LINE 2 GLASS PROCESSING
SULFURIC ACID MIST
EMISSIONS TEST REPORT
GUARDIAN INDUSTRIES CORPORATION
CARLETON, MICHIGAN

Test Date: October 22, 2015

Report Date: December 15, 2015

Prepared for:

Guardian Industries Corp.
14600 Romine Road
Carleton, Michigan 48117

Prepared by:

Air/Compliance Consultants, Inc.
1050 William Pitt Way
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PA Lab Registration #02-04775

Project Number: 15-081

Air/Compliance Consultants, Inc.

LINE 2 GLASS PROCESSING SULFURIC ACID MIST EMISSIONS TEST REPORT GUARDIAN INDUSTRIES CORPORATION CARLETON, MICHIGAN

1 TEST RESULTS SUMMARY

Permit Number: PTI 105-14
Source Name: Line 2 Glass Production
Source ID: EU00080

Pollutant	Average Result	Limit	Compliant/ Non-compliant
Sulfuric Acid Mist (H_2SO_4)	1.95 lb/hr	1.6 lb/hr	Non-compliant

2 INTRODUCTION

Guardian Industries Corporation (Guardian) contracted Air/Compliance Consultants, Inc. (ACCI), an affiliate of Montrose Air Quality Services, LLC. (Montrose), to perform an evaluation of sulfuric acid mist (H_2SO_4) emissions at their facility located in Carleton, Michigan. Testing was conducted on the Line 2 Glass Production (Line 2) in accordance with Michigan Department of Environmental Quality (MDEQ) requirements; United States Environmental Protection Agency (USEPA), Title 40 CFR, Part 60, Appendix A; and procedures outlined in the March 2015 Test Protocol. Filterable particulate matter, ammonia and metals compliance testing was conducted on July 22, 2015 and the test results were compliant with the Permit to Install (PTI) 105-14. The October 22, 2015 test for H_2SO_4 was conducted to repeat the July 22, 2015 H_2SO_4 which resulted in a non-compliant test result. A copy of the March 2015 Test Protocol is contained in Appendix A.

3 CONTACT INFORMATION

Facility Contact	Testing Firm
Mr. Michael Smolenski EH & S Manager Guardian Industries Corporation 14600 Romine Road Carleton, Michigan 48117 (734)-654-6264 – Telephone msmolenski@guardian.com	Mr. Paul A. Jadlowiec, QSTI Senior Project Manager Air/Compliance Consultants, Inc. 1050 William Pitt Way Pittsburgh, Pennsylvania 15238 (412) 826-3636 – Telephone pjadlowiec@montrose-env.com

4 TEST DATES AND PERSONNEL INFORMATION

Emission testing for H_2SO_4 was conducted on October 22, 2015. The following table details the contact personnel regarding this test program:

Organization	Personnel	Responsibility
Guardian	Joe Ventline	Test Liaison
MDEQ	Mark Dziadosz	Agency Observer
ACCI/Montrose	Joshua S. Varner, QSTI, Project Scientist	Equipment Handler and Sample Recovery
	Owen H. Daly, Scientist I	RM CTM-013B Operator and Sample Recovery

5 ANAYLTICAL LABORATORY INFORMATION

Samples were collected and analyzed according to the applicable method. An H_2SO_4 audit was provided by ERA. Analyses were performed by the following:

USEPA CTM 013B

Maxxam Analytics Inc.
Mr. Clayton Johnson
6740 Campobello Road
Mississauga, Ontario, Canada L5N 2L8
(905) 817-5769 –Telephone
cjohnson@maxxam.ca
PA Lab Registration #68-01745

6 PROCESS DESCRIPTION AND PROCESS DATA

6.1 Process Description

Guardian manufactures flat glass at the Carleton, Michigan facility. Line 2 (EU00080) consists of a raw material melting furnace, glass forming and finishing, and glass cutting. Line 2 produces flat glass using the float method. Raw materials of sand, soda ash, dolomite, limestone and other minor constituents are weighed and mixed with water in the batch-house before entering the natural gas fired furnace. The percentages of the raw material mixes varies depending on the product type desired. Glass then enters the tin bath to be formed and drawn,

and then it enters a lehr to reduce its temperature. Line 2 rated capacity is 650 tons of glass pulled per day.

