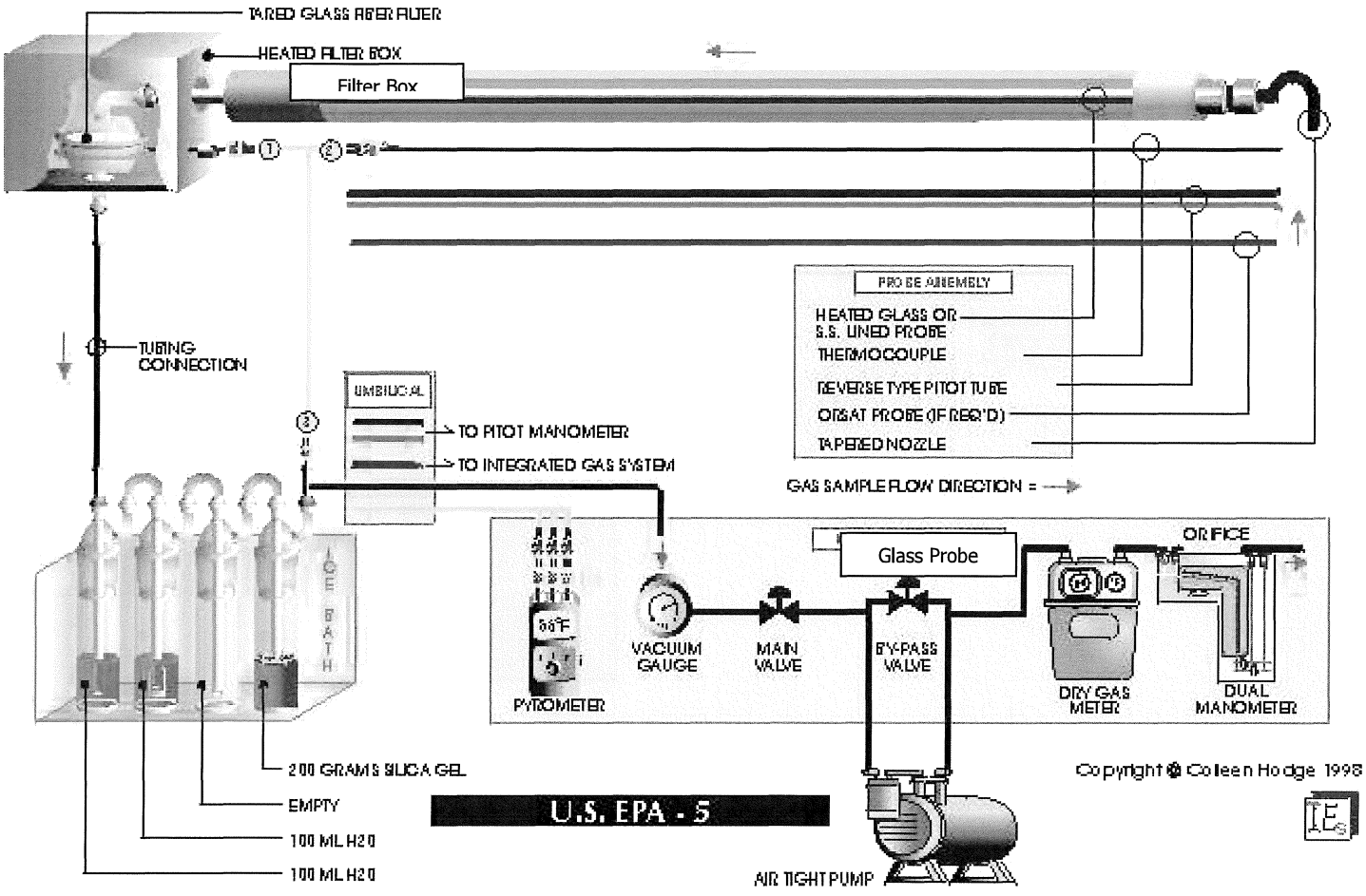
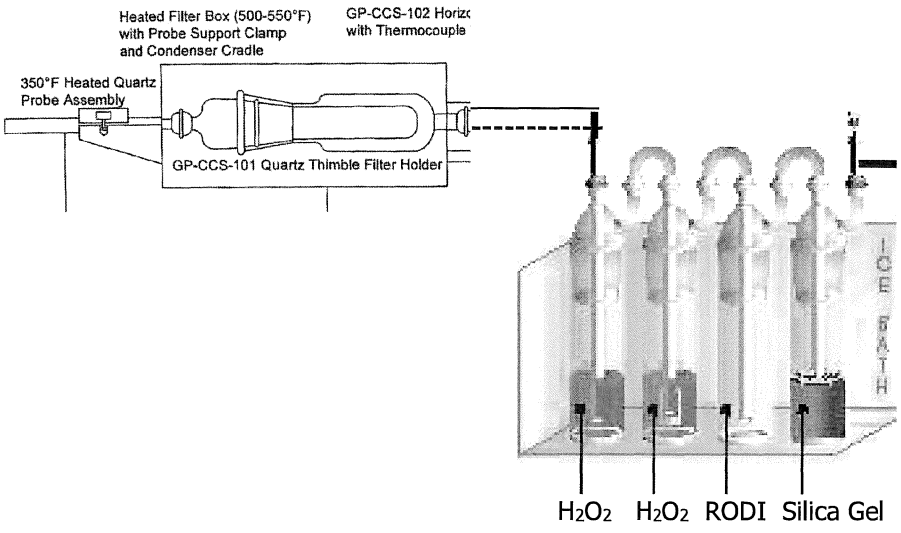


Figure 5-4: CTM 013 Sampling Train



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 is essential for ensuring 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 were 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 is used. If the display being calibrated and the ALTEK were within +/-1°F and/or +/-2% of the reference temperature, the calibration is acceptable, else the display is re-calibrated.

6.3.3 Thermocouple Calibration

According to EMTIC GD-28, a single point (at ambient temperature) check of the thermocouple were 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 is 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

During testing, the barometric station pressure was 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 is optional; however, a leak-check after the sampling run is 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 is found to be no greater than 0.02 cfm, the results were acceptable, and no correction were 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 is 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 is found to be no greater than 0.02 cfm, the results were acceptable, and no correction were 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 are included in the report.

The wet-chemistry data were 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 are only used in an emergency and were not used during this test program.

6.7 Safety

These methods involve 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 shall meet the criteria of RM 1. Test ports (loosened and cleaned), safe access, and suitable power to be provided by the client. The above items need to be 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 is 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 retains the right of final refusal to stop testing for any unsafe condition.

A. FPM DATA & CALCULATIONS (RM 5)