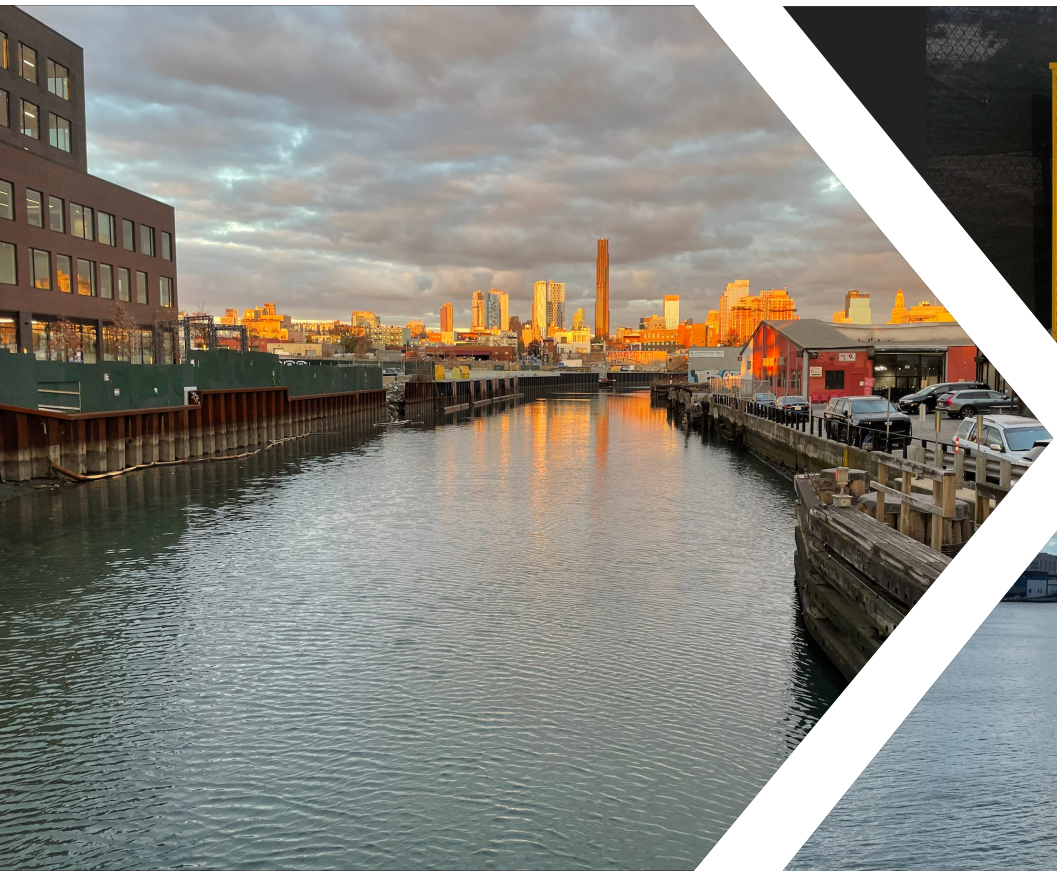
Community Air Monitoring Plan

Gowanus Canal Superfund Site:

Remediation Target Area 2 | Brooklyn, NY



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1 Glossary

BTEX	A subset of VOCs including benzene, toluene, ethyl benzene, and xylenes
CAAL	Concentration Above Action Level, as a 15-minute average of TVOC or PM_{10}
CAMP	Community Air Monitoring Plan
COC	Contaminants of Concern
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FPD	Flame Photometric Detector
GC	Gas Chromatograph or Gas Chromatography
H_2S	The molecular formula of hydrogen sulfide
NAAQS	National Ambient Air Quality Standard
NH_3	The molecular formula of ammonia
NIST	National Institute of Standards and Technology
NWS	National Weather Service
NYSDOH	New York State Department of Health
PHA	Public Health Assessment
PID	Photo Ionization Detector
PM	Particulate Matter, specifically PM_{10} (less than 10 microns in diameter) for this plan
ppb	Parts per billion, a unit of measure for concentration
ppm	Parts per million, a unit of measure for concentration
QA/QC	Quality Assurance and Quality Control
RTA2	Remediation Target Area 2
SOP	Standard Operating Procedure
TVOC	Total Volatile Organic Compounds
$\mu g/m^3$	Micrograms per cubic meter, a unit of measure for concentration
µm	A micrometer (aka micron); 1 millimeter (mm) = 1000 micrometers (µm).
VOC	Volatile Organic Compounds

2 Introduction

This Community Air Monitoring Plan (CAMP) provides protocol for perimeter air monitoring activities that will be performed during remediation activities in Remediation Target Area 2 (RTA2) at the Gowanus Canal Superfund Site located in Brooklyn, Kings County, New York (the "Site"). RTA2 remedial activities will include the following:

- Mobilization of equipment and staging of materials at the Staging Site currently located at 659 Smith Street.
- Mechanical dredging
- Installation of bulkhead supports
- In-situ stabilization
- Capping

Collectively, the Site work zones are located in an urban area with numerous residences, businesses, and industrial operations in close Site proximity. Refer to Site Map, Figure 2, in Section 8 describing the Monitoring Locations.

