CleanAir

CleanAir Engineering
500 W. Wood Street
Palatine, IL 60067-4975
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PROTOCOL FOR PERMANENT TOTAL ENCLOSURE TESTING

Atlanta Facility

Indoor Air System

Sterigenics US, LLC
2015 Spring Road, Suite 650
Oak Brook, IL 60523
Client Reference No. (Pending)

CleanAir Project No. 14004-2
A2LA ISO 17025 Certificate No. 4342.01
A2LA / STAC Certificate No. 4342.02
Revision 1, Final Protocol
October 31, 2019

COMMITMENT TO QUALITY

To the best of our knowledge, the test plan and any state and federal regulations presented in this protocol have met all pre-determined program requirements. Modifications to the test plan or methodology presented in this original protocol will be performed only at the discretion of CleanAir and in accordance with all applicable parties involved. CleanAir operates in conformance with the requirements of ASTM D7036-04 Standard Practice for Competence of Air Emission Testing Bodies.

_______________________________ October 31, 2019

Kenny Sullivan
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Date

_______________________________ October 31, 2019

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PROTOCOL REVISION HISTORY

Version	Revision	Date	Pages	Comments
Draft	D0a	10/25/19	All	Draft version of original document.
Final	0	10/30/19	All	Final version of original document.
Final	1	10/31/19	1	Revised Table 1-1 and list of test parameters.
			2	Revised Table 1-2.
			8	Revised details under Procedures and Regulations.

PROJECT PERSONNEL

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ACRONYMS & ABBREVIATIONS

AAS (atomic absorption spectrometry)
acfm (actual cubic feet per minute)
ACI (activated carbon injection)
ADL (above detection limit)
AIG (ammonia injection grid)
APC (air pollution control)
AQCS (air quality control system(s))
ASME (American Society of Mechanical Engineers)
ASTM (American Society for Testing and Materials)
BDL (below detection limit)
Btu (British thermal units)
CAM (compliance assurance monitoring)
CARB (California Air Resources Board)
CCM (Controlled Condensation Method)
CE (capture efficiency)
°C (degrees Celsius)
CEMS (continuous emissions monitoring system(s))
CFB (circulating fluidized bed)
CFR (Code of Federal Regulations)
cm (centimeter(s))
COMS (continuous opacity monitoring system(s))
CT (combustion turbine)
CTI (Cooling Technology Institute)
CTM (Conditional Test Method)
CVAAS (cold vapor atomic absorption spectroscopy)
CVAFS (cold vapor atomic fluorescence spectrometry)
DI H_2O (de-ionized water)
%dv (percent, dry volume)
DLL (detection level limited)
DE (destruction efficiency)
DCI (dry carbon injection)
DGM (dry gas meter)
dscf (dry standard cubic feet)
dscfm (dry standard cubic feet per minute)
dscm (dry standard cubic meter)
ESP (electrostatic precipitator)
FAMS (flue gas adsorbent mercury speciation)
°F (degrees Fahrenheit)
FB (field blank)
FCC (fluidized catalytic cracking)
FCCU (fluidized catalytic cracking unit)
FEGT (furnace exit gas temperatures)
FF (fabric filter)
FGD (flue gas desulfurization)
FIA (flame ionization analyzer)
FID (flame ionization detector)
FPD (flame photometric detection)
FRB (field reagent blank)
FSTM (flue gas sorbent total mercury)
ft (feet or foot)
ft^2 (square feet)
ft^3 (cubic feet)
ft/sec (feet per second)
FTIR (Fourier Transform Infrared Spectroscopy)
FTRB (field train reagent blank)
g (gram(s))
GC (gas chromatography)
GFAAS (graphite furnace atomic absorption spectroscopy)
GFC (gas filter correlation)
gr/dscf (grains per dry standard cubic feet)
> (greater than)/ ≥ (greater than or equal to)
g/s (grams per second)
H_2O (water)
HAP(s) (hazardous air pollutant(s))
HI (heat input)
hr (hour(s))
HR GC/MS (high-resolution gas chromatography and mass spectrometry)
HRVOC (highly reactive volatile organic compounds)
HSRG(s) (heat recovery steam generator(s))
HVT (high velocity thermocouple)
IC (ion chromatography)
IC/PCR (ion chromatography with post column reactor)
ICP/MS (inductively coupled argon plasma mass spectroscopy)
ID (induced draft)
in. (inch(es))
in. H_2O (inches water)
in. Hg (inches mercury)
IPA (isopropyl alcohol)
ISE (ion-specific electrode)
kg (kilogram(s))
kg/hr (kilogram(s) per hour)
< (less than)/ ≤ (less than or equal to)
L (liter(s))
lb (pound(s))
lb/hr (pound per hour)
lb/MMBtu (pound per million British thermal units)
lb/TBtu (pound per trillion British thermal units)
lb/lb-mole (pound per pound mole)
LR GC/MS (low-resolution gas chromatography and mass spectrometry)
m (meter)
m^3 (cubic meter)
MACT (maximum achievable control technology)
MASS® (Multi-Point Automated Sampling System)
MATS (Mercury and Air Toxics Standards)
MDL (method detection limit)
µg (microgram(s))
min. (minute(s))
mg (milligram(s))
ml (milliliter(s))
MMBtu (million British thermal units)
MW (megawatt(s))
NCASI (National Council for Air and Stream Improvement)
ND (non-detect)
NDIR (non-dispersive infrared)
NDO (natural draft opening)
NESHAP (National Emission Standards for Hazardous Air Pollutants)
ng (nanogram(s))
Nm^3 (Normal cubic meter)
% (percent)
PEMS (predictive emissions monitoring systems)
PFGC (pneumatic focusing gas chromatography)
pg (picogram(s))
PJFF (pulse jet fabric filter)
ppb (parts per billion)
PPE (personal protective equipment)
ppm (parts per million)
ppmdv (parts per million, dry volume)
ppmwv (parts per million, wet volume)
PSD (particle size distribution)
psi (pound(s) per square inch)
PTE (permanent total enclosure)
PTFE (polytetrafluoroethylene)
QA/QC (quality assurance/quality control)
QI (qualified individual)
QSTI (qualified source testing individual)
QSTO (qualified source testing observer)
RA (relative accuracy)
RATA (relative accuracy test audit)
RB (reagent blank)
RE (removal or reduction efficiency)
RM (reference method)
scf (standard cubic feet)
scfm (standard cubic feet per minute)
SCR (selective catalytic reduction)
SDA (spray dryer absorber)
SNCR (selective non-catalytic reduction)
STD (standard)
STMS (sorbent trap monitoring system)
TBtu (trillion British thermal units)
TEOM (Tapered Element Oscillating Microbalance)
TEQ (toxic equivalency quotient)
ton/hr (ton per hour)
ton/yr (ton per year)
TSS (third stage separator)
USEPA or EPA (United States Environmental Protection Agency)
UVA (ultraviolet absorption)
WFGD (wet flue gas desulfurization)
%wv (percent, wet volume)