Line 2 emissions are controlled by a newly installed control system consisting of a dry scrubber, particulate filter, and selective catalytic reduction (SCR). The dry scrubber uses hydrated lime stored in a 3,000 cubic foot storage silo with a passive bin vent for injection into the scrubber to remove gaseous pollutants. Aqueous NH_3, stored in a 20,000 gallon pressurized storage tank, is injected into the gas stream to treat the exhaust gas for NO_X control. An UltraCat Filter System removes particulate after the dry scrubber control. The final control is selective catalyst reduction that uses high temperature, light weight ceramic filters impregnated with catalyst to remove remaining gaseous emissions.

6.2 Process Data

Guardian personnel were responsible for recording pertinent process data at a minimum of once every 15 minutes during each emission testing period. The specific process data recorded was:

- Glass pull rate (tph & tpd)
- Natural gas usage

Plant process data is contained in Appendix B.

7 TEST PROCEDURES

Testing was performed in accordance with USEPA Methods and the procedures outlined in USEPA 40 CFR, Part 60, Appendix A and the March 2015 Test Protocol. All field data sheets are contained in Appendix C.

7.1 Testing Stations and Traverse Locations – USEPA Method 1

USEPA Method 1, *Sample and Velocity Traverses for Stationary Sources,* was utilized to determine the number and location of the traverse points. Figure 1 provides a schematic of the sampling and traverse point locations as measured in the field. A copy of the cyclonic flow check data can be found in Appendix C.

7.2 Gas Velocity and Moisture – USEPA Method 2

The gas flow and temperature measurements followed the principles of USEPA Method 2, *Determination of Stack Gas Velocity and Volumetric Flow Rate (S-Type Pitot Tube).* The gas flow rate and temperature profiles for the gas stream were measured by conducting simultaneous velocity and temperature traverses during each sampling run. Gas velocity head was measured using a calibrated S-Type Pitot tube that was connected to a manometer. The static pressure was measured using the same Pitot tube and manometer. A Chrome-Alumel thermocouple attached to a digital indicator was used to measure the gas temperature at each of the traverse points.

7.3 Determination of O_2 and CO_2 – USEPA Method 3

The principles of USEPA Method 3, *Gas Analysis for the Determination of Dry Molecular Weight*, were used to measure oxygen (O_2) and carbon dioxide (CO_2) to determine the molecular weight of the flue gas for the measurement of gas flow. A Fyrite analyzer was used to determine the percent by volume of O_2 and CO_2 in the stack gas. Nitrogen (N_2) was determined by the difference.

7.4 Moisture Content Sampling – USEPA Method 4

Moisture content sampling was conducted concurrently with each sampling run using the principles and sampling apparatus presented in USEPA Method 4, *Determination of Moisture Content in Stack Gases.* The parameters evaluated to determine the gas-stream moisture content were sample gas volume, temperature and pressure, and impinger and silica gel moisture gain.

7.5 Determination of Sulfuric Acid Mist – USEPA Method CTM 013B

Sulfuric acid mist emissions were conducted in accordance with the procedures outlined in USEPA Method CTM 013B, *Determination of Sulfuric Acid and Sulfur Dioxide Emissions from Combination Fuel Boilers, Recovery Furnaces, and Thermal Oxidizers – Isokinetic Method.*

7.5.1 Sampling Train Setup and Operation

Prior to sampling, all glassware was cleaned with soap and water, rinsed with tap water, and finally rinsed with deionized (DI) water.

The sampling apparatus contained a quartz nozzle connected to a quartz-lined temperature-controlled (~400°F) probe using a glass-coated stainless steel union and graphite ferrules. The exit of the probe was connected to a quartz filter holder containing a 30 x 100 mm diameter quartz filter. The filter was inside an oven heated to > 500°F. The exit of the filter holder was connected to six Greenburg-Smith impingers. The first and second impingers contained 100 milliliters (ml) of 100% isopropyl alcohol (IPA). The outlet of the second impinger was connected to an unheated borosilicate glass filter holder with glass frit filter support containing a glass fiber filter. The third impinger was left empty and was followed by the fourth and fifth impingers which contained 100 ml each of DI water. The sixth impinger contained a known quantity of silica gel.

The impinger train was connected to a commercially available metering system. Prior to sampling, the dry gas meter was calibrated utilizing the critical orifice procedures detailed in Section 16.2 of USEPA Method 5. A calibrated critical orifice set covering the anticipated sampling rates was utilized. Along with pre-test and post-test meter calibrations, the S-Type Pitot, thermocouple and nozzle were calibrated prior to and following use in the field according to USEPA Method 5 procedures.