The CAMP describes the methodology that will be employed in association with active RTA2 remediation. The CAMP is organized into ten sections as follows:

Section 1 - Glossary
Section 2 - Introduction
Section 3 - Contaminants of Concern (COC)
Section 4 - Objectives
Section 5 - Methodology
Section 6 - Action Levels
Section 7 - Frequency
Section 8 - Monitoring Locations
Section 9 – Quality Assurance and Quality Control (QA/QC)
Section 10 - Data Management, Validation, and Reporting.

This CAMP was developed using guidance from the New York State Department of Health (NYSDOH) Generic CAMP (2010)[1] and the February 17, 2023 *RTA1 CAMP*.

[1] DER-10 / Technical Guidance for Site Investigation and Remediation. May 3, 2010. Prepared by New York State Department of Environmental Conservation. Albany, NY 12233.

3 Contaminants of Concern (COC)

A Public Health Assessment (Final Release January 11, 2017)[2] examined the health risks associated with exposure via inhalation to organic contaminants present in outdoor ambient air near the canal. The NYSDOH evaluated compounds with maximum concentrations greater than their EPA residential air regional screening levels based upon data found in the EPA Remedial Investigation Report[3]. These contaminants included benzene, chloroform, ethyl benzene, methylene chloride, xylenes (o,m,p) and naphthalene.

Contaminants to be monitored in ambient air as part of the CAMP include the same parameters that were monitored during prior CAMP programs conducted during previous pilot programs and RTA1 in calendar years 2017 and 2018, and 2020 - 2024. These contaminants included primarily volatile organic compounds such as benzene, toluene, ethylbenzene and xylenes (o,m,p) and hydrogen sulfide.

The following parameters will be monitored as part of this CAMP for RTA2:

- Total Volatile Organic Compounds (TVOC) (15-min)
- Particulate Matter with a diameter of 10 micrometers or less (PM_{10}) (15-min)
- Volatile Organic Compounds (VOCs) including benzene, chloroform, ethyl benzene, methylene chloride, toluene, and xylenes (o,m,p)
- Hydrogen sulfide, and other reduced sulfur compounds[4]
- Ammonia
- Odors (during work hours)
- Naphthalene

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[2]Public Health Assessment Final Release Gowanus Canal EPA Facility ID: NYN000206222. January 11,2017. Prepared by NYSDOH under a Cooperative Agreement with the US Department of Health and Human Services Agency for Toxic Substances and Disease Registry Division of Community Health Investigations Atlanta, Georgia 30333

[3] Gowanus Canal Remedial Investigation Report Volume 1, January 2011. Prepared by: HDR, CH2MHill, and GRB Environmental Services, Inc. Prepared for: USEPA. Contract No. EP-W-09-009 Work Assignment No. 013-RICO-02ZP. https://www.gowanussuperfund.com/wp-content/uploads/2021/09/Gowanus-Canal-Remedial-Investigation-Report-V.-1-DRAFT.pdf

[4]For the purpose of this monitoring program, reduced sulfur compounds include hydrogen sulfide, methyl mercaptan and ethyl mercaptan.

4 Objectives

The purpose of this monitoring program is to continuously measure particulate matter and TVOC in the air around the perimeter of various Site work zones. Other Contaminants of Concern (COC) including BTEX, naphthalene, NH_3 and H_2S will be monitored periodically along the perimeter of active work zones. Continuous monitoring will be conducted along the perimeter of the Site and within the staging site. Each station will continuously measure TVOC (quantified and reported as benzene) and particulate matter as respirable dust (PM_{10}); 24 hours a day, seven (7) days a week. Continuous air monitors will be equipped with alarm capabilities at predefined Alert and Action Levels, providing an early warning to project management that control measures might be needed. CAMP personnel will notify the Trust Representative if an Alert Level is reached, which will serve as a pre-Action Level notification and should reduce the occurrences of Concentrations Above the Action Level (CAAL) and resultant corrective actions or mitigation measures associated with these occurrences.

In order to meet these objectives, the following community air monitoring program, described herein, has been designed to protect public and community health and the safety of workers on-Site, during remediation of the Gowanus Canal.