1. PROJECT OVERVIEW

Test Program Summary

Sterigenics US, LLC (Sterigenics) contracted CleanAir Engineering (CleanAir) to complete permanent total enclosure (PTE) verification testing on the ethylene oxide (EtO) Indoor Air System (IA-1) at the facility, located in Atlanta, Georgia.

The main objective of this test program is to perform verification testing to demonstrate that IA-1 meets 100% capture as requested in a Georgia Department of Natural Resources (DNR) Environmental Protection Division (EPD) letter to Sterigenics, dated October 9, 2019, entitled "Re: Request for additional information regarding Application No. 27153 received July 31, 2019 Sterigenics U.S., LLC, Atlanta, AIRS No:06700093." The letter requested that Sterigenics conduct testing and engineering analyses to evaluate the modifications proposed in Application No. 27153. The modifications included the construction and implementation of a facility indoor air system that captures all fugitive emissions, removes emissions via a dry bed adsorption (DBA) system, then exhausts effluent gas via a dedicated stack.

A summary of the standard is shown in Table 1-1.

Table 1-1:
Summary of Permit / Regulatory Limits

Source / **Constituent**	**Standard**[1]
Indoor Air Control System	
EtO Capture efficiency (%)	100

[1] Standard requested in Georgia DNR EPD letter to Sterigenics dated October 9, 2019 entitled "Re: Request for additional information regarding Application No. 27153 received July 31, 2019 Sterigenics U.S., LLC, Atlanta, AIRS No: 06700093".

Test Program Details

PARAMETERS

The test program will include the following measurements:

- EtO capture efficiency, in percent (%);
- Pressure differential between the interior and exterior of PTE affected areas, in inches water (in. H_2O);
- direction of air flow through all NDOs;
- Identification, area, and equivalent diameter determination of each natural draft opening (NDO);
- Ratio of total NDO area to total PTE area.

SCHEDULE

The test program will be conducted after construction is complete. See the proposed timetable below.

Table 1-2:
Test Schedule

DAY	ACTIVITY	LOCATION	REPLICATES	SAMPLE TIME
1	Mobilization / Set-up			
	Process Capture Verification, NDO Identification & Measurements	PTE	1	As Needed
2	Directional Flow	Each NDO	1	60 min.[1]
	Pressure Differential	Each Affected Area Inside PTE	1	As Needed
	Demobilization			

[1] Direction of flow through each NDO will be observed at 10-minute intervals for an hour.

DISCUSSION

Ethylene Oxide Capture Efficiency Determination

Since 40 CFR 63.7, Subpart O does not specify the means of demonstrating 100% capture efficiency, CleanAir will evaluate the enclosure surrounding the affected facility against a set of criteria ensuring 100% capture. The criteria for PTE verification will include the following:

- the total area of all NDOs shall not exceed 5% of the surface area of the enclosure's four walls, floor and ceiling;
- the direction of air flow through all NDOs shall be into the enclosure;
- The enclosures shall be under negative pressure;
- All access doors and windows where areas are not included as NDOs and are not included in the calculations are closed during routine operation of the process;
- All EtO emissions must be captured and contained for discharge through a control device.

End of Section

2. RESULTS

The example tables summarize how test program data will be presented in the test report.

Table 2-1:
Indoor Air System (IA-1) – Example PTE Verification Results

PTE VERIFICATION CRITERIA	Minimum Value During Test	Acceptable? (yes, no, or n/a)
1. The total area of all NDO's shall not exceed 5 percent of the surface area of the enclosures four walls, floor and ceiling.	*TBD* %	**TBD**
2. The direction of air flow through all NDO's shall be into the enclosure.	*TBD*	**TBD**
3. The pressure differential across the enclosure	*TBD* in. H_2O	**TBD**
4. All access doors and windows that were not included as NDO's above shall remain closed during source operation.	*TBD*	**TBD**
5 All EtO must be captured and contained for discharge through a control device	*TBD*	**TBD**

If all of the above criteria are met, then an enclosure is considered to be a permanent total enlcosure and the EtO capture efficiency can be assumed to be 100%.