The sample train was assembled, allowed to reach operating temperature, and leak checked by plugging the nozzle with a rubber septum and pulling a vacuum of approximately 15" of mercury (Hg). Once an acceptable leak check of less than 0.02 cubic feet per minute (cfm) was achieved, the sampling train was placed at the first traverse point and sampling began immediately. The sampling train was operated at an isokinetic rate with an isokinetic variation of 90% to 110%.

Each test run was 60 minutes in duration. At the conclusion of each test run, the sample train was cooled sufficiently, utilizing ambient air or ice, to allow the nozzle to be plugged with the rubber septum. The sampling train was leak-checked at a vacuum equal to or greater than the maximum value reached during sampling. An acceptable leakage rate was less than 0.02 cfm or 4% of the average sampling rate (whichever is less). In addition, a post-test Pitot leak check was performed. At the conclusion of the leak checks, the probe was disconnected and the remaining parts of the train were purged with clean ambient air for 15 minutes at the average sampling rate used during sampling.

7.5.2 Sample Recovery and Analysis

The probe and front-half of the quartz filter holder were rinsed with 100% IPA and added to a high density polyethylene (HDPE) sample bottle along with the quartz filter (Container 1). The extract was analyzed for SO_4^{2-} by ion chromatography (IC).

The contents of Impingers 1, 2 and 3 were quantitatively transferred to a HDPE sample bottle (Container 2). The back half of the filter holder, all connections, and the impingers were rinsed with a minimal amount of 100% IPA and these rinses were added to Container 2.

The unheated filter was transferred into a separate HDPE sample bottle (Container 3) containing approximately the same volume of 80% IPA as Container 2. The connections from the back of the third impinger and the front-half of the unheated filter holder were rinsed with a minimal amount of 100% IPA and added to Container 3. Container 4 contained the contents of the fourth and fifth impingers and the DI water rinses of these impingers and connections. Container 4 was discarded.

Field blanks of 25 ml of 80% IPA, 25 ml of 3% H_2O_2, and 200 ml DI water per batch of reagent were analyzed along with the samples by IC.

Sulfuric acid mist and audit sample laboratory results are contained in Appendix D. Sulfuric acid mist emissions are reported on a pounds per hour (lb/hr) and pounds per ton (lb/ton) basis.

7.6 Quality Assurance and Quality Control

All quality assurance/quality control (QA/QC) procedures as required by each USEPA Method were followed with no modifications. Appendix E contains all related QA/QC information.

The following field equipment calibrations are contained in Appendix E:

- Nozzle
- Pitot Tubes
- Thermocouple (TC)
- Dry Gas Meter and Orifices
- Qualified Source Testing Individual (QSTI) Certifications