5 Methodology

5.1 Program Overview

This CAMP contains provisions for the continuous monitoring of ambient TVOC and PM_{10} along the Site perimeter, as well as semi-continuous monitoring/sampling for other COCs including: BTEX, naphthalene, H_2S, NH_3, mercaptans and other reduced sulfur compounds. The CAMP network will be comprised of up to seventeen (17) battery or solar powered monitoring stations around the Site and two (2) monitoring stations at the staging site. Each continuous monitoring station, installed at fixed locations, will be comprised of monitoring instrumentation for TVOC and PM_{10} with data transmitted by wireless telemetry on a continuous basis from each monitoring station to a central computer. On-Site wind direction data will be collected using a meteorological station operating on a continuous basis during the term of the remediation program. This data will provide the basis for the identification of stations as upwind and downwind perimeter locations during the course of the program. The following sections describe the monitoring approach including instrumentation and methodology, monitoring and sampling frequency, as well as associated QA/QC and program reporting requirements.

The objectives of this CAMP will be met by employing a variety of monitoring procedures. A summary of the COC and monitoring/sampling methodologies are provided Table 1.

Each sampling station will consist of a Met One ES-642 particulate monitor and a Mocon (formerly Baseline) piD-Tech eVx Photoionization Sensor for the detection of TVOC, inside of an enclosure with the air inlet at breathing zone height. Data will be collected on a continuous basis, as 15-minute averages, at each station and transmitted by wireless telemetry to the central command data-logger for direct comparison to the pred-defined Action Levels (refer to Section 6). Visual and text alarms will be activated should any concentrations exceed Alert or Action Levels. If concentrations exceed Alert Levels, the Trust Representative will be notified immediately via cellphone to coordinate corrective actions. These self-imposed alerts serve to notify on-Site personnel so that corrective actions / emission mitigation measures can be taken prior to reaching Action Levels. In the event of a TVOC CAAL or the observance of sulfur odors, additional measurements will be taken including collection of a Tedlar® bag sample at each affected location followed by GC analyses for BTEX or RSCs. Each occurrence of a CAAL, its cause and corrective actions taken (if needed) will be documented by entry in the field logbook. Weekly reports will be prepared that document all CAALs as well as responses and/or corrective actions taken as a result.

Table 1: ***Summary of Gowanus RTA2 CAMP Monitoring Parameters***

Continuous Monitoring Parameters	**Alarm / Action Levels**	**Detection Limit**	**Equipment Model**
TVOC (15-min) – 24/7	0.75 / 1.0 ppm	5 ppb	Mocon piD-TECH eVx Photoionization Sensor
PM10 (15-min) – 24/7	100 / 150 µg/m^3	5 µg/m^3	Met One ES-642
Periodic Monitoring Parameters	**Frequency and Location**	**Detection Limit**	**Equipment Model**
TO-15	During the first six months: Once weekly at 2 locations + collocated sample *	< 1 ppb	Summa Canisters /Flow Regulators
Hydrogen sulfide (H_2S)	1x daily at all locations 2x daily at locations near active remediation	3 ppb	Arizona Instruments Jerome Model J605
Ammonia (NH_3)	1x daily at all locations 2x daily at locations near active remediation	10 ppb	ATO-SKY2000-NH3
BTEX	As needed triggered by a TVOC CAAL	25-50 ppb	Bag Sampling and analyses by GC/PID SRI Model 8610 GC
Odors (during work hours)	1x daily at all locations 2x daily locations near active remediation	0 – 3 scale	Olfactory survey field staff
• **Naphthalene**	As needed triggered by odor event	25-50 ppb	Bag Sampling and analyses by GC/PID SRI Model 8610 GC
• **Mercaptans & Reduced Sulfur Compounds**	As needed triggered by off-Site/on-Site odor event	50-100 ppb	Bag Sampling and analyses by GC/FPD SRI Model 8610 GC
Meteorological Monitoring Parameters	**Frequency and Location**	**Resolution**	**Equipment Model**
Precipitation	24/7 from the Staging Area	0.1 mm	R.M. Young Tipping Bucket Rain Gauge Model 52202
Wind Speed **Wind Direction** **Temperature** **Relative Humidity** **Atmospheric Pressure**	24/7 from the Staging Area	0.01 m/s 0.1 ° 0.1 °C 0.1% 0.1 hPa	R.M. Young Response One Weather Transmitter Model 92000

* Analyses will be conducted for the volatile Contaminants of Concern identified in Section 3. These data will be evaluated after six months to see if a reduction in the number of samples collected is warranted for the remainder of the program.

5.2 Monitoring Methodology

This community air monitoring program will be conducted in two phases: pre-construction background and remediation monitoring. The background monitoring program will be conducted over five days, prior to active remediation, and will include monitoring for the following parameters:

- Meteorological – wind speed, wind direction, and precipitation monitored continuously,
- Particulate matter – PM_{10}, monitored continuously,
- TVOC monitored continuously, and
- TO-15 sampling – three 24-hour sampling events.

In the event access is not attainable at all candidate locations, only those locations that are accessible will be utilized for background monitoring.