$Ø_{eq}$ Equivalent NDO or exhaust hood or duct diameters.

Table 2-2:
Indoor Air System (IA-1) – Example NDO Summary

NDO No.	Description	NDO Area (ft^2)	Equivalent Diameter (ft)	Distance from Nearest VOC Emission Point (NDO D_{eq})	Distance from Nearest VOC Exhaust Point (Exhaust D_{eq})
1		x.xx	x.xx	x.xx	x.xx
2		x.xx	x.xx	x.xx	x.xx
3		x.xx	x.xx	x.xx	x.xx
4		x.xx	x.xx	x.xx	x.xx
. . . .					
x		x.xx	x.xx	x.xx	x.xx
Total NDO Area					
A_{NDO}	Total area of NDOs (ft^2)	x.xx			

Table 2-3:
Indoor Air System (IA-1) – Example PTE Dimensional Summary

Wall Dimensions	Surface Area (ft^2)	Description
xxx" W by xxx" H	xx.xx	
xxx" W by xxx" H	xx.xx	
xxx" W by xxx" H	xx.xx	
xxx" W by xxx" H	xx.xx	
xxx" W by xxx" H	xx.xx	
⋮		
xxx" W by xxx" H	xx.xx	
Ceiling	xx.xx	
Floor	xx.xx	
Total surface area	**xx.xx**	

Table 2-4:
Indoor Air System (IA-1) – Example Pressure Differential Summary

	Run 1		Run 2		Run 3	
NDO (ID)	Time (hh:mm)	Pressure Drop (in H_2O)	Time (hh:mm)	Pressure Drop (in H_2O)	Time (hh:mm)	Pressure Drop (in H_2O)
1	xx:xx	x.xxxx	xx:xx	x.xxxx	xx:xx	x.xxxx
2	xx:xx	x.xxxx	xx:xx	x.xxxx	xx:xx	x.xxxx
3	xx:xx	x.xxxx	xx:xx	x.xxxx	xx:xx	x.xxxx
4	xx:xx	x.xxxx	xx:xx	x.xxxx	xx:xx	x.xxxx
5	xx:xx	x.xxxx	xx:xx	x.xxxx	xx:xx	x.xxxx
⋮						
X	xx:xx	x.xxxx	xx:xx	x.xxxx	xx:xx	x.xxxx
	Average	**x.xxxx**	**Average**	**x.xxxx**	**Average**	**x.xxxx**
	Maximum	**x.xxxx**	**Maximum**	**x.xxxx**	**Maximum**	**x.xxxx**
	Minimum	**x.xxxx**	**Minimum**	**x.xxxx**	**Minimum**	**x.xxxx**

End of Section

3. DESCRIPTION OF INSTALLATION

Process Description

Sterigenics US, LLC operates a commercial contract sterilization facility in Atlanta, Georgia, which utilizes EtO to sterilize its customers' product. It also has the ability to use propylene oxide to treat nutmeats.

When EtO is used for medical device sterilization, the medical devices must have a specifically defined sterilization process, which is validated for a specific sterilization chamber or chambers. The Atlanta facility uses 10 sterilization chambers ranging in size from 5 pallets to up to 30 pallets. While all 10 sterilization chambers are similar in design, each chamber may only process products approved for that chamber and cannot process other products that have not been validated and approved by the appropriate regulatory agency for that specific chamber.

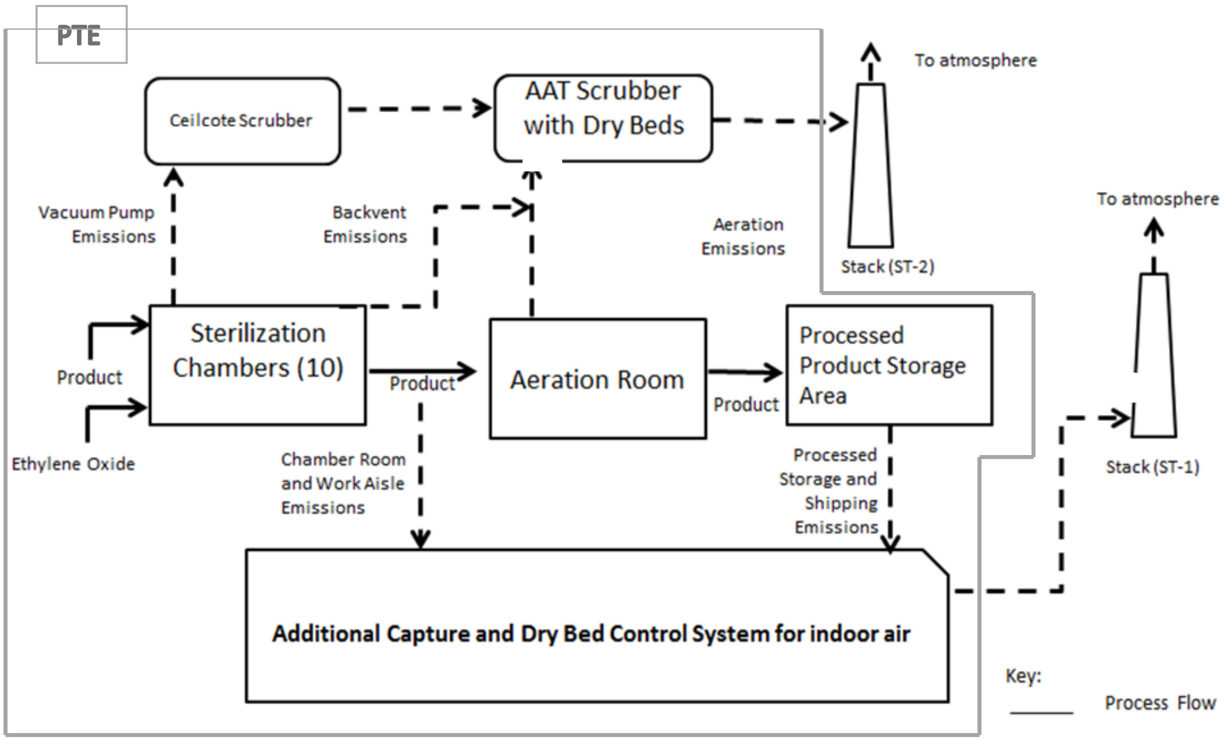
The sterilization process begins with evacuating the air from the chamber and introducing nitrogen (N_2). While under negative pressure inside the chamber, EtO is introduced into the sterilization chamber to sterilize the product. Once EtO is introduced, the dwell stage can last from 30 minutes to up to several hours, according to the validated cycle for the product. Once complete, the sterilization chamber vacuum pumps remove most of the EtO from the chamber by exhausting and purging with N_2 multiple times. Vacuum pump emissions are routed to the Ceilcote wet acid scrubber, which will be routed to the existing Advanced Air Technologies (AAT) wet acid scrubber with dry bed reactor, then to additional polishing beds, and then to a common stack.

