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Jacksonville, Florida 32202-3139

June 5, 2009



Ms. Trina Vielhauer
Chief Bureau of Air Regulation
Department of Environmental Protection
2600 Blair Stone Road, MS-5505
Tallahassee, FL. 32399

E L E C T R I C

W A T E R

S E W E R

RE: JEA / St. Johns River Power Park (SJRPP)
Air Construction Permit 0310045-017-AC
Emissions Performance Testing: Notification, Protocol & Schedule

Dear Ms. Vielhauer:

Pursuant to the above referenced JEA/SJRPP Air Construction Permit 0310045-017-AC's Emissions Performance Testing condition 8.(c): "At least 15 days prior to initiating the performance tests, the permittee shall submit a test notification, preliminary test schedule and test protocol to the Bureau of Air Regulation and the Compliance Authority", please find attached the "Protocol for Compliance Testing", which presents the required testing and scheduling information.

Please note that Clean Air Engineering (CleanAir) is tentatively scheduled to perform air emissions testing the week commencing June 22, 2009.

Please do not hesitate to contact me at (904) 665-8729 if you have any questions or require any additional information.

Sincerely,

A handwritten signature in black ink that reads "Jay Worley". The signature is written in a cursive style with a large loop at the beginning.

Jay Worley
Director, Environmental Programs

xc: W. Walker, ERMD
M. Halpin, FDEP
C. Kirts, FDEP
L. Haynes, EPA
D. Nunez, CleanAir

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CleanAir.

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PROTOCOL FOR COMPLIANCE TESTING

To be performed for:
SJRPP
UNIT 1 STACK
SAINT JOHN'S RIVER POWER PARK

CleanAir Project No: 10805
Revision R1: 6/05/2009

To the best of our knowledge, the data presented in this protocol is accurate, complete, error free, legible and representative of the actual emissions during the test program.

Submitted by,

A handwritten signature in black ink, appearing to read 'Daniel J Nunez', with a long horizontal flourish extending to the right.

Daniel J Nunez
Project Manager
(281) 443-6400
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PROJECT OVERVIEW

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INTRODUCTION

In accordance with the below JEA - St. Johns River Power Park's (SJRPP) Air Construction Permit 0310045-017-AC Emissions Performance Testing 8, Clean Air Engineering (CleanAir) is tentatively scheduled to perform air emissions testing the week commencing June 22, 2009.

Emissions Performance Testing

8. Initial Performance Tests – Ammonia Injection for SAM Emissions Control: Within 90 days of completing construction of both Boilers 1 and 2 SCR systems, the permittee shall conduct a series of initial performance tests on either Boiler 1 or 2 to determine the SAM emissions rate under a variety of operating scenarios that documents the impact of ammonia injection on reducing SAM emissions and results in the development of correlation/curves between injection rates, operating conditions and emissions.

- a) For each set of operating conditions being evaluated, the permittee shall conduct at least a 1-hour test run to determine SAM emissions. At least nine such test runs shall be conducted to evaluate the effect of SAM emissions on such parameters as the SO₂ emission rate prior to the SCR catalyst (and FGD system), the unit load, the flue gas flow rate, the ammonia injection rate and the current catalyst oxidation rate.
- b) Tests shall be conducted under a variety of fuel blends and load rates that are representative of the actual operating conditions intended for Boilers 1 and 2. Sufficient tests shall be conducted to establish the SAM emissions rates for the following scenarios: bypass of the SCR reactor, SCR reactor in service without ammonia injection, and SCR reactor in service under varying operating conditions and levels of ammonia injection.
- c) At least 15 days prior to initiating the performance tests, the permittee shall submit a test notification, preliminary test schedule and test protocol to the Bureau of Air Regulation and the Compliance Authority.
- d) Within 45 days following the last test run conducted, the permittee shall provide a report summarizing the emissions tests and results. All SAM emissions test data shall be provided with this report.
- e) Within 45 days following the submittal of the emissions test report and no later than 90 days following the last test run conducted, the permittee shall submit a project report summarizing the following: identify each set of operating conditions evaluated, identify each operating parameter evaluated, identify the relative influence of each operating parameter, describe how the automated control system will adjust the ammonia injection rate based on the selected parameters, identify the frequency with which operational parameters will be reevaluated and adjusted within the automated control system, provide the algorithm used for the automated control system or a series of related performance curves, and provide details for calculating and estimated the SAM emissions rate based on the level of ammonia injection and operating

PROJECT OVERVIEW

1-2

conditions. The test results shall be used to adjust the ammonia injection control system and estimate SAM emissions.
[Rules 62-4.070(3) and 62-212.300(1)(e), F.A.C.]

All testing will be conducted in accordance with the regulations set forth by the United States Environmental Protection Agency (USEPA) and the Florida Department of Environmental Protection (FLDEP).

Test Program Parameters

The testing to be performed at the Unit 1 Stack in June, 2009 will include the following emissions measurements:

- sulfuric acid mist (H₂SO₄) (SAM)
- ammonia (NH₃)
- flue gas composition (e.g., O₂, CO₂, H₂O)
- flue gas flow rate
- flue gas temperature

TEST PROGRAM SYNOPSIS**Test Schedule**

The on-site schedule followed during the test program is outlined in Table 1-1.

**Table 1-1:
Schedule of Activities**

Day	Activity	Location	Test Method	Runs	Sample Time
1	Mobilization				
2	Set-up Equipment				
	Preliminary Flow Traverse	U1 Stack	1-4	1	Varied
3	C2 11:00-14:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
4	C5 08:00-11:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes

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	C7 14:00-17:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
5	C10 11:00-14:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
	C12 16:00-19:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
6	S1 11:00-14:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
	SO ₂	U1 SCR Inlet	EPA 6C	continuous	continuous
	SAM	U1 SCR Inlet	Method 8*	2	60 minutes
	SAM	U1 SCR Outlet	Method 8*	2	60 minutes
6/7	S3 22:00-01:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
	SO ₂	U1 SCR Inlet	EPA 6C	continuous	continuous
	SAM	U1 SCR Inlet	Method 8*	2	60 minutes
	SAM	U1 SCR Outlet	Method 8*	2	60 minutes
7	C15 09:00-12:00				
	SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
	Ammonia testing	U1 Stack	CTM-027	2	60 minutes
	SO ₂	U1 SCR Inlet	EPA 6C	continuous	continuous
	SAM	U1 SCR Inlet	Method 8*	2	60 minutes
	SAM	U1 SCR Outlet	Method 8*	2	60 minutes

PROJECT OVERVIEW

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7/8

C17 22:00-01:00

SAM (3 simultaneous trains)	U1 Stack	Method 8*	1	60 minutes
Ammonia testing	U1 Stack	CTM-027	2	60 minutes
SO ₂	U1 SCR Inlet	EPA 6C	continuous	continuous
SAM	U1 SCR Inlet	Method 8*	2	60 minutes
SAM	U1 SCR Outlet	Method 8*	2	60 minutes

PROJECT OVERVIEW

TEST PROGRAM SYNOPSIS (CONTINUED)

**Table 1-2:
Summary of Testing Conditions**

Test Activity	Activity Name	Unit Load	SCR Operation ¹	Fuel ²	SO ₃ System Operation ³
C2	Permit Test – Bypass	100%	SCR Bypass	Colombian	Automatic
C5	Permit Test – No SCR NH ₃ /Auto SO ₃	100%	No NH ₃ Injection.	Colombian	Automatic
C7	Permit Test – No SCR NH ₃ /SO ₃ Off	100%	No NH ₃ Injection	Colombian	Off
C10	Permit Test – SCR NH ₃ Injection/SO ₃ Off	100%	Normal	Colombian	Off
C12	Permit Test – SCR NH ₃ Injection/ ½ SO ₃	100%	Normal	Colombian	½ Flow
S1a	Permit Test – Normal Operation	100%	Normal	Colombian	Automatic
S3a	Permit Test – Normal Minimum Load Operation	50%	Normal	Colombian	Automatic
C15	Permit Test – Design Load Domestic	100%	Normal	Domestic	Automatic
C17	Permit Test – Minimum Load Domestic	50%	Normal	Domestic	Automatic

Notes:

- The following is a description of the SCR operating options:
 SCR Bypass = SCR system is out of service, with bypass dampers in bypass position.
 Normal = SCR system in operation with the SCR ammonia system in automatic.
 No NH₃ injection = SCR system in operation but with no ammonia being injected in to the SCR
- The following is a description of the fuel options:
 Colombian = Unit firing 100 percent Colombian coal.
 Domestic = Unit firing 100 percent Domestic coal.
 Plant Preference = Fuel choice is dictated by plant operations, no specific fuel is required for the test.
- The following is a description of the SO₃ system operating options:
 Automatic = SO₃ control system operating such that the DCS controls the ammonia injection rate.
 ½ Flow = SO₃ control system operating with NH₃ injection rate set at ½ of the NH₃ flow rate demand from DCS.
 Off = SO₃ control system not in operation, no ammonia injection.