Remediation monitoring will be conducted during all invasive remediation activities planned on Site for RTA2, and will include monitoring for all parameters listed previously, in Table 1.

The methodology for each monitoring and sampling parameter is further detailed in the following subsections, and the frequency defined for each phase is described in Section 7 of the plan.

5.2.1 Meteorological Monitoring

A meteorological (met) station will be erected on a tower. The station will be equipped with an RM Young Response One system to measure wind speed, wind direction, relative humidity, barometric pressure and ambient temperature on a continuous basis. The Response One utilizes ultrasonic sound waves for determining wind speed and direction and has no moving parts. Ultrasonic sensors have improved sensitivity and accuracy over mechanical sensors and require no maintenance. Additionally, precipitation will be monitored continuously utilizing an RM Young Tipping Bucket Rain Gauge, mounted onto the meteorological station trailer. Real-time data from the met station will be displayed by an RM Young translator and 15-minute averages for all met parameters will be stored on the project database.

5.2.2 Particulate Monitoring

PM_{10} will be monitored using a Met One ES-642 at each station on a real-time basis. The 15-minute average data values will be used for comparison to an Alert Level of 100 µg/m^3, as well as, an Action Level of 150 µg/m^3. Data will be transmitted via telemetry to field PC and backed up to the project database.

5.2.3 TVOC Monitoring

TVOC data will be monitored at each of the stations on a continuous basis via the use of a PID Instrument (Mocon piD-TECH eVx Photoionization Sensor).

Data from TVOC monitor will be transmitted using wireless telemetry to the field PC. The 15-minute averaged data values will be used for comparison to alert levels of 0.75 parts per million (ppm) as well as an Action Level of 1.0 ppm. Data will be transmitted via telemetry to the field PC and backed up to the project database.

5.2.4 On-Site Chemical Speciation (Tedlar® Bag Sampling)

Bag samples will be collected as needed, in response to TVOC concentrations above action limits or increased observance of odors near remediation activities, for near real-time analysis for COCs. One GC will be installed on-Site for chemical speciation of BTEX and reduced sulfur compounds via analyses of bag samples. The GC will

be equipped with 2-mL injection loops and capillary columns to effectively separate individual compounds and fitted with a PID detector for analysis of BTEX and naphthalene, and a flame photometric detector (FPD) for H_2S and mercaptans. Detection limits in the 25-100 ppb (v/v) are typically achieved.

5.2.4.1 BTEX

On-Site chemical speciation of air samples may be triggered when TVOC concentrations are measured above the TVOC Action Level. When a 15-minute average exceeds the proposed Action Level of 1.0 ppm, a Tedlar® bag sampling event will be automatically triggered at the affected station, while TVOC monitoring is continued. The automated sampling system will collect ambient air in the bag over a 15-minute period, unattended. Should the 15-minute period following the initial sampling event also exceed 1.0 ppm, an additional sample will be collected for that 15-minute period and the process continued until PID readings have decreased below 1.0 ppm. Tedlar® bags will be retrieved by the CAMP personnel and analyzed for BTEX in the on-Site trailer by GC/PID (SRI Model 8610)

5.2.4.2 Reduced Sulfur Compounds and Naphthalene

Air sampling for reduced sulfur compounds and/or naphthalene may be warranted due to one or more of the following:

- persistent odors are observed by on-Site personnel
- odor complaints are received from off-Site residents
- elevated concentrations of hydrogen sulfide are recorded during periodic sampling events

If needed, an air sample will be collected using a personal sampling pump connected to a Tedlar® bag. Samples collected as a result of an odor event will be analyzed via GC. Concentrations for reduced sulfur compounds will be detected by a FPD, while concentrations of naphthalene will be detected by an PID. In the event that odors attributable to RSCs are observed and on-Site analysis results are below detection, these samples will be sent to an off-Site laboratory for confirmatory analysis.

5.3 Periodic Monitoring

Hydrogen sulfide and ammonia will be monitored daily. Portable hand-held monitoring devices will be employed to take short term measurements twice daily at two monitoring locations, to be strategically selected and varied based on where primary remedial activities are taking place. Hydrogen sulfide will be measured using a Jerome J605 (Arizona Instruments) H_2S detector. The Jerome J605 is capable of achieving detection limits of 3 parts per billion (ppb). CAMP personnel will use an ATO-SKY2000 handheld ammonia gas detector to monitor for ambient ammonia concentrations on a periodic basis. The ATO-SKY2000 is capable of achieving detection limits of 10 ppb. Periodic measurements of H_2S and NH_3 will be completed once daily at all locations, and at least twice daily at locations adjacent to active remediation activities. These data will be downloaded and archived daily utilizing a direct USB connection to the field PC. CAMP personnel will note any trends in observed concentrations to determine if Site activities could be contributing to any fluctuations in daily readings. Results of periodic monitoring will be documented in field logs/forms, and reported in weekly summary reports.