Once the sterilization chamber process is complete and the chamber door is partially opened, the backvent fan activates to extract residual amounts of EtO from the chamber. This fan remains on while the chamber door is open. After 15 minutes, the pallets of product are removed from the sterilization chamber and placed into aeration rooms to further off-gas residual EtO. Both the backvents and aeration rooms are ducted to the AAT and treated with dry bed reactors, and then to a common stack.

A negative pressure system has been installed to capture air internally from chamber rooms, work aisles, processed product storage, and shipping areas. This captured air will be ducted to a new dry bed control system consisting of 18 dry beds and then to a dedicated stack.

The testing reported in this document will be performed on the facility negative pressure (NP) system. Testing will be performed in areas deemed part of the negative pressure area. A schematic of the process is shown in Figure 3-1 on the following page.

Figure 3-1:
Process Schematic

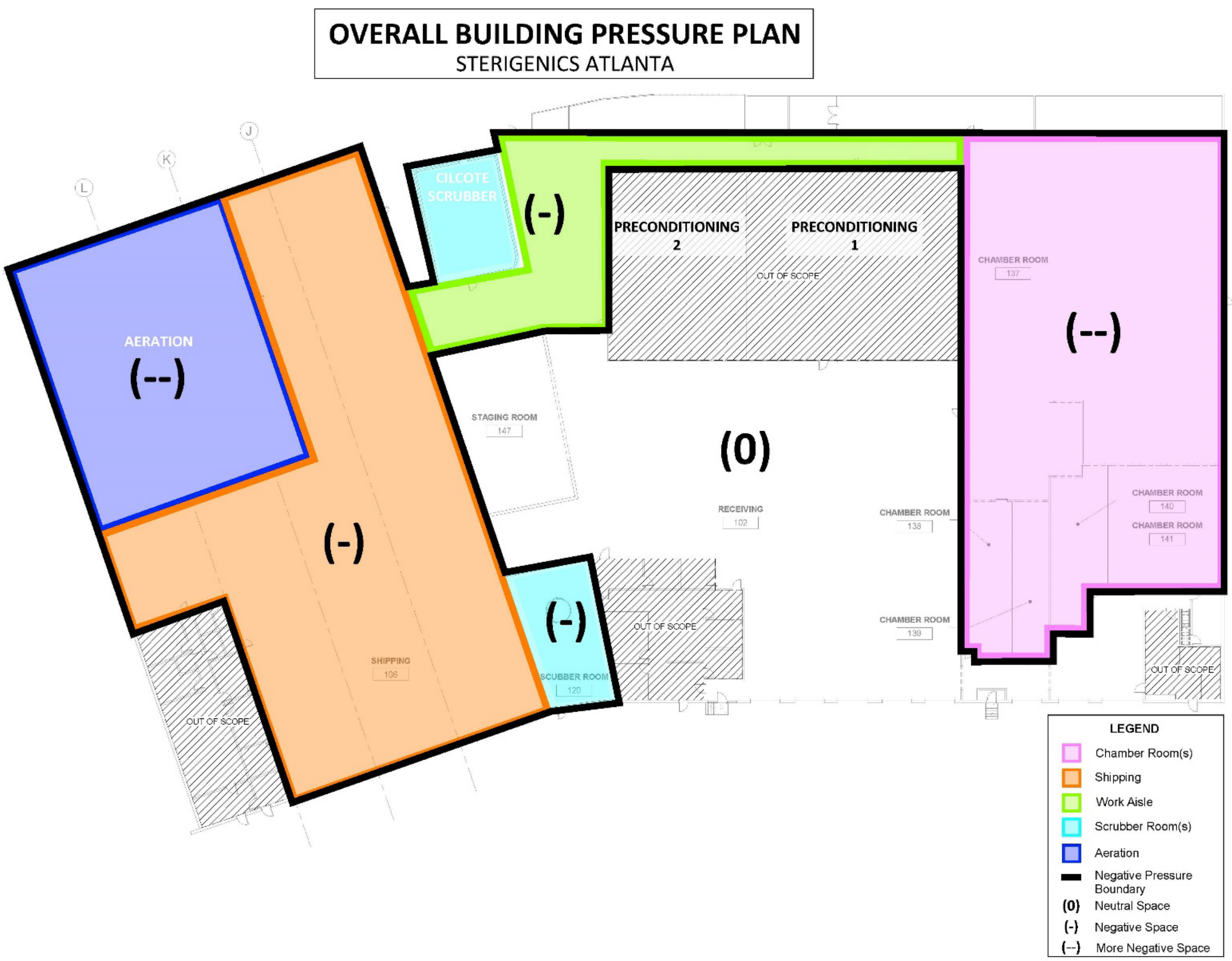


Test Locations

The measurement point placement will be determined by EPA Method 204 specifications. Interior differential pressure measurement points will be located near the center of each affected facility PTE area. Exterior differential pressure measurement points will be located outside of the PTE in a neutral pressure location. The final test report will include all affected facility PTE area schematics and diagrams, including all dimensions and NDO locations.

Figure 3-2 presents the NDO location diagram that will be presented in the final test report.

Figure 3-2:
NDO Location Diagram



End of Section

4. METHODOLOGY

Procedures and Regulations

The test program sampling measurements will follow procedures and regulations outlined by the United States Environmental Protection Agency (USEPA) and the DNR EPD. These methods appear in detail in Title 40 of the CFR and at https://www.epa.gov/emc. Appendix A includes a description of the sampling apparatus, as well as specifications for sampling.

CleanAir will follow specific QA/QC procedures 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 measures are outlined in CleanAir's internal Quality Manual.

Methodology Discussion

The PTE enclosure will be evaluated based on the following set of criteria:

- the total area of all NDOs shall not exceed 5% of the surface area of the enclosure's four walls, floor and ceiling;
- the direction of air flow through all NDOs shall be into the enclosure;
- The enclosures shall be under negative pressure;
- All access doors and windows where areas are not included as NDOs and are not included in the calculations are closed during routine operation of the process;
- All EtO emissions must be captured and contained for discharge through a control device.

The dimensions of the enclosure will be measured using a tape measure, measuring wheel, or taken from building plans. The sizes of all NDOs and the distances from each EtO emitting point and each exhaust point from the enclosure will be measured using a tape measure. The equivalent diameter of each NDO and the NDO area to enclosure surface area ratio (NEAR) will be calculated following EPA Method 204 procedures. Equivalent diameter will be calculated following procedures outlined in EPA Method 1.