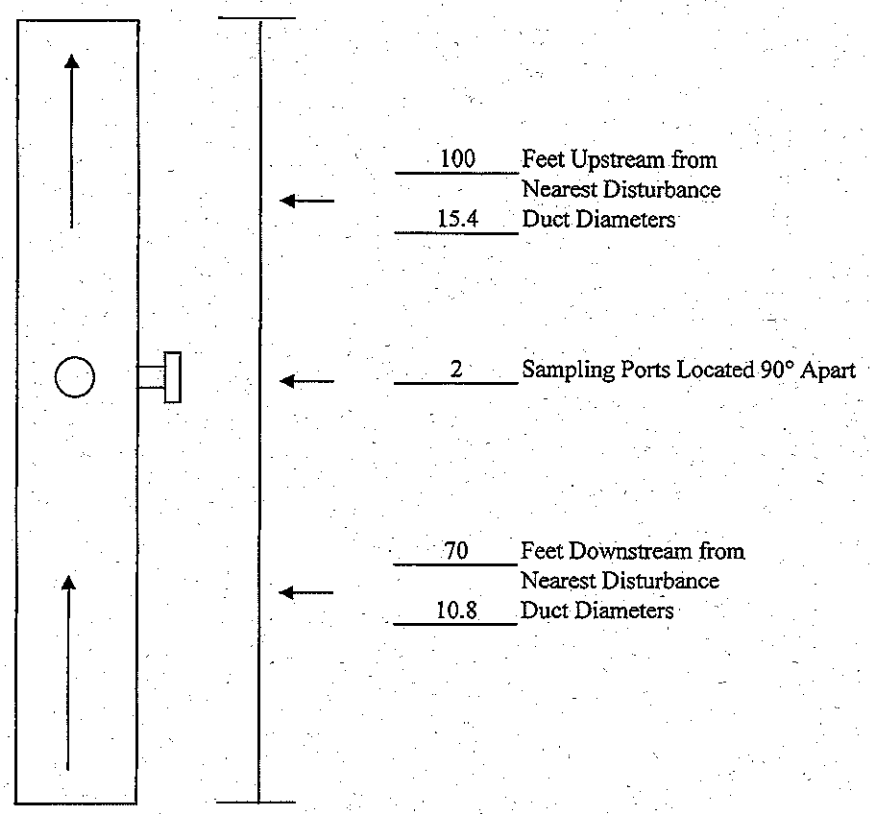
8 TEST RESULTS

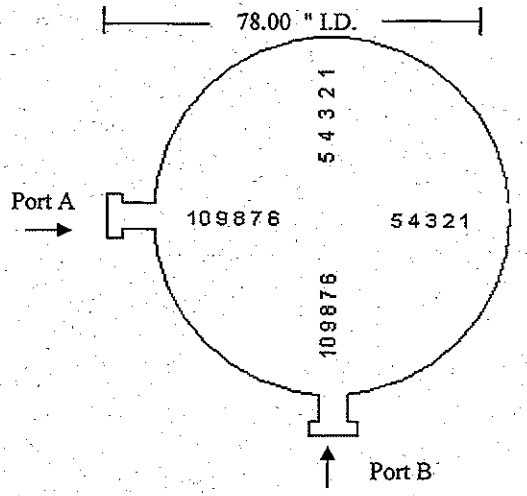
Sulfuric acid mist test results are contained in Table 1. Table 2 contains the table nomenclature. Appendix F contains sample calculations for one complete test run.

9 CONCLUSION

Air/Compliance Consultants, Inc. has completed sulfuric acid mist compliance emissions testing for the Guardian Industries Corporation, Glass Manufacturing Line 2, at their Carleton, Michigan facility. ACCI believes the test results are representative of the prevailing operating conditions at the time of testing.

REPORT – FIGURE





Point Number Each Port	Method 1 Value (inches)
1	75.97
2	71.60
3	66.61
4	60.37
5	51.32
6	26.68
7	17.63
8	11.39
9	6.40
10	2.03

Air/Compliance Consultants, Inc.

Glass Manufacturing Line 2 Sampling Stack Diagram
Guardian Industries Corporation, Carleton, Michigan

Figure 1

Y:\Guardian Industries\15-081 - Carleton MI - Stack Testing\Reports\Comp\Repeat H2SO4 Figure 1.xls\Sheet1

REPORT - TABLES

Table 1. Sulfur Acid Mist Emission Test Results Summary, Line 2 Glass Production
Guardian Industries, Carleton, Michigan

Test Data		**Run 1**	**Run 2**	**Run 3**	**Average**	
Date		10/22/15	10/22/15	10/22/15		
Start Time		11:56 AM	2:39 PM	4:47 PM		
End Time		1:03 PM	3:47 PM	5:54 PM		
Flow Rate	(ACFM)	126,015	122,026	133,569	127,203	
Flow Rate	(SCFM)	61,871	59,745	65,207	62,275	
Flow Rate	(DSCFM)	54,487	52,274	57,803	54,855	
Sample Volume	(DSCF)	72.433	60.904	66.583	66.640	
Carbon Dioxide (CO_2)	(dry volume %)	6.00	6.00	6.00	6.00	
Oxygen (O_2)	(dry volume %)	12.50	12.00	12.50	12.33	
Water Vapor (H_2O)	(volume %)	11.93	12.50	11.35	11.93	
Stack Temperature	(°F)	624.4	627.0	623.0	624.8	
Percent of Isokinetic Sampling	(%)	95.8	96.4	95.3	95.8	
Product Rate (Glass Pull Rate)	(ton/hr)	18.54	18.54	18.54	18.54	
Results						**Limit**
Sulfuric Acid Mist (H_2SO_4)						
Total mass as H_2SO_4	(mg)	10.98	7.52	34.01	17.50	
Sulfuric Acid Mist Concentration as H_2SO_4	(ppm_{dv})	1.32	1.07	4.44	2.28	
Sulfuric Acid Mist Emission as H_2SO_4	(lb/hr)	1.09	0.85	3.91	1.95	**1.6**
Sulfuric Acid Mist Emission as H_2SO_4	(lb/ton of glass)	0.059	0.046	0.211	0.105	

Table 2.