5.4 VOC Sampling – EPA Method TO-15

Air samples via EPA Method TO-15 will be collected for VOCs during both the Background Phase and the

Remedial Phase of the project. These samples will be collected routinely for a subset of VOCs identified in the 2017 PHA, during the remediation program. These COCs are as follows: benzene, chloroform, ethyl benzene, methylene chloride, toluene and xylenes (o,m,p). Initially, two monitoring stations will be selected, determined by wind direction and remediation activities, for VOC sampling every week. In this manner, sampling locations will rotate among the stations along the Site to collect data representative of the community around the Site.

VOCs will be collected using a 6-liter evacuated stainless steel Summa canister. A calibrated regulator (flow controller with a critical orifice) connected to the inlet of the canister ensures the air flow into the canister is maintained at a constant rate to fill the canister over a 24-hour period. The field sampling Standard Operating Procedure (SOP) is provided in Appendix B. VOC samples will be shipped to an accredited laboratory approved in conformance with the National Environmental Laboratory Accreditation Conference Standards (2016) for the category environmental analyses air and emissions. for analysis in accordance with EPA Method TO-15 employing gas chromatography/mass spectrometry (GC/MS). Target VOCs consist of those listed in Pace Laboratory's SOP with the addition of naphthalene. The laboratory's SOP is provided in Appendix A.

5.5 Odor Monitoring

In addition to periodic monitoring for H_2S and NH_3, odor surveys will be performed on a regular basis by CAMP personnel. These will be performed concurrently with H_2S and NH_3 surveys described previously. Odor observations and relevant other information will be recorded during each survey on odor survey forms (an example odor survey form is shown in Figure 1).

While the intensity of odors is subjective, and odor threshold concentrations vary from person to person, nuisance odors are expected during the course of the remediation program. Odor observations will be classified following the odor classification scale below:

- "0" – No odors are detected at the perimeter location.
- "1" – A slight odor is present at the perimeter location. The odor is intermittent and not steady. Minimal impact to off-Site community receptors downwind of the location. Odor control measures at the Site are adequate and activities may continue.
- "2" – Odors at the perimeter are stronger than "1" condition and relatively steady. There is no indication that the off-Site community receptors downwind of the location have been affected. In order to mitigate potential community impacts, additional odor control measures will be implemented including vapor-suppression foam, covering (tarping) of exposed face, or water spray.
- "3" – "2" condition still exists after additional odor control measures have been applied. The community has become aware of the situation and is reacting. Most likely on-Site odor-generating activities will cease, and full odor control measures will be applied (see condition "2"). The situation will be re-evaluated prior to resuming odor-generation activities.

If the odor classification is a "0" or "1", activities will continue. If the odors are classified as a "2", odor control measures will be implemented. If odors are classified as a "3", activities will be halted and full odor control measures implemented. A follow-up odor assessment will be performed and deemed acceptable (Classified as a "2" or below) prior to resumption of on-Site activities that most likely generated the odors.

Figure 1: Example Odor Survey Form

Project Name:	Gowanus Canal Superfund Site RTA2
Project Location:	Brooklyn, New York
Wind Direction & Speed:	
Project Activities:	

LOCATION (STATION #)	ODOR CLASSIFICATION (0, 1, 2, or 3)	OTHER OBSERVATIONS

Conducted By:	
Signature:	
Date:	

6 Action Levels

The Alert and Action Levels were developed considering potential risks to off-Site receptors. Alert Levels are self-imposed and serve as a warning or pre-notification that concentrations are nearing Action Levels and allow for corrective action to be taken as a means to maintain concentrations below the Action Level. Action Levels represent the highest acceptable ambient concentration (AAC) where, if recorded for 15-minutes or more, would require enhanced corrective action and potentially work stoppages.

The Action Levels for the perimeter monitoring program are as follows:

Table 2: Site Specific Alert and Action Levels

Parameter	Alert Level	Action Level
TVOC	0.75 ppm	1.0 ppm
PM_{10}	100 µg/m^3	150 µg/m^3 *
*Equivalent to the National Ambient Air Quality Standard (NAAQS) for PM_{10}. The NAAQS represents a 24-hour time weighted average concentration for PM_{10} in ambient air.		

6.1 Derivation of Action Levels

PM_{10}

The PM_{10} Action Level in place for this CAMP is the equivalent of the NAAQS for PM_{10}, and was dictated by Appendix 1A of NYSDEC's DER-10 guidance document, which reads:

> "The action level will be established at 150 ug/m^3 (15 minutes average). While conservative, this short-term interval will provide a real-time assessment of on-Site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m^3, the upwind background level must be confirmed immediately. If the Site particulate measurement is greater than 100 ug/m^3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect Site personnel and reduce the potential for contaminant migration."