The pressure drop across the enclosure will be measured with a calibrated electronic micromanometer. The direction of flow through all NDOs will be verified using smoke tubes or streamers. Access doors and windows, which are kept closed during the PTE verification and routine operation, will be noted.

End of Section

5. APPENDIX

Appendix A: Test Method Specifications

Appendix B: CleanAir Resumes and Certifications

APPENDIX A: TEST METHOD SPECIFICATIONS

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Shortridge AirData Multimeter ADM-860C

Rental and Application Notes:

- Shipping Weight: 21 lbs.
- Air velocity readings are displayed as local density, true air velocity or flow.
- Internal calibration, temperature compensation, range selection and zeroing are fully automatic with each reading. No external adjustments needed.
- Memory can hold up to 100 readings for individual recall and can give a reading total and average.
- The max. recommended length of pneumatic tubing for the measurement of airflow, velocity or differential pressure is 18 ft. Minimum is ID 3/16”.

Specifications:

- Weight: 32 oz.
- Dimensions: 6” x 6.4” x 2.7”.
- Power: 120VAC, 60 Hz, 8w.
- Output: RS-232.
- Response Time: 1 sec. at high pressure inputs, 7sec. at inputs less than 0.003wc. Extrememly low presure/flow/ velocity inputs require longer sample times.
- Air Velocity: 25-29,000 fpm w/ standard pitot tube, 25-5,000 fpm w/ AirFoil probe, 25-2,500 fpm w/ VelGrid.
- Air Bleed: Each pressure measurement requires a small volume of air to pass through the meter. The pressure source must be capable of supplying this volume without significant depletion to ensure accurate measurements.
- Absolute Pressure: 10 - 40 in Hg. Max. safe pressure is 60 psi. Accuracy: ± 2% of reading ±0.1 in Hg from 14-40 in Hg.
- Differential Pressure: 0.0001-60.00wc. Max. safe pressure is 20 psid. Accuracy: ± 2% of reading ±0.001wc from 0.05-50wc.
- Opertational Temperature: 40°F - 104°F.
- Connections: 1/4” OD slip-on for 3/16” ID soft tubing.

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APPENDIX B: CLEANAIR RESUMES AND CERTIFICATIONS

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Ken Sullivan
Project Manager

Professional Profile

Mr. Sullivan has 10 years of experience in wet method and instrumental testing for engineering, diagnostic, performance guarantee, and compliance purposes. Initially hired as a field technician in 2009, Mr. Sullivan started leading test programs in 2011, and has been project managing since 2014. Mr. Sullivan has been involved with projects utilizing EPA Methods 1 through 29, 201, 201A, 202, 320, Conditional Test Method (CTM) 027, CTM-013, and Other Test Methods (OTM) 027 and OTM-028, from the planning stage to field testing and reporting. In addition, Mr. Sullivan has extensive experience leading Engineers and Field Technicians to execute applicable EPA methods for numerous projects worth hundreds of thousands of dollars to clients. Through his experience, he has attained valuable testing skills, such as setting up and operating continuous emissions monitoring systems (CEMS) for various pollutants, on-site mercury analysis with an Ohio Lumex spectrometer, on-site laboratory analysis for numerous methods, experience in Micro GC (gas chromatography), and in FTIR (Fourier Transform Infrared Spectrometer) analysis.