PROJECT OVERVIEW

Results Summary

Table 1- summarizes the required results of the test program.

**Table 1-3:
Summary of Test Results**

<u>Source</u> Constituent	Sampling Method	Average Emission	Permit Limit ¹
<u>Unit 1 Stack</u> SO3 (TPY)	EPA Method 8*	x.xx	1323
NH3 (ppmdv)	CTM-027	x.xx	5

¹ Permit limits obtained from SJRPP permit number: 0310045-017-AC.

060509 124044

Discussion of Test Program

CleanAir will perform EPA Methods 8*, CTM-027, and 6C for the determination of sulfuric acid mist (SAM), ammonia, and sulfur dioxide.

At the stack, SAM testing will be performed using three (3) separate sampling trains during one (1) single 60 minute run, while the ammonia testing will utilize one (1) sample train and two (2) 60 minute runs.

During conditions S1 and S3, in addition to the SAM and ammonia testing at the stack, SO₂ & SAM testing will occur at the inlet of one of the two SCR reactors and SAM testing will also occur at the outlet of the same reactor.

A preliminary velocity traverse and moisture determination will be performed at all locations during set-up, in order to determine.

Analysis of the ammonia samples will be performed onsite via Ion Chromatography (IC).

The SO₃ fractions of the SAM testing will also be analyzed on-site using IC. The SO₂ fraction will be analyzed via titration.

*SJRPP and CleanAir are currently in discussions with Florida DEP requesting approval for the alternative Method 8A (Controlled Condensation) for SAM testing. As such, methodology descriptions for both Method 8 and the alternative method are included in this protocol for reference purposes.

End of Section 1 – Project Overview

DESCRIPTION OF INSTALLATION

2-1

PROCESS DESCRIPTION

SJRPP operates two 624 MW power generating units. In addition to these, the plant has a series of Air Pollution Control Devices (APCDs) that are used to control emissions from the operation of the plant.

The testing reported in this document will be performed at the Unit 1 Stack and the inlet and outlet of the Unit 1 Selective Catalytic Reduction (SCR).

DESCRIPTION OF SAMPLING LOCATIONS

Sampling point locations were determined according to EPA Method 1.

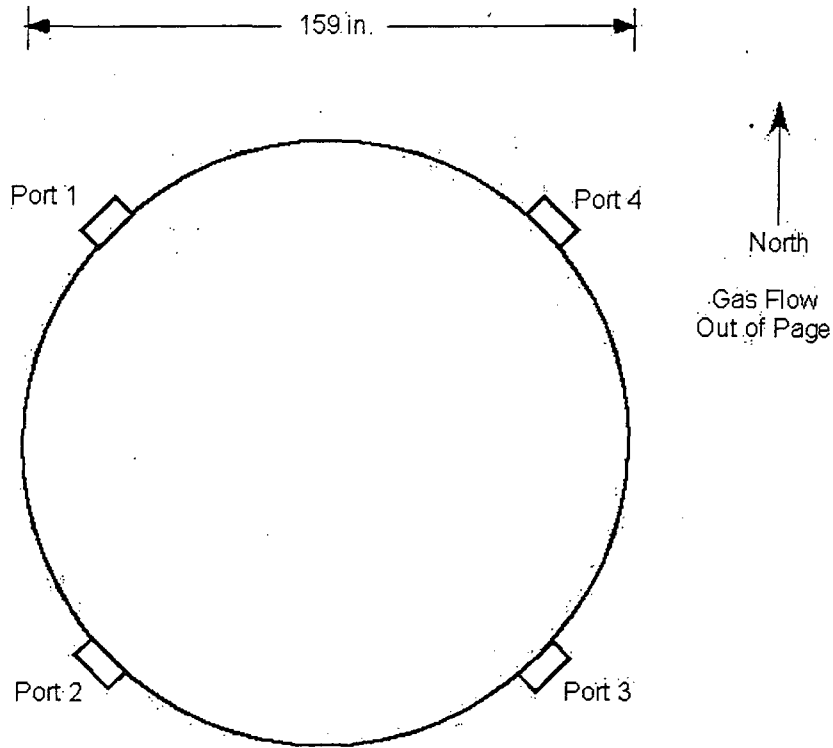
Table 2-1 outlines the sampling point configurations. Figure 2- through 2-2 illustrate the orientation of sampling ports for each of the sources to be tested in the program.

**Table 2-1:
Sampling Points**

<u>Source</u>		Run	Points per	Minutes per	Total		
Constituent	Method	No.	Port	Point	Minutes	Figure	
<u>Unit 1 Stack</u>							
SAM	EPA Method 8*	1	4	1	60	60	2-1
NH ₃	CTM-027	1-2	4	1	60	60	
<u>Unit 1 SCR Inlet</u>							
SAM	EPA Method 8*	1	7	1	60	60	2-2
SO ₂	EPA 6C	1-2	7	varied	continuous	varied	
<u>Unit 1 SCR Outlet</u>							
SAM	EPA Method 8*	1-2	12	1	60	60	2-3

DESCRIPTION OF INSTALLATION
DESCRIPTION OF SAMPLING LOCATIONS (CONTINUED)

2-2



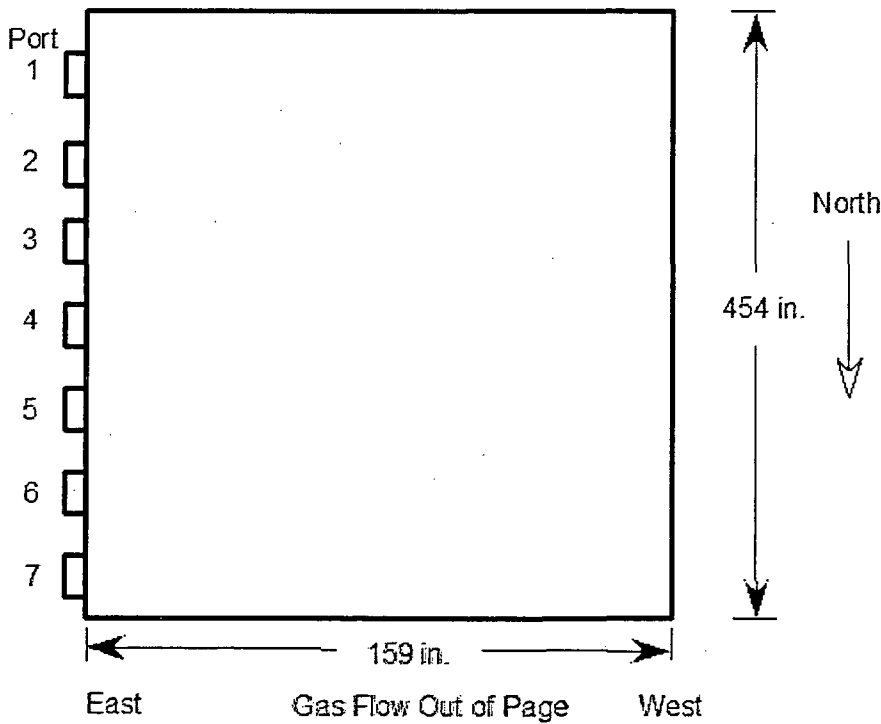
Duct diameters upstream from flow disturbance (A):	16.0	Limit: 0.5
Duct diameters downstream from flow disturbance (B):	21.4	Limit: 2.0

Figure 2-1: Unit 1 Stack

DESCRIPTION OF INSTALLATION

2-3

DESCRIPTION OF SAMPLING LOCATIONS (CONTINUED)