TVOC

Action Levels should reflect potential risks to off-site receptors. These risks are to be based on a residential exposure scenario that consists of the following components:

- Exposure period of three years
- Target risk level of $1x10^{-5}$
- Target quotient of 1

The risk-based analysis resulted in a calculated TVOC Action Level of 2.62 ppm (based on benzene). To be conservative, an Action Level of 1 ppm was selected, with a 75% Alert Level of 750 ppb. These same Alert and Action Levels for TVOC were employed during both CAMP programs performed during the pilot programs conducted in the Gowanus Canal Turning Basin and during RTA1 activities.

6.2 Real Time Alarm Notifications

In the event measured concentrations reach Alert or Action Levels, the following actions will be taken.

- Visual alarms will be activated and displayed on the screen of the field PC if 15-minute average TVOC or PM_{10} concentrations reach the Alert Levels. The Trust Representative will be notified so that corrective actions/emission mitigation measures can be implemented.
- CAMP personnel will be immediately notified when concentrations reach Alert Levels by receipt of an automated e-mail and/or cell phone text message. The CAMP personnel will validate the concentration above the Action Level and immediately notify the Trust Representative.
- In the event that concentrations are recorded above the Action Level for TVOC or $PM_{10,}$ the affected value will be adjusted for background (the difference between upwind and downwind airborne concentrations of TVOC or PM_{10}).
- If upwind concentrations are recorded above Action Levels, no corrective action is required as they are typically attributable to off-Site activities.
- Simultaneous occurrences of concentrations above an Action Level at downwind and upwind stations will be considered to have originated from an off-Site source. If this occurs, the numerical concentration for the most upwind location is subtracted from the downwind concentration. CAMP personnel will make effort to determine the off-Site cause of concentrations reaching Action Levels.

In order to maximize responsiveness to concentrations reaching self-imposed Alert Levels, continuous radio/cell phone contact will be maintained between CAMP personnel and the Trust Representative. Accordingly, corrective actions can be taken to avert concentrations reaching Action Levels should measured concentrations reach an Alert Level. CAMP personnel will document all actions taken by the remediation contractor in response to concentrations above Alert Levels and Action Levels for TVOC and PM_{10}. These actions will be documented in field logs and summarized in daily/weekly reports as appropriate.

7 Frequency

7.1 Background

Background monitoring will take place prior to commencement of active Site remediation (e.g. dredging). Five (5) consecutive days of perimeter monitoring will be performed employing the complete CAMP station network, assuming access agreements at all locations have been arranged. In the event access is not attainable at all candidate locations, only those locations that are accessible will be utilized for background monitoring. Continuous monitoring for TVOC and PM_{10} will take place on a 24 hour/day basis. Additionally, VOC samples will be collected on a time weighted basis (approximately 24 hours) at two stations, including collocated sampling at one station, in accordance with US EPA Method TO-15. These data will collectively represent the background data base characteristic of the Site environs prior to the start of active remediation.

7.2 Remediation

Air monitoring, along the Site and at the staging site, will take place during remediation activities including dredging, bulkhead installation, in-situ stabilization, and capping. TVOC and PM10 will be monitored continuously at each CAMP monitoring stations. Periodically, grab samples or short-term measurements will be collected for additional COCs, as summarized in Section 5.3.

Sampling and analyses for VOCs in accordance with EPA Method TO-15 will continue on a weekly basis during the remediation program. Similar to the background sampling, weekly sampling will occur at two stations. The sampling locations will be determined based on wind direction and rotated so that all stations are represented over the course of the remediation program. These data will be evaluated after six months to determine if a reduction in the sampling frequency is warranted for the remainder of the program.

7.3 Measured Concentrations Above Action Levels

TVOCs and particulates will be monitored continuously at all network monitoring stations 24 hours a day, seven (7) days a week, for comparison to Site-specific Alert and Action Levels. Upwind and downwind directions will be determined on an on-going basis by evaluating the real-time meteorological data recorded at the Site. If predominant wind direction cannot be determined (e.g., wind speeds less than 2 mph or the direction variable), then all locations will be considered downwind locations.

If a measured TVOC concentration (15-minute average value) exceeds the TVOC Action Level (1.0 ppm) at any station, an automated system will initiate the collection of a BTEX bag sample at the affected location. If the next consecutive 15-minute average exceeds the TVOC Action Level, a second BTEX bag sample will be collected. Analysis via GC will be performed on the most recent sample first. In the event that two consecutive 15-minute TVOC concentrations are greater than the Action Level, the Site activity determined to have contributed to the CAAL may be halted until a 15-minute measurement at that location is restored below the Action Level of 1.0 ppm.