Mr Sullivan has been responsible for compliance and diagnostic test programs performed in a multitude of states across the country. He has also been responsible for engineering and consulting studies performed in Canada, Netherlands, Spain, and South Africa.

Relevant Experience

Coal Industry; Labadie and Meramec, MO

Led a large field crew in executing various EPA methods, including 30B, 5/202, 29, 26, 3A, 7E, and 10 at multiple locations to determine design variables for retrofitted wet scrubbers. Set-up and operated a CEMS showing real-time NO_X, O_2, CO_2, and CO emissions. Performed on-site mercury analysis with an Ohio Lumex spectrometer in accordance with EPA Method 30B. Assisted in determining the concentration deviation between elemental and oxidized mercury at the stack to establish scrubber performance, carbon injection interference, and other design constraints.

Natural Gas Delivery (Pipeline); Middlebourne, WV

Project managed a test program to determine sources and locations of black powder along various points of the pipeline, by utilizing a personally designed modified EPA Method 17 sampling apparatus. Led field execution, collected samples and recovered sample filters on-site while maintaining communication with the client and several other parties involved to resolve the issue of equipment malfunction and degradation due to the black powder buildup.

Manufacturing Industry; Apeldoorn, Netherlands

Planned, managed, led, and executed this job from start to finish. Ran an FTIR and performed EPA Methods 320 and 25A to provide the client with carbon monoxide, hydrocarbon, and formaldehyde diagnostic data at several key points along the process line. Processed and analyzed a plethora of raw data into utile and interpretable formats and drafted an in-depth report.

Carbon Capture; Cohasset, MN

Project managed a test program designed to determine the input/output chemistry of a non-commercial scale carbon capture system prototype. The test program included measurements for over 20 compounds of interest, utilizing FTIR, GC-FPD, Micro GC, FID, UV, and photometric technologies. Developed extensive analysis that included studies in atom balance, removal, minimum detection limit, and exponential decay.

Coal Industry; Secunda, South Africa

Aided in accumulating dust concentration data and mass loading at various points in the Fluidized Catalytic Cracking Unit (FCCU), utilizing EPA Method 17. Was involved in on-site recovery and particle size analysis, and used a TESTO 350XL to determine effluent gas composition. Also trained a South African testing company how to efficiently and accurately execute methods concerning filterable particulate matter (FPM) collection.

Oil Refining Industry; Detroit, MI

Aided multi-million net-worth client in meeting new emission limits required by a permit issued by the Michigan Department of Environmental Quality (MDEQ) and Sierra Club due to implications of the Detroit Heavy Oil Upgrade Project (DHOUP). Executed several different methods, including EPA Methods 1, 2, 3A, 4, 5/202, 6C, 7E, 25A, 10, and 18, and ASTM Draft CCM, at various locations throughout the Detroit refinery. Managed every test program from planning to reporting.

Professional Certifications & Qualifications

OSHA 10-Hour
NSC CPR/AED Certification
NSC First-Aid Certification

Qualified Source Testing Individual (QSTI) Test Exams (Certificate No. 2012-711):

- Group 1 (Manual Gas Volume and Flow Measurements and Isokinetic Particulate Sampling Methods) – exam passed on 10/22/2015 (certification attached)
- Group 2 (Manual Gaseous Pollutants Source Sampling Methods) – exam passed on 4/28/2016 (certification attached)
- Group 3 (Gaseous Pollutants Source Sampling Methods) – exam passed on 4/27/2016 (certification attached)
- Group 4 (Hazardous Metals Measurement Methods) – exam passed on 6/1/2017 (certification attached)

Qualified Individual (QI)

Field Test Leader	Ohio Lumex (EPA Method 30B Analysis)	EPA Methods 320/321 (Extractive FTIR)	Field Laboratory
Project Manager	Modified EPA Conditional Test Method 013 / Draft ASTM Controlled Condensation Method		

Education

Bachelor of Science in Civil Engineering with a focus in Environmental and Atmospheric Sciences (with honors), 2009
University of Illinois; Urbana-Champaign

Bachelor of Science in Physics, 2006
Elmhurst College; Elmhurst, Illinois

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

KENNETH J. SULLIVAN

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 22ND DAY OF OCTOBER 2015 AND EFFECTIVE UNTIL OCTOBER 21ST, 2020

Peter R. Westlin, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2012-711

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SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

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HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GASEOUS POLLUTANTS SOURCE SAMPLING METHODS

ISSUED THIS 28TH DAY OF APRIL 2016 AND EFFECTIVE UNTIL APRIL 27TH, 2021

Peter R. Westlin, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2012-711

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

KENNETH J. SULLIVAN

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS

ISSUED THIS 27TH DAY OF APRIL 2016 AND EFFECTIVE UNTIL APRIL 26TH, 2021

Peter R. Westlin, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2012-711

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

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KENNETH J. SULLIVAN

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

HAZARDOUS METALS MEASUREMENT METHODS

ISSUED THIS 1ST DAY OF JUNE 2017 AND EFFECTIVE UNTIL MAY 31ST, 2022

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2012-711

SOURCE EVALUATION SOCIETY CORPORATE SEAL 1995 NORTH CAROLINA

Bill Ansell

Midwest Engineering Group Technical Leader and Sr. Project Manager

Professional Profile

Mr. Ansell has over 30 years of experience in the environmental field in the areas of air emissions testing and consulting. He was initially hired as a Field Engineer. Since 1988, Mr. Ansell has been involved with projects utilizing EPA, ASTM, NIOSH, ASME methods from the planning stage through field execution and reporting. In addition, Mr. Ansell has extensive process and control device knowledge across a variety of industries including:

- municipal and medical waste combustors;
- petrochemical industries and refineries;
- utility and institutional coal, oil, and natural gas-fired boilers;
- foundries and steel mills;
- simple and combined cycle gas turbines;
- printing and coating facilities;
- automotive assembly plants;
- glass plants;
- food processing facilities;
- ammunition plants; and
- pulp and paper mills, as well as other industrial sources.