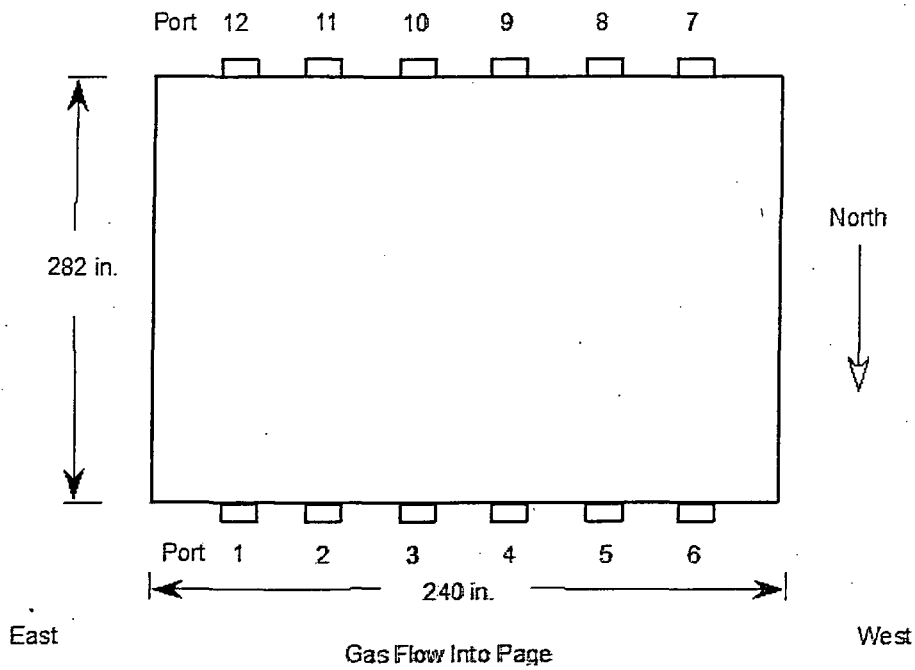


Equivalent Duct diameters upstream from flow disturbance (A):	1.22	Limit: 0.5
Equivalent Duct diameters downstream from flow disturbance (B):	3.21	Limit: 2.0

Figure 2-2: Unit 1 SCR Inlet (A or B)

DESCRIPTION OF INSTALLATION
DESCRIPTION OF SAMPLING LOCATIONS (CONTINUED)

2-4



Equivalent Duct diameters upstream from flow disturbance (A):	0.09	Limit: 0.5
Equivalent Duct diameters downstream from flow disturbance (B):	1.42	Limit: 2.0

Figure 2-3: Unit 1 SCR Outlet (A or B)

End of Section 3 – Description of Installation

METHODOLOGY

Clean Air Engineering followed procedures as detailed in USEPA Methods 1, 2, 3A, 4, CTM-027 and Method 8*. The following table summarizes the methods and their respective sources.

**Table 3-1:
Summary of Sampling Procedures**

Title 40 CFR Part 60 Appendix A

Method 1	"Sample and Velocity Traverses for Stationary Sources"
Method 2	"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
Method 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 4	"Determination of Moisture Content in Stack Gases"
Method 8	"Determination of Sulfuric Acid and Sulfur Dioxide Emissions from Stationary Sources"

Conditional Test Methods (CTM)

CTM-027	"Procedure for Collection and Analysis of Ammonia in Stationary Sources"
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These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR) and on the World Wide Web at <http://www.cleanair.com>.

Diagrams of the sampling apparatus and major specifications of the sampling, recovery and analytical procedures are summarized for each method in Appendix A.

CleanAir followed specific quality assurance and quality control (QA/QC) procedures as outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods", EPA/600/R-94/038C. Additional QA/QC methods as prescribed in CleanAir's internal Quality Manual were also followed. Results of all QA/QC activities performed by CleanAir are summarized in Appendix D.

METHODOLOGY

3-2

Sample and Velocity Traverse Points – USEPA Method 1

USEPA Method 1 provides guidance for the selection of sampling ports and traverse points at which sampling for air pollutants will be performed. This method is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source. A measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. Traverse points are then located within each of these equal areas.

The requirements of this method must be considered before construction of a new facility from which emissions are to be measured; failure to do so may require subsequent alterations to the stack or deviation from the standard procedure. Cases involving variants are subject to approval by the Administrator.

This method is applicable to gas streams flowing in ducts, stacks, and flues. It cannot be used when:

- the flow is cyclonic or swirling,
- a stack is smaller than 0.30 meter (12 in.) in diameter,
- a stack is smaller than 0.071 m^2 (113 in^2) in cross-sectional area.

Two procedures for determining cyclonic flow are presented in Method 1: a simplified procedure, and an alternative measurement site procedure. The magnitude of cyclonic flow of effluent gas in a stack or duct is the only parameter quantitatively measured in the simplified procedure. The simplified procedure cannot be used when the measurement site is less than two stack or duct diameters downstream or less than a half diameter upstream from a flow disturbance. In these cases, the alternative measurement site procedure, which involves traversing the source with a directional flow-sensing probe (3D Probe), must be used to measure the pitch and yaw angles of the gas flow at 40 or more traverse points. The resultant angle is then calculated and compared to acceptable criteria for mean and standard deviation.

Volumetric Flow Rate – USEPA Method 2

USEPA Method 2 is used to determine the average velocity and the volumetric flow rate of a gas stream. The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube.

This method is not applicable at measurement sites that fail to meet certain criteria of USEPA Method 1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams. Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, must be employed to produce accurate flow rate determinations. Examples of such alternative procedures are:

METHODOLOGY

3-3

- to install straightening vanes;
- to calculate the total volumetric flow rate stoichiometrically;
- to move to another measurement site at which the flow is acceptable.

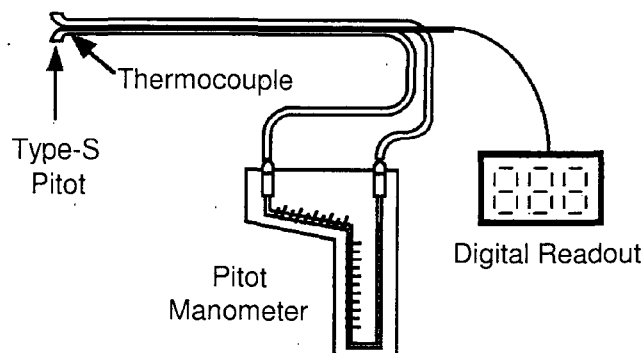


Figure 3-1: Velocity Apparatus (EPA Method 2)

Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrument Analyzer Procedure) – USEPA Method 3A

USEPA Method 3A applies to the determination of oxygen (O₂) and carbon dioxide (CO₂) concentrations in emissions from stationary sources.

A sample is continuously extracted from the effluent stream: a portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of O₂ and CO₂ concentration(s). Performance specifications and test procedures are provided to ensure reliable data.

Determination of Moisture Content in Stack Gases – USEPA Method 4

USEPA Method 4 is used for the determination of the moisture content of stack gas. A gas sample is extracted at a constant rate from the source; moisture is removed from the sample stream and determined either volumetrically or gravimetrically.

The method contains two possible procedures:

- reference method
- approximation method

The reference method is used for accurate determinations of moisture content. The reference method is often conducted simultaneously with a pollutant emission measurement run. When it is, calculation of percent isokinetic, pollutant emission rate, etc., for the run is based upon the results of the reference method or its equivalent.

METHODOLOGY

3-4

The approximation method provided is used to estimate percent moisture to aid in setting isokinetic sampling rates prior to a pollutant emission measurement run. Alternative means for approximating the moisture content (*e.g.*, drying tubes, wet bulb-dry bulb techniques, condensation techniques, stoichiometric calculations, previous experience, etc.) are also acceptable as approximation methods.

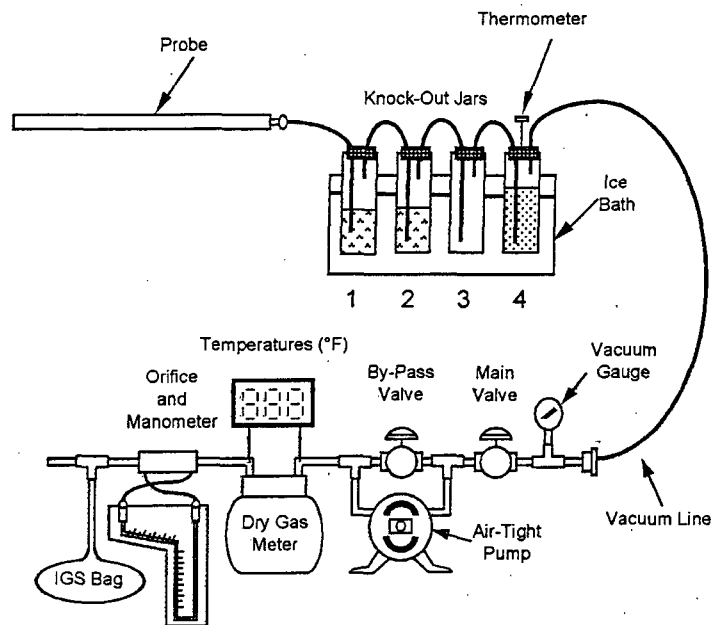


Figure 3-2: Moisture and Molecular Weight train (EPA Method 4)

Sulfur Dioxide Emissions from Stationary Sources (Instrument Analyzer Method) – USEPA Method 6C

USEPA Method 6C is used for the determination of sulfur dioxide (SO₂) concentrations in controlled and uncontrolled emissions from stationary sources.