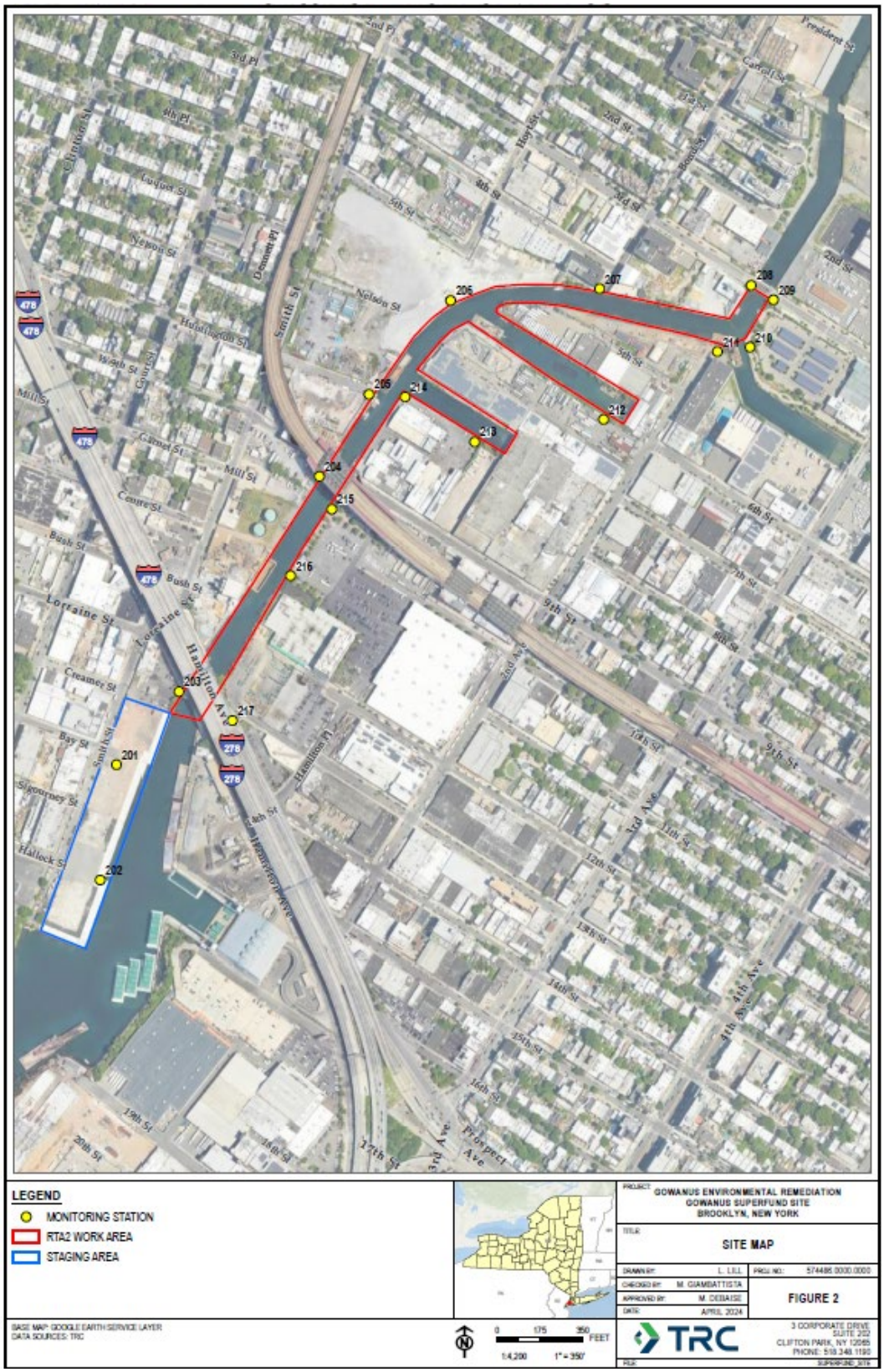
If a measured PM_{10} concentration is greater than the Action Level (150 ug/m^3), corrective actions will be initiated. If the next consecutive 15-minute measurement is also greater than the Action Level, the Site activity determined to have contributed to the CAAL may be halted until a 15-minute measurement at that location is restored below the Action Level of 150 $\mu g/m^3$.

8 Monitoring Locations

The network will be comprised of up to seventeen (17) monitoring stations as follows: two (2) monitoring stations will be located within the staging area located at 595 Smith Street, and up to fifteen (15) monitoring stations will be located along the RTA2 Site perimeter. Measures will be taken in advance of remedial/construction activities to secure the perimeter of each work zone such that there are no homes, occupied buildings or potentially exposed populations within a 20-foot distance from the perimeter of the work zone. Further, engineering controls will be employed on-Site to control airborne contamination attributable to remedial/construction activities from entering the ventilation systems of occupied buildings.