Mr. Ansell was responsible for projects performed in 30 states as well as China, South Korea, Puerto Rico, Morocco, and the Bahamas.

Relevant Experience

Automotive Assembly Plant; Mishawaka, IN

Project Manager and Field Test Leader for a VOC capture and destruction efficiency test program conducted on the e-coat, prime, and topcoat paint lines at an automotive assembly plant. Project included verifying that enclosures surrounding paint lines met criteria for permanent and temporary total enclosures per EPA Method 204. VOC emissions from five sources to the control device, as well as fugitive VOC emissions from 16 sources, were determined simultaneously, following EPA Methods 1-4, 25A, and 204B. Tests were conducted with a nine-man test crew

Yeast Production Facility; Memphis, TN

Project Manager and Field Test Leader for annual VOC emission test programs to meet requirements of the facility’s Title V Permit and 40 CFR 63, Subpart CCCC - National Emissions Standards for Hazardous Air Pollutants: Manufacturing of Nutritional Yeast. Client monitors brew ethanol concentrations during production instead of installing fermenter exhaust monitors. NESHAP requires testing to develop a brew to exhaust correlation calculation relating the brew ethanol concentration during fermentation to THC emissions concentration as propane. Test programs were conducted over complete production batches, 13 to 31 hours in duration requiring multiple test crews for 24-hour coverage on-site.

Paper Mill; Rhinelander, WI

Project Manager and Field Test Leader for a VOC capture and destruction efficiency test program on a thermal oxidizer system serving a paper coater line. The test program included the construction of a temporary total enclosure (TTE), including a fugitive vent system to prevent VOC concentrations from building up within the enclosure, which surrounded the coater to allow the VOC capture efficiency to be determined and the process to be operated normally.

Project Manager and Field Test Leader for performance and compliance test programs on coal and natural gas-fired boilers, including the initial certification and annual RATA for SO_2, NO_X, CO, HCl, and PM CEMS, as well as sorbent trap mercury emissions testing.

Coal-Fired Power Plant (Wet Scrubber); Huntington, UT

Project Manager and Field Test Leader for a wet flue gas desulfurization (FGD) system performance guarantee test program at a coal-fired power plant. The FGD test program included determining SO_2 emissions from the FGD system as well as determining overall FGD system pressure drop, stoichiometry ratio, gypsum oxidation level and percent solids dewatering. The sound pressure levels for new operating equipment related to the FGD system, including slurry pumps and ID Booster Fans, were measured as well.

Limestone slurry and gypsum slurry samples were collected and analyzed to determine reagent / byproduct quality, limestone consumption rates and scrubber stoichiometry. Preliminary particulate, SO_2 and SO_3 results were determined on-site.

Coal-Fired Power Plant (SCR, ACI, Dry FGD); Big Stone City, ND

Project Manager and Field Test Leader for a boiler pressure part modification and separated over fire air (SOFA) system, dry flue gas desulfurization (DFGD) system, activated carbon injection (ACI) system, selective catalytic reduction (SCR) system, and centrifugal ID fan system performance guarantee test program on a coal-fired boiler. The boiler pressure and SOFA tests included measuring pressure losses, heat output, and unburned carbon. The SCR performance tests included measuring pressure loss, power consumption, SO_2, SO_3, NO_X and ammonia emissions and ammonia distribution. The ACI system tests included measuring flue gas flow rate and composition, powdered activated carbon (PAC) injection rate, and sound pressure levels around ACI process equipment. The DFGD system tests included measuring flue gas flow rate and composition, filterable and condensable particulate matter (FPM and CPM), SO_2, SO_3, HCl, lime stoichiometry, power consumption, pressure loss, and sound pressure levels around specified DFGD equipment. The ID Fan performance tests included measuring flue gas temperatures, static and total pressures, and 3-D flow rates, including pitch and yaw angles and axial velocity.

The test program was conducted in a single mobilization using a 13-man test crew over an 11-day period. Preliminary analytical results for SO_2, SO_3, HCl, FPM, and ammonia were performed on-site by CleanAir personnel.

Coal-Fired Power Plant (SNCR and SCR); Healy, AK

Project Manager and Field Test Leader for SCR and SNCR performance guarantee test programs on two coal-fired boilers: one with SNCR system and one with SCR system. The SNCR test program included determining ammonia slip and ammonia emissions. The SCR test program included determining NO_X removal efficiency, SO_2 to SO_3 oxidation rate, and ammonia slip. Preliminary analytical results for SO_2, SO_3, and ammonia were performed on-site by CleanAir personnel.

Petrochemical Refinery; Morris, Illinois

Project Manager and Test Leader for multiple test programs on polyethylene and polypropylene production processes and waste gas flares at a petrochemical facility. The test programs included determining concentrations and mass emission rates of THCs and specific VOCs. VOC sampling programs included both collecting integrated grab samples in Tedlar bags or impingers for analysis by gas chromatography (GC) with multiple detectors, as well as direct interface sampling with GC/FID.