A gas sample is continuously extracted from a stack, and a portion of the sample is conveyed to an instrumental analyzer for determination of SO₂ gas concentration using an ultraviolet (UV), nondispersive infrared (NDIR), or fluorescence analyzer. Performance specifications and test procedures are provided to ensure reliable data.

The analytical range is determined by the instrumental design. For this method, a portion of the analytical range is selected by choosing the span of the monitoring system. The span of the monitoring system is selected such that the pollutant gas concentration equivalent to the emission standard is not less than 30 percent of the span. If at any time during a run the measured gas concentration exceeds the span, the run is considered invalid.

METHODOLOGY

3-5

The minimum detectable limit depends on the analytical range, span, and signal-to-noise ratio of the measurement system. For a well designed system, the minimum detectable limit is less than 2 percent of the span.

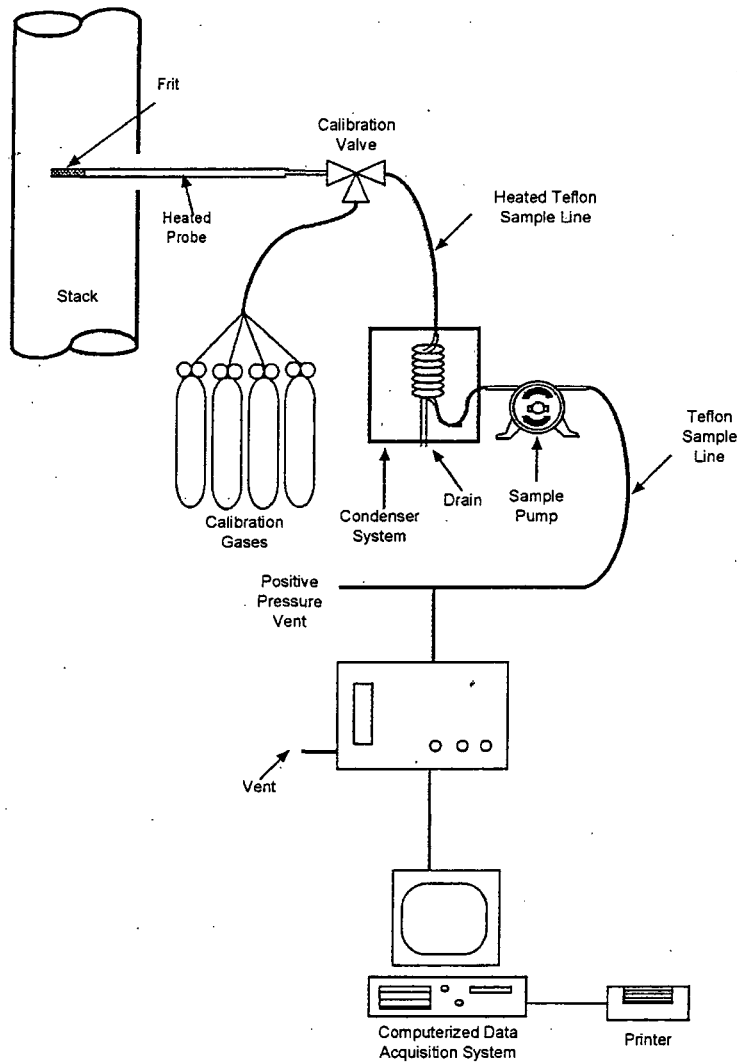


Figure 3-3: CEMs Apparatus (EPA Method 6C)

METHODOLOGY

3-6

Sulfuric Acid and Sulfur Dioxide Emissions from Stationary Sources – USEPA Method 8

USEPA Method 8 is used to measure sulfuric acid (including H₂SO₄ mist and SO₃) and gaseous SO₂ emissions from stationary sources. Source gas is withdrawn isokinetically and bubbled through isopropanol (to collect H₂SO₄ mist and SO₃) followed by a solution of hydrogen peroxide (to collect SO₂). The H₂SO₄/SO₃ and the SO₂ fractions are measured separately by the barium-thorin titration method.

Filterable particulate matter may be determined along with SO₃ and SO₂ (subject to the approval of the Administrator) by inserting a heated glass fiber filter between the probe and isopropanol impinger. If this option is chosen, particulate analysis is done gravimetrically and sulfuric acid is not determined.

Possible interfering agents of USEPA Method 8 include fluorides, free ammonia, and dimethyl aniline. If any of these interfering agents is present (this can be determined by knowledge of the process), alternative methods, subject to the approval of the Administrator, are required.

METHODOLOGY

3-7

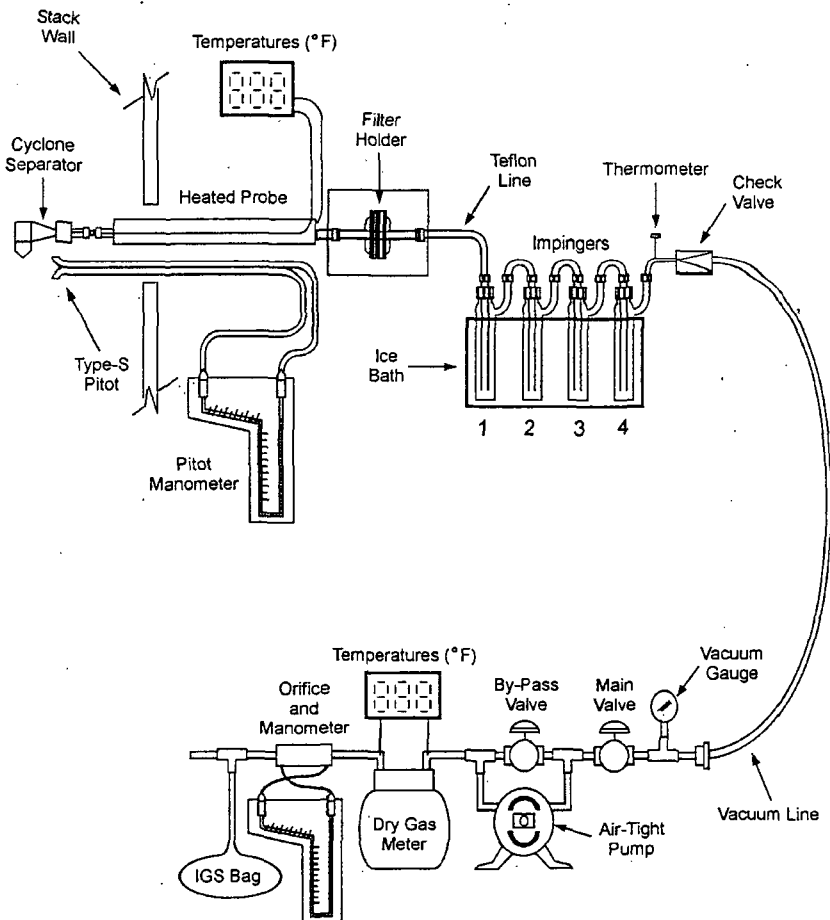


Figure 3-4: (SAM) train (EPA Method 8)

Determination of Ammonia Emissions – USEPA Conditional Test Method 027

USEPA Conditional Test Method 027 is used to determine gaseous concentration of ammonia in flue gas streams. This method collects the emission sample using a modified Method 17 sampling apparatus.

The gas sample is withdrawn isokinetically from the source and filtered in-stack using a glass-fiber filter. A glass or quartz probe is used to extract the gas sample. An acidic absorbing solution (0.1 Normal Sulfuric Acid) contained in a series of glass impingers captures the gaseous ammonia from the particulate-free gas. The acidic solutions are recovered and analyzed for ammonia using ion chromatography.