TABLE NOMENCLATURE

SYMBOL		DESCRIPTION	SYMBOL		DESCRIPTION	SYMBOL		DESCRIPTION
%	-	Percent	gpm	-	Gallons per minute	O_2	-	Oxygen
% Volume	-	Percent by volume	gr/DSCF	-	Grains per dry standard cubic feet	OSHA	-	Occupational Safety & Health Administration
°F	-	Degrees Fahrenheit	H_2O	-	Water	PADEP	-	PA Department of Environmental Protection
<	-	Less than	H_2SO_4	-	Sulfuric acid	Pb	-	Lead
>	-	Greater than	HAP	-	Hazardous air pollutant	PEL	-	Permissible exposure limit
AB	-	Acetone Blank	Hg	-	Mercury	PM	-	Particulate matter
ACFM	-	Actual cubic feet per minute	HI	-	Heat input	PM_{10}	-	Particulate matter less than 10 microns
BACT	-	Best Available Control Technology	Hp	-	Horsepower	ppb	-	Parts per billion
BHP	-	Brake horsepower	hr	-	Hour	PPE	-	Personal protective equipment
BTU	-	British thermal units	IC	-	Ion chromatography	ppm	-	Parts per million
BTU/scf	-	British thermal units per standard cubic feet	in H_2O	-	Inches of Water	ppm_{dv}	-	Parts per million, dry volume
C_3H_8	-	Propane	in Hg	-	Inches of Mercury	ppm_{wv}	-	Parts per million, wet volume
CE	-	Capture efficiency	Kg	-	Kilograms	psia	-	Pounds per square inch absolute
CEMS	-	Continuous emission monitor system	lb	-	Pound	psig	-	Pounds per square inch gauge
cf	-	Cubic foot	lb/hr	-	Pound per hour	PTI	-	Permit to Install
CFR	-	Code of Federal Regulations	lb/lb-mole	-	Pound per pound mole	PTE	-	Permanent total enclosure
CH_4	-	Methane	MACT	-	Maximum Achievable Control Technology	RA	-	Relative Accuracy
C_2H_6	-	Ethane	m^3	-	Cubic meters	RATA	-	Relative Accuracy Test Audit
Cl_2	-	Chlorine	MDL	-	Minimum detection limit	RM	-	Reference Method
CO	-	Carbon monoxide	mg	-	Milligrams	RMD	-	Relative mean difference
CO_2	-	Carbon dioxide	mg/g	-	Milligrams per gram	rpm	-	Revolutions per minute
COG	-	Coke oven gas	min	-	Minute	S	-	Sulfur
DACF	-	Dry actual cubic feet	mL	-	Milliliter	SCF	-	Standard cubic feet
DACM	-	Dry actual cubic meters	mm HG	-	Millimeters of mercury	SCFM	-	Standard cubic feet per minute
DE	-	Destruction efficiency	MMBtu	-	Million British thermal units	SCM	-	Standard cubic meters
DSCF	-	Dry standard cubic feet	MNOC	-	Maximum normal operating capacity	SO_2	-	Sulfur dioxide
DSCFM	-	Dry standard cubic feet per minute	MSDS	-	Material Safety Data Sheet	STD	-	Standard
FID	-	Flame Ionization Detector	MW	-	Megawatts	TEQ	-	Toxicity Equivalence Quotient
ft	-	Foot	N_2	-	Nitrogen	THC	-	Total hydrocarbons
ft/sec	-	Feet per second	ND	-	Non-detectable	tph	-	Tons per hour
Ft^2	-	Square feet	NDO	-	Natural draft opening	tpy	-	Tons per year
Ft^3	-	Cubic feet	NESHAP	-	National Emission Standard for Hazardous Air Pollutants	µg	-	Micrograms
ft^3/lb-mole	-	Cubic feet per pound mole	ng	-	Nanograms	USEPA	-	United States Environmental Protection Agency
g	-	Grams	NMEVOC	-	Non-methane, non-ethane volatile organic compounds	VE	-	Visible emissions
g/bhp-hr	-	Grams of brake horsepower per hour	NMVOC	-	Non-methane volatile organic compound	VOC	-	Volatile organic compound
g/mL	-	Gram per milliliter	NO_2	-	Nitrous Oxide	vol.	-	Volume
GC	-	Gas Chromatography	NO_x	-	Oxides of Nitrogen	w/o	-	With out