Test programs ranged from two-day test programs with two crew members to week-long, round the clock test programs with large test crews at multiple sources. Most test programs included on-site sample analysis using GC/FID.

Coal-Fired Power Plant (SCR, DSI, and AH); Fruitland, NM

Project Manager and Test Leader for a performance test program conducted on dry sorbent injection (DSI), SCR, and tri-sector air pre-heater (APH) systems installed on a coal-fired boiler. The DSI and SCR testing included the determination of SO_2 to SO_3 conversion rate, NO_X removal efficiency, NO_X to ammonia distribution, ammonia slip, boundary to boundary and intermediate pressure drops, power consumption, sound pressure levels of system components, hydrated urea and hydrated lime consumption, and particulate emissions from material handling duct collectors.

Tri-sector APH testing included determining primary and secondary air draft losses and flue gas draft loss. The air to gas leakage across the APH, as well as outlet temperature (without leakage), were also determined.

The test program was conducted in a single mobilization using a 15man test crew over an 11-day period. Preliminary analytical results for SO_2, SO_3, HCl, FPM, and ammonia were performed on-site by CleanAir personnel.

Combined Cycle Gas Turbine; Bundang, South Korea

Project Manager for an emissions test program conducted on a combined cycle gas turbine generator to collect data for completing construction permits for future similar installations in the United States. Pollutant emissions determined included FPM and CPM, NO_X, CO, THC, methane, ethane, propane, propylene, iso-butane, butane and butene. Preparation and mobilization for the project, including the shipment of all test equipment and reagents, were conducted in a period of less than two weeks.

Professional Certifications & Qualifications

OSHA 10-Hour
Hazardous Materials Shipping Certification
NSC CPR/AED Certification
NSC First-Aid Certification

Qualified Source Testing Individual (QSTI) Test Exams (Certificate No. 2008-271):

- Group 1 (Manual Gas Volume and Flow Measurements and Isokinetic Particulate Sampling Methods) – exam passed on 03/10/2017 (certification attached)
- Group 2 (Manual Gaseous Pollutants Source Sampling Methods) – exam passed on 06/01/2017 (certification attached)
- Group 3 (Gaseous Pollutants Source Sampling Methods) – exam passed on 06/01/2017 (certification attached)
- Group 4 (Hazardous Metals Measurement Methods) – exam passed on 07/09/2015 (certification attached)

Qualified Individual (QI)

Field Test Leader	Field Laboratory	Project Manager
Performance Specification 11 (PS11 – Particulate Matter)	SW-846 Test Method 0011 (Aldehydes & Ketones)	SW-846 Test Method 0030/0031 (Volatile Organic Compounds)
Performance Specification 12B (PS12B – Mercury Using Sorbent Trap)	EPA Method 22 (Fugitive Emissions)	EPA Methods 23 / SW-846 0010/0023A (PCDD/PCDF/SVOC)
EPA Method 25 (Total Gaseous Non-Methane Organics)	Trace Metals	EPA Method 204 (Permanent or Temporary Total Enclosure)
SW-846 Test Method 0061 / EPA Method 306 (Chromium)	Conditional Test Method 027 (Ammonia)	Other Test Method 29 (Hydrogen Cyanide)
Modified EPA Conditional Test Method 013 Controlled Condensation Method	CARB Method 501 (Size Distribution of Particulate Matter)	

Education

Southern Illinois University; Carbondale, Illinois
Bachelor of Science in Mechanical Engineering Technology, 1988

William Rainey Harper College; Palatine, Illinois
Associate of Arts in Liberal Arts, 1985

SOURCE EVALUATION SOCIETY

Qualified Source Testing Individual

LET IT BE KNOWN THAT

WILLIAM F. ANSELL, Jr.

HAS SUCCESSFULLY PASSED A COMPREHENSIVE EXAMINATION AND SATISFIED EXPERIENCE REQUIREMENTS IN ACCORDANCE WITH THE GUIDELINES ISSUED BY THE SES QUALIFIED SOURCE TEST INDIVIDUAL REVIEW BOARD FOR

MANUAL GAS VOLUME MEASUREMENTS AND ISOKINETIC PARTICULATE SAMPLING METHODS

ISSUED THIS 10TH DAY OF MARCH 2017 AND EFFECTIVE UNTIL MARCH 9TH, 2022

Peter R. Westlin, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

CERTIFICATE NO. 2008-271

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MANUAL GASEOUS POLLUTANTS SOURCE SAMPLING METHODS

ISSUED THIS 1^{ST} DAY OF JUNE 2017 AND EFFECTIVE UNTIL MAY 30^{TH}, 2022

Peter R. Westlin, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

Bruce Randall QSTI/QSTO Review Board

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GASEOUS POLLUTANTS INSTRUMENTAL SAMPLING METHODS

ISSUED THIS 1ST DAY OF JUNE 2017 AND EFFECTIVE UNTIL MAY 30TH, 2022

Peter R. Westlin, QSTI/QSTO Review Board

J. Wade Bice, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

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HAZARDOUS METALS MEASUREMENT SAMPLING METHODS

ISSUED THIS 9TH DAY OF JULY 2015 AND EFFECTIVE UNTIL JULY 8TH, 2020

Peter R. Westlin, QSTI/QSTO Review Board

Peter S. Pakalnis, QSTI/QSTO Review Board

Theresa Lowe, QSTI/QSTO Review Board

C. David Bagwell, QSTI/QSTO Review Board

Karen D. Kajiya-Mills , QSTI/QSTO Review Board

Glenn C. England, QSTI/QSTO Review Board

CERTIFICATE NO. 2008-271

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