METHODOLOGY

3-8

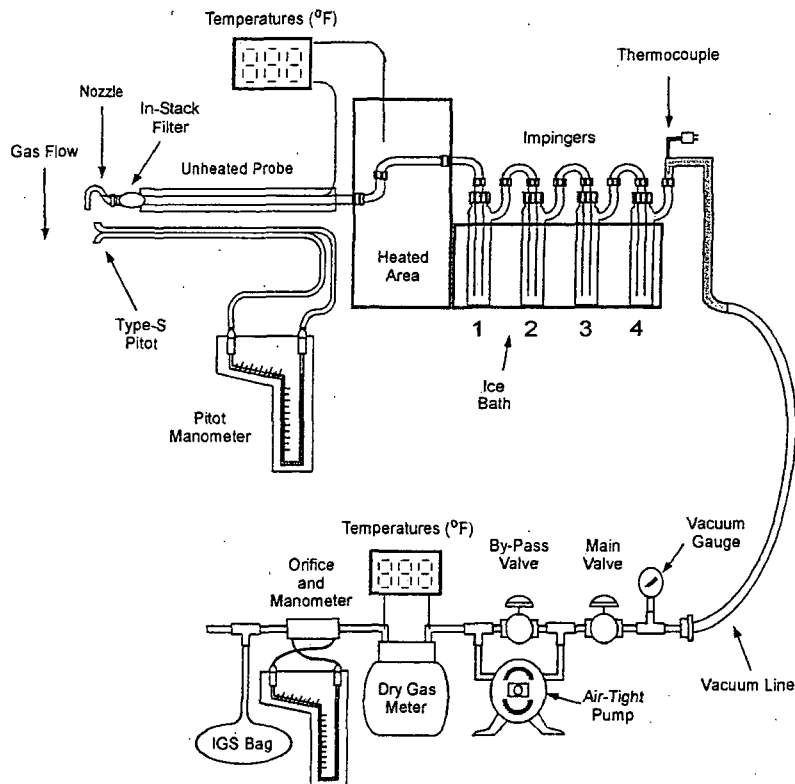


Figure 3-5: Ammonia train (EPA CTM-027)

Sulfuric Acid Mist – Method 8A (Controlled Condensation)

This method is applicable for the determination of sulfur dioxide, sulfur trioxide, and sulfuric acid vapor and/or mist using a controlled condensation sampling system train. CleanAir developed this method as an alternate procedure to ASTM D3226-73T and NCASI Method 8A for the determination of sulfuric acid emissions from combustion sources, principally fossil fuel fired steam boilers.

A particulate-laden gas sample is extracted at a constant flow rate from the source using a glass lined probe heated to 316 ± 14 °C (600 ± 25 °F), and then passed through a glass fiber filter maintained at a temperature of 288 ± 14 °C (550 ± 25 °F). The gas stream sample is passed through an impaction type condenser for collection of residual sulfuric acid vapor and/or mist. The probe rinse, filter and the condenser collection media are each extracted separately with 80% isopropyl alcohol, and the extractions are titrated with barium chloride-thorin solution. The impinger solution is recovered separately, and titrated using the barium chloride-thorin titration method.

METHODOLOGY

Free ammonia is a possible interferent. Free ammonia interferes with this method by reacting with SO₂ and SO₃ to form particulate sulfite and sulfates and by reacting with the indicator. The presence of free ammonia in the gas stream will typically require analysis by ion chromatography.

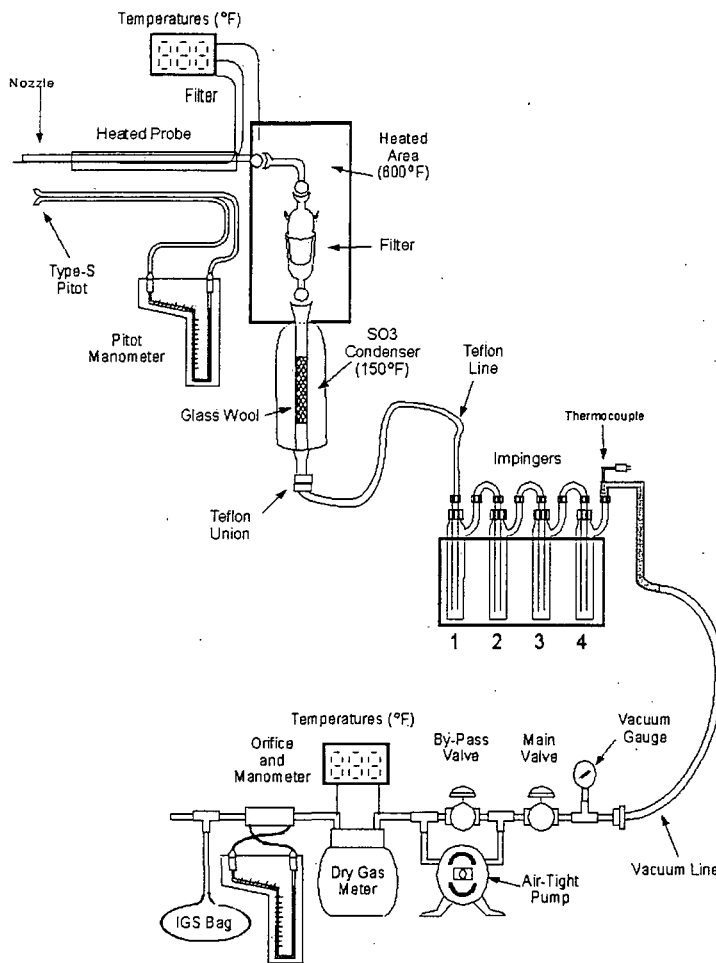


Figure 3-6: CCM (SAM) train (Method 8A)

End of Section 4 – Methodology

RESUMES

4-1

CleanAir.

Daniel J Nuñez Project Manager

Professional Profile

Mr. Nuñez has been with CleanAir since July 2005. He has been working with the Source Testing team since September 2007; prior to that, he worked with the Analytical Services team. During his time in the laboratory, he was involved with hundreds of Ion Chromatography, Gas Chromatography and Gravimetric projects.

Since 2005, Mr. Nuñez has been involved with various projects covering a wide range of technical work. This work incorporates both laboratory and field analyses. He is responsible for project management, field testing supervision, sample preparation and analysis, as well as calibration and operation of analytical devices used in the field and laboratory.

The laboratory portion of this work includes:

- Ion Chromatography (IC) Analysis and Method Development
- Gas Chromatography (GC) Analysis
- Wet Chemistry Laboratory Analysis and Method Development
- Scrubber performance analysis according to EPRI and ASTM approved methods

Mr. Nuñez has also received his Qualified Source Testing Individual (QSTI) certification.

Relevant Experience

Babcock Power / Santee Cooper

Winyah Generating Station; Georgetown, South Carolina

Field Crew Member responsible for on-site Sulfate and Ammonium analysis by Ion Chromatography.

Fuel Tech / Santee Cooper

Cross Generating Station; Pineville, South Carolina

Field Crew Member for the determination of SO₂ conversion across the SCR and Air Pre-Heater on Units 2 and 3. SO₂/SO₃ determinations were made by controlled condensation at the inlet and outlet of the SCR and the outlet of the Air Pre-Heater. All SO₂/SO₃ samples were analyzed on-site by Ion Chromatography and Barium Perchlorate titrations.

Louisa Environmental Project Partners / MidAmerican Energy Corp.

Louisa Generating Station; Muscatine, Iowa

Field Test Leader and Project Manager for the Lime quality and Scrubber efficiency guarantee. Coordinated sample collection and flue gas flow rate determination over various usage periods, in order to demonstrate scrubber performance with regards to Lime quality, Lime consumption, and stoichiometric ratio of available lime and present SO₂.

Evonik-Degussa Corporation

Consumer Specialties; Janesville, Wisconsin

Field Test Leader and GC operator for the compliance and pre-compliance test of a Cryogenic Scrubber installed for the removal of VOCs (primarily Methyl Chloride). Mr. Nuñez determined operating conditions for GC analysis in order to yield accurate and timely results.

Goodyear Tire & Rubber Company

Natsyn Line; Beaumont, Texas

Field Test Leader, Project Manager and GC operator for the compliance test of the Natsyn crumb tank emissions. Mr. Nuñez developed the protocol and proper GC operating conditions for the analysis of 14 compounds.

Black & Veatch

Saint John's River Power Park; Jacksonville, Florida

Field Test Leader and Project Manager for SCR Performance Guarantee. CleanAir's Multi-point Automated Sampling System (MASS) was used to determine Outlet NO_x distribution in addition to removal efficiency. SO₂ conversion across the SCR on Unit 2 utilizing ASTM D3226-73T (Controlled Condensation) and Ammonia slip sampling by CTM 027 were also utilized. All samples were analyzed on-site to expedite the results and allow B&V to complete its guarantee in a timely manner.

Education

Bachelor of Arts in Chemistry, 2004

Minor in Environmental Studies

Knox College, Galesburg, Illinois

CleanAir

Jacob Voorhies Field Test Coordinator

Professional Profile

Mr. Voorhies has field testing experience in both compliance and diagnostic Environmental Protection Agency (EPA) source testing, utilizing most of Methods 1 through 29 of the Code of Federal Regulations (CFR40 Part 60). Mr. Voorhies's responsibilities include pre- and post-test equipment calibration, packing, shipping, maintenance, software applications, equipment set-up, field testing, data acquisition, post-test data reduction, and report preparation.

Relevant Experience

B & W; KCPL Hawthorne Plant; Kansas City, MO

Determination of ammonia slip at SCR Outlet. EPA methods 1-4, CTM-027 were used

AES Deepwater Cogeneration; Pasadena, Texas

Performed annual Relative Accuracy testing on boiler for flow and CEMs including SO₂, NO_x, CO₂, and CO. EPA Methods 1-4, 3A, 6C, 7E, and 10 were used.

Anthony Forest Products, Co; Urbana, Arkansas

Perform diagnostic emission measurements on 3 wood-fired process boilers.
EPA Methods 1-4, 29 were used.

Temple-Inland; Hope, Arkansas

Perform emission measurements at pre-press bag house to determine formaldehyde concentration.
EPA Methods 1,2,3A,4, NCASI were used.

Temple-Inland; Thomson, Georgia

Perform metals & organic HAPs testing to provide the plant with data for use in Risk Modeling.
EPA Methods 1-4, 29, NCASI 99.02 were used.

Goodyear; Beaumont, Texas

Performed testing for NO, CO, NO_x, NO₂, and O₂. EPA Methods 1-4 and CTM-030 were used

Invista; Victoria, TX

Performed particulate/metals, HCl/Cl₂, particulate sizing, SO₂, NO_x and CO testing upon a boiler where 2 different fuels were used. EPA Methods 1-4, 5/29, 26A, CARB 501, 6C, 7E and 10 were used.

Fossil & Hydro; Chesapeake, VA

Determination of ammonia slip at SCR Outlet. EPA methods 1-4, CTM-027 were used

Education

Bachelor of Science, Environmental Science, 2006, Springfield College

SAMPLE CALCULATIONS

4-2

**CTM-027
 NH₃ Analyte Calculations**

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

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 K

1. Ammonium to NH₃ conversion factor

$$K_{NH_3} = \frac{MW_{NH_3}}{n \times MW_{NH_4^+}}$$

Where:

MW _{NH3}	= molecular weight of NH ₃ (mg/mg-mole)	=	17.030	mg/mg-mole
MW _{NH4+}	= molecular weight of ammonium ion (mg/mg-mole)	=	18.040	mg/mg-mole
n	= molar ratio of ammonium to NH ₃	=	1.0	mole NH ₄ ⁺ /mole NH ₃
K _{NH3}	= conversion factor to convert mass NH ₄ ⁺ to mass NH ₃	=	0.944	

2. Total NH₃ collected (mg)

$$m_{NH_3} = K_{NH_3} \times \frac{(S_{NH_4^+} v_1 + S_{NH_4^+} v_2)}{1000}$$

Where:

K _{NH3}	= conversion factor to convert mass NH ₄ ⁺ to mass NH ₃	=	0.944	
S _{NH4-1}	= ammonium concentration of sample fraction 1 (mg/liter)	=	<0.0050	mg/liter
v ₁	= liquid volume of sample fraction 1 (ml)	=	774.0	ml
S _{NH4-2}	= ammonium concentration of sample fraction 2 (mg/liter)	=	0.0000	mg/liter
v ₂	= liquid volume of sample fraction 2 (ml)	=	0.0	ml
1000	= conversion factor (ml/liter)	=	1000	ml/liter
m _{NH3}	= total NH ₃ collected in sample (mg)	=	<0.0037	mg

Note: Non-detects are treated as zero in summations.

DEFINITION

Fraction 1 = entire sample except last impinger containing applicable absorbing reagent.
 Fraction 2 = last impinger containing applicable absorbing reagent, analyzed separately to evaluate collection efficiency.
 If entire sample is analyzed as a single fraction, then data is included as Fraction 1 (Fraction 2 = 0).

3. Allowable blank subtraction (mg)

$$m_b = K_{NH_3} \times B_{NH_4^+} \times \frac{(v_1 + v_2)}{1000}$$

$$m_b = 0 \quad \text{if } B_{NH_4^+} < MDL$$

4. Total NH3 collected, corrected for blank (mg)

$$m_{nb} = m_{NH_3} - m_b$$

Where:

m_{NH_3}	= total NH ₃ collected in sample (mg)	=	<0.0037	mg
m_b	= allowable blank subtraction (mg)	=	0.0000	mg
m_{nb}	= total NH ₃ collected, corrected for blank (mg)	=	<0.0037	mg

5. Minimum detectable NH3 (mg)

$$m_{MDL} = K_{NH_3} \times MDL \times \frac{(v_1 + v_2)}{1000}$$

Where:

K_{NH_3}	= conversion factor to convert mass NH ₄ ⁺ to mass NH ₃	=	0.944	
MDL	= minimum detectable ammonium concentration	=	0.063	mg/liter
v_1	= liquid volume of sample fraction 1 (ml)	=	774.0	ml
v_2	= liquid volume of sample fraction 2 (ml)	=	0.0	ml
1000	= conversion factor (ml/liter)	=	1000	ml/liter
m_{MDL}	= minimum detectable NH ₃ (mg)	=	0.0460	mg

6. Total NH3 value used in emission calculations (mg)

$$m_n = \text{MAXIMUM} [m_{nb} \text{ or } < m_{MDL}]$$

Where:

m_{nb}	= total NH ₃ collected, corrected for blank (mg)	=	<0.0037	mg
m_{MDL}	= minimum detectable NH ₃ (mg)	=	0.0460	mg
m_n	= total NH ₃ value used in emission calculations (mg)	=	<0.0460	mg

7. Collection QC check (% mass collected in second fraction)

$$EFF = 100 \times \frac{K_{NH_3} \times S_{NH_4-2} \times \frac{v_2}{1000}}{m_{NH_3}}$$

Where:

K_{NH_3}	= conversion factor to convert mass NH ₄ ⁺ to mass NH ₃	=	0.944	
S_{NH_4-2}	= ammonium concentration of sample fraction 2 (mg/liter)	=	0.0000	mg/liter
v_2	= liquid volume of sample fraction 2 (ml)	=	0.0	ml
m_{NH_3}	= total NH ₃ collected in sample (mg)	=	<0.0037	mg
1000	= conversion factor (ml/liter)	=	1000	ml/liter
100	= conversion factor	=	100	%
EFF	= Collection QC check (% mass collected in second fraction)	=	0.00	%

**CTM-027
 NH₃ Sample Calculations**

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

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 N_K

1. NH₃ concentration (lb/dscf)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	= <0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	= 39.7518	dscf
2.205×10^{-3}	= conversion factor (lb/g)	= 2.205E-03	lb/g
1000	= conversion factor (mg/g)	= 1,000	mg/g
C_{sd}	= NH ₃ concentration (lb/dscf)	= <2.5533E-09	lb/dscf

2. NH₃ concentration (ppmdv)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{0.850}{1000} \right) \left(\frac{10^6}{MW} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	= <0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	= 39.7518	dscf
MW	= molecular weight of NH ₃ (g/g-mole)	= 17.030	g/g-mole
0.850	= conversion factor (dscf/g-mole)	= 0.850	dscf/g-mole
1000	= conversion factor (mg/g)	= 1,000	mg/g
10^6	= conversion factor (ppm)	= 10^6	ppm
C_{sd}	= NH ₃ concentration (ppmdv)	= <0.0578	ppmdv

3. NH₃ concentration (ppmwv)

$$C_w = C_{sd} \left(1 - \frac{B_w}{100} \right)$$

Where:

C_{sd}	= NH ₃ concentration (ppmdv)	= <0.0578	ppmdv
B_w	= actual water vapor in gas (% v/v)	= 10.3481	% v/v
100	= conversion factor (%)	= 100	%
C_w	= NH ₃ concentration (ppmwv)	= <0.0518	ppmwv

4. NH₃ concentration (mg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) (35.31)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
C_{sd}	= NH ₃ concentration (mg/dscm)	=	<0.0409	mg/dscm

5. NH₃ concentration (mg/Nm³ dry)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) (35.31) \left(\frac{68 + 460}{32 + 460} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	
C_{sd}	= NH ₃ concentration (mg/Nm ³ dry)	=	<0.0439	mg/Nm ³ dry

6. NH₃ concentration corrected to x% O₂ (ppmdv example)

$$C_{sdx} = C_{sd} \left(\frac{20.9 - x}{20.9 - O_2} \right)$$

Where:

C_{sd}	= NH ₃ concentration (ppmdv)	=	<0.0578	ppmdv
x	= oxygen content of corrected gas (%)	=	3.0	%
O ₂	= proportion of oxygen in the gas stream by volume (%)	=	3.3	%
20.9	= oxygen content of ambient air (%)	=	20.9	%
C_{sdx}	= NH ₃ concentration corrected to x%O ₂ (ppmdv)	=	<0.0588	ppmdv @ x%O ₂

7. NH₃ concentration corrected to y% CO₂ (ppmdv example)

$$C_{sdy} = C_{sd} \left(\frac{y}{CO_2} \right)$$

Where:

C_{sd}	= NH ₃ concentration (ppmdv)	=	<0.0578	ppmdv
y	= carbon dioxide content of corrected gas (%)	=	12.0	%
CO ₂	= proportion of carbon dioxide in the gas stream by volume (%)	=	14.6	%
C_{sdy}	= NH ₃ concentration corrected to y%CO ₂ (ppmdv)	=	<0.0475	ppmdv @ y%CO ₂

8. NH₃ concentration at actual gas conditions (lb/acf example)

$$C_a = C_{sd} \left(\frac{Q_{std}}{Q_a} \right)$$

Where:

C_{sd}	= NH ₃ concentration (lb/dscf)	= <2.5533E-09	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 626,931	dscfm
Q_a	= volumetric flow rate at actual conditions (acfm)	= 1,622,493	acfm
C_a	= NH ₃ concentration at actual gas conditions (lb/acf)	= <9.8660E-10	lb/acf

9. NH₃ rate (lb/hr)

$$E_{lb/hr} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (Q_{std})(60)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	= <0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	= 39.7518	dscf
2.205×10^{-3}	= conversion factor (lb/g)	= 2.205E-03	lb/g
1000	= conversion factor (mg/g)	= 1,000	mg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 626,931	dscfm
60	= conversion factor (min/hr)	= 60	min/hr
$E_{lb/hr}$	= NH ₃ rate (lb/hr)	= <0.0960	lb/hr

10. NH₃ rate (kg/hr)

$$E_{kg/hr} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{Q_{std}(60)}{10^6} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	= <0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	= 39.7518	dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 626,931	dscfm
60	= conversion factor (min/hr)	= 60	min/hr
10^6	= conversion factor (mg/kg)	= 10^6	g/kg
$E_{kg/hr}$	= NH ₃ rate (kg/hr)	= <0.0436	kg/hr

11. NH₃ rate (Ton/yr)

$$E_{T/yr} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (Q_{std})(60) \left(\frac{Cap}{2000} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	= <0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	= 39.7518	dscf
2.205×10^{-3}	= conversion factor (lb/g)	= 2.205E-03	lb/g
1000	= conversion factor (mg/g)	= 1,000	mg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 626,931	dscfm
60	= conversion factor (min/hr)	= 60	min/hr
Cap	= capacity factor for process (hours operated/year)	= 8,760	hours/yr
2000	= conversion factor (lb/Ton)	= 2,000	lb/Ton
$E_{T/yr}$	= NH ₃ rate (Ton/yr)	= <0.4207	Ton/yr

12. NH₃ rate - F_d-based (lb/MMBtu)

$$E_{Fd} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (F_d) \left(\frac{20.9}{20.9 - O_2} \right)$$

Where:

m _n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V _{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
2.205 x 10 ⁻³	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
F _d	= ratio of gas volume to heat content of fuel (dscf/MMBtu)	=	9,621	dscf/MMBtu
O ₂	= proportion of oxygen in the gas stream by volume (%)	=	3.3	%
20.9	= oxygen content of ambient air (%)	=	20.9	%
E _{Fd}	= NH ₃ rate (lb/MMBtu)	=	<2.9171E-05	lb/MMBtu

13. NH₃ rate - F_c-based (lb/MMBtu)

$$E_{Fc} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (F_c) \left(\frac{100}{CO_2} \right)$$

Where:

m _n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V _{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
2.205 x 10 ⁻³	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
F _c	= ratio of gas volume to heat content of fuel (dscf/MMBtu)	=		dscf/MMBtu
CO ₂	= proportion of oxygen in the gas stream by volume (%)	=	14.6	%
100	= conversion factor	=	100	
E _{Fc}	= NH ₃ rate (lb/MMBtu)	=	N/A	lb/MMBtu

14. NH₃ rate - Heat Input-based (lb/MMBtu)

$$E_{Hi} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) \left(\frac{Q_{std} (60)}{H_i} \right)$$

Where:

m _n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V _{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
2.205 x 10 ⁻³	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
Q _{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	626,931	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
H _i	= actual heat input (MMBtu/hr)	=		MMBtu/hr
E _{Hi}	= NH ₃ rate (lb/MMBtu)	=	N/A	lb/MMBtu

15. NH₃ rate - Production-based (lb/unit)

$$E_{RP} = \left(\frac{m_n}{V_{mstd}} \right) \left(2.205 \times 10^{-3} \right) \left(\frac{Q_{std} \times 60}{1000 \times R_p} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	626,931	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
1000	= conversion factor (mg/g)	=	1000	mg/g
R_p	= production rate (units/hr)	=		units/hour
E_{RP}	= NH ₃ rate - production based(lb/xxxx)	=	N/A	lb/unit

16. NH₃ rate - Production-based (kg/unit)

$$E_{RP} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{Q_{std} \times 60}{10^6 \times R_p} \right)$$

Where:

m_n	= total NH ₃ collected, corrected for applicable blank (mg)	=	<0.0460	mg
V_{mstd}	= volume metered, standard (dscf)	=	39.7518	dscf
10^6	= conversion factor (mg/kg)	=	1,000,000	mg/kg
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	626,931	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=		units/hour
E_{RP}	= NH ₃ rate - production based(lb/xxxx)	=	N/A	kg/unit

**USEPA Method 8
 SO3 Analyte Calculations**

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

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 ©

1. Sulfate to SO3 conversion factor

$$K_a = \frac{MW_a}{n \times MW_{ion}}$$

Where:

MW _a	= molecular weight of SO3 (mg/mg-mole)	=	80.058	mg/mg-mole
MW _{ion}	= molecular weight of Sulfate ion (mg/mg-mole)	=	96.057	mg/mg-mole
n	= molar ratio of Sulfate to SO3	=	1.0	mole SO4--/mole SO
K _a	= conversion factor to convert mass SO4-- to mass SO3	=	0.833	

2. Total SO3 collected (mg)

$$m_a = K_a \times \frac{(S_{i-1} v_1 + S_{i-2} v_2)}{1000}$$

Where:

K _a	= conversion factor to convert mass SO4-- to mass SO3	=	0.833	
S _{i-1}	= Sulfate concentration of sample fraction 1 (mg/liter)	=	124.7500	mg/liter
v ₁	= liquid volume of sample fraction 1 (ml)	=	122.0	ml
S _{i-2}	= Sulfate concentration of sample fraction 2 (mg/liter)	=	0.0000	mg/liter
v ₂	= liquid volume of sample fraction 2 (ml)	=	0.0	ml
1000	= conversion factor (ml/liter)	=	1000	ml/liter
m _a	= total SO3 collected in sample (mg)	=	12.6778	mg

Note: Non-detects are treated as zero in summations.

DEFINITION
 Fraction 1 = entire sample except last impinger containing applicable absorbing reagent.
 Fraction 2 = last impinger containing applicable absorbing reagent, analyzed separately to evaluate collection efficiency.
 If entire sample is analyzed as a single fraction, then data is included as Fraction 1 (Fraction 2 = 0).

3. Allowable blank subtraction (mg)

$$m_b = K_a \times B_i \times \frac{(v_1 + v_2)}{1000}$$

$$m_b = 0 \quad \text{if } B_i < MDL$$

4. Total SO3 collected, corrected for blank (mg)

$$m_{nb} = m_a - m_b$$

Where:

m_a	= total SO3 collected in sample (mg)	=	12.6778	mg
m_b	= allowable blank subtraction (mg)	=	0.0000	mg
m_{nb}	= total SO3 collected, corrected for blank (mg)	=	12.6778	mg

5. Minimum detectable SO3 (mg)

$$m_{MDL} = K_a \times MDL \times \frac{(v_1 + v_2)}{1000}$$

Where:

K_a	= conversion factor to convert mass SO4-- to mass SO3	=	0.833	
MDL	= minimum detectable Sulfate concentration	=	0.281	mg/liter
v_1	= liquid volume of sample fraction 1 (ml)	=	122.0	ml
v_2	= liquid volume of sample fraction 2 (ml)	=	0.0	ml
1000	= conversion factor (ml/liter)	=	1000	ml/liter
m_{MDL}	= minimum detectable SO3 (mg)	=	0.0286	mg

6. Total SO3 value used in emission calculations (mg)

$$m_n = \text{MAXIMUM} [m_{nb} \text{ or } < m_{MDL}]$$

Where:

m_{nb}	= total SO3 collected, corrected for blank (mg)	=	12.6778	mg
m_{MDL}	= minimum detectable SO3 (mg)	=	0.0286	mg
m_n	= total SO3 value used in emission calculations (mg)	=	12.6778	mg

7. Collection QC check (% mass collected in second fraction)

$$EFF = 100 \times \frac{K_a \times S_{i-2} \times \frac{v_2}{1000}}{m_a}$$

Where:

K_a	= conversion factor to convert mass SO4-- to mass SO3	=	0.833	
S_{i-2}	= Sulfate concentration of sample fraction 2 (mg/liter)	=	0.0000	mg/liter
v_2	= liquid volume of sample fraction 2 (ml)	=	0.0	ml
m_a	= total SO3 collected in sample (mg)	=	12.6778	mg
1000	= conversion factor (ml/liter)	=	1000	ml/liter
100	= conversion factor	=	100	%
EFF	= Collection QC check (% mass collected in second fraction)	=	0.00	%

USEPA Method 8 SO3 Sample Calculations

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

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 N_@

1. SO3 concentration (lb/dscf)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	24.0000	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
C_{sd}	= SO3 concentration (lb/dscf)	=	1.1576E-05	lb/dscf

2. SO3 concentration (ppmdv)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{0.850}{1000} \right) \left(\frac{10^6}{MW} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	24.0000	dscf
MW	= molecular weight of SO3 (g/g-mole)	=	80.058	g/g-mole
0.850	= conversion factor (dscf/g-mole)	=	0.850	dscf/g-mole
1000	= conversion factor (mg/g)	=	1,000	mg/g
10^6	= conversion factor (ppm)	=	10^6	ppm
C_{sd}	= SO3 concentration (ppmdv)	=	0.0059	ppmdv

3. SO3 concentration (ppmwv)

$$C_w = C_{sd} \left(1 - \frac{B_w}{100} \right)$$

Where:

C_{sd}	= SO3 concentration (ppmdv)	=	0.0059	ppmdv
B_w	= actual water vapor in gas (% v/v)	=	9.1895	% v/v
100	= conversion factor (%)	=	100	%
C_w	= SO3 concentration (ppmwv)	=	0.0054	ppmwv

4. SO3 concentration (mg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) (35.31)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	24.0000	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
C_{sd}	= SO3 concentration (mg/dscm)	=	185.3775	mg/dscm

5. SO3 concentration (mg/Nm3 dry)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}} \right) (35.31) \left(\frac{68 + 460}{32 + 460} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	24.0000	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	
C_{sd}	= SO3 concentration (mg/Nm3 dry)	=	198.9417	mg/Nm ³ dry

6. SO3 concentration corrected to x% O2 (ppmdv example)

$$C_{sdx} = C_{sd} \left(\frac{20.9 - x}{20.9 - O_2} \right)$$

Where:

C_{sd}	= SO3 concentration (ppmdv)	=	0.0059	ppmdv
x	= oxygen content of corrected gas (%)	=	3.0	%
O_2	= proportion of oxygen in the gas stream by volume (%)	=	3.4	%
20.9	= oxygen content of ambient air (%)	=	20.9	%
C_{sdx}	= SO3 concentration corrected to x% O2 (ppmdv)	=	0.0058	ppmdv @ x%O ₂

7. SO3 concentration corrected to y% CO2 (ppmdv example)

$$C_{sdy} = C_{sd} \left(\frac{y}{CO_2} \right)$$

Where:

C_{sd}	= SO3 concentration (ppmdv)	=	0.0059	ppmdv
y	= carbon dioxide content of corrected gas (%)	=	12.0	%
CO_2	= proportion of carbon dioxide in the gas stream by volume (%)	=	8.8	%
C_{sdy}	= SO3 concentration corrected to y% CO2 (ppmdv)	=	0.0081	ppmdv @ y%CO ₂

8. SO3 concentration at actual gas conditions (lb/acf example)

$$C_a = C_{std} \left(\frac{Q_{std}}{Q_a} \right)$$

Where:

C_{std}	= SO3 concentration (lb/dscf)	= 1.1576E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 109,477	dscfm
Q_a	= volumetric flow rate at actual conditions (acfm)	= 236,938	acfm
C_a	= SO3 concentration at actual gas conditions (lb/acf)	= 5.3488E-06	lb/acf

9. SO3 rate (lb/hr)

$$E_{lb/hr} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (Q_{std})(60)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	= 126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	= 24.0000	dscf
2.205×10^{-3}	= conversion factor (lb/g)	= 2.205E-03	lb/g
1000	= conversion factor (mg/g)	= 1,000	mg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 109,477	dscfm
60	= conversion factor (min/hr)	= 60	min/hr
$E_{lb/hr}$	= SO3 rate (lb/hr)	= 76.0397	lb/hr

10. SO3 rate (kg/hr)

$$E_{kg/hr} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{Q_{std}(60)}{10^6} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	= 126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	= 24.0000	dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 109,477	dscfm
60	= conversion factor (min/hr)	= 60	min/hr
10^6	= conversion factor (mg/kg)	= 10^6	g/kg
$E_{kg/hr}$	= SO3 rate (kg/hr)	= 325331.4648	kg/hr

11. SO3 rate (Ton/yr)

$$E_{T/yr} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (Q_{std})(60) \left(\frac{Cap}{2000} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	= 126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	= 24.0000	dscf
2.205×10^{-3}	= conversion factor (lb/g)	= 2.205E-03	lb/g
1000	= conversion factor (mg/g)	= 1,000	mg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	= 109,477	dscfm
60	= conversion factor (min/hr)	= 60	min/hr
Cap	= capacity factor for process (hours operated/year)	= 8,760	hours/yr
2000	= conversion factor (lb/Ton)	= 2,000	lb/Ton
$E_{T/yr}$	= SO3 rate (Ton/yr)	= 333.0540	Ton/yr

12. SO3 rate - Fd-based (lb/MMBtu)

$$E_{Fd} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (F_d) \left(\frac{20.9}{20.9 - O_2} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	74.3801	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
F_d	= ratio of gas volume to heat content of fuel (dscf/MMBtu)	=	.	dscf/MMBtu
O_2	= proportion of oxygen in the gas stream by volume (%)	=	9.8	%
20.9	= oxygen content of ambient air (%)	=	20.9	%
E_{Fd}	= SO3 rate (lb/MMBtu)	=	N/A	lb/MMBtu

13. SO3 rate - Fc-based (lb/MMBtu)

$$E_{Fc} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) (F_c) \left(\frac{100}{CO_2} \right)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	74.3801	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
F_c	= ratio of gas volume to heat content of fuel (dscf/MMBtu)	=	.	dscf/MMBtu
CO_2	= proportion of oxygen in the gas stream by volume (%)	=	8.8	%
100	= conversion factor	=	100	
E_{Fc}	= SO3 rate (lb/MMBtu)	=	N/A	lb/MMBtu

14. SO3 rate - Heat Input-based (lb/MMBtu)

$$E_{Hi} = \left(\frac{m_n}{V_{mstd}} \right) \left(\frac{2.205 \times 10^{-3}}{1000} \right) \left(\frac{Q_{std}}{H_i} \right) (60)$$

Where:

m_n	= total SO3 collected, corrected for applicable blank (mg)	=	126.0000	mg
V_{mstd}	= volume metered, standard (dscf)	=	74.3801	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
1000	= conversion factor (mg/g)	=	1,000	mg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	109,477	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
H_i	= actual heat input (MMBtu/hr)	=	.	MMBtu/hr
E_{Hi}	= SO3 rate (lb/MMBtu)	=	N/A	lb/MMBtu