The approximate locations of these monitoring stations, the staging site command center/trailer and the meteorological station are shown in Figure 2.

Figure 2: Proposed Monitoring Station Locations



A survey of the Gowanus Canal was conducted by TRC on March 26, 2024. The purpose of this survey was to identify candidate locations for monitoring stations along RTA2. These candidate locations are listed in Table 4. Final locations will be selected during the course of the CAMP review and property access process and listed in the Final CAMP.

Table 3: Coordinates and Descriptions of Candidate Monitoring Locations

Site Number	Latitude N	Longitude W	Location Description
201	40°40'14.86"	73°59'59.09"	Staging Area, near Bay Street
202	40°40'10.20"	73°59'59.95"	Staging Area, near met station
203	40°40'17.81"	73°59'55.77"	West Side of Hamilton Bridge
204	40°40'26.50"	73°59'48.32"	Bridge house at 9th Street Bridge
205	40°40'29.81"	73°59'45.69"	Huntington Street Promenade
206	40°40'33.60"	73°59'41.36"	National Grid Tunnel Entrance at Citizen's Site
207	40°40'34.08"	73°59'33.45"	Dead end at Bond Street
208	40°40'34.21"	73°59'25.41"	SW Corner 3rd Street Bridge
209	40° 40' 33.63"	73° 59' 24.23"	SE Corner 3rd St. Bridge
210	40°40'31.72"	73°59'25.47"	Whole Foods Promenade at TB4
211	40°40'31.54"	73°59'27.20"	Dead end at 2nd Ave
212	40°40'28.80"	73°59'33.24"	Parking Lot at 36 2nd Ave
213	40°40'27.89"	73°59'40.08"	Parking Lot at Emdad Construction
214	40°40'29.71"	73°59'43.77"	Parking Lot of Heights Woodworking
215	40°40'25.17"	73°59'47.66"	NW corner Lowe's Parking at 9th St. Bridge
216	40°40'22.49"	73°59'49.85"	SW corner Lowe's Parking at TB11
217	40°40'16.64"	73°59'52.94"	East Side of Hamilton Bridge

9 Quality Assurance and Quality Control (QA/QC)

The QA/QC procedures for this program are described in this section. The QA/QC procedures associated with the air quality monitoring program are designed to ensure that data collected at the perimeter and proximate to the work area are of defined precision and accuracy. The QA/QC procedures will be conducted so as not to interfere with routine on-Site activities.

The overall QA objective is to develop and implement data validation and reporting procedures for continuous PM_{10} and TVOC monitoring, air sampling for VOCs, and periodic grab short-term sampling for other COCs, to provide results that are scientifically valid, and defensible to applicable US EPA standards.

- All data should be traceable to a NIST standard.
- All data shall be of a known and documented quality. Two major measurements used to define quality are precision and bias.
- All data shall be comparable. This means all data shall be produced in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, auditing, etc. referenced in the QAPP should achieve this goal.
- All data shall be representative of the parameters being measured with respect to time, location, and the conditions from which the data are obtained. The use of approved standard methodologies will ensure that the data generated are representative.

9.1 TVOC Monitors

A TVOC/PID organic vapor monitor (Mocon piD-TECH eVx Photoionization Sensor) will be used to monitor perimeter TVOC concentrations at each monitoring station. Calibration checks will be performed daily (all workdays) using a zero and span benzene gas standard (certified and NIST traceable). Calibrations will be recorded on instrument calibration data sheets. Results from the daily calibration checks are recorded on Calibration and Maintenance Data Sheets. If the unit fails to meet calibration check criteria (± 10% difference), the instrument calibration will be adjusted, and rechecked with the span level gas standard. If it is determined that the instrument has a problem that cannot be resolved by adjustment, the unit will be replaced with one of the spare units on-Site.

9.2 Particulate Monitors

A MetOne Model ES-642 Particulate Monitor will be used to monitor perimeter PM_{10} concentrations at each monitoring station. The ES-642 performs optical system zero self-tests once per hour of operation. During the self-test operation, a separate zero air pump activates and circulates clean air through the optical system. The ES-642 filters the air through a 0.2-micron pore size, 99.99% efficient filter element before it enters the sensor. The ES-642 zeros itself based on this clean air condition. During the zero portion of the automatic periodic self-test cycle, the main sample pump is turned off and the purge pump is turned on. The air is filtered by the purge filter and circulated through the laser module at a higher flow rate. The air in the laser module is 100% filtered during this process, and no scattered light should enter the detector. The ES-642 takes a zero reading and establishes a new signal baseline. A check valve prevents air from back-flowing through the purge pump during the normal sampling.

The ES-642 contains a comprehensive system of error and alarm codes that are used to alert the operator of any problems with the unit. These error codes may be generated during normal operation or during a self-test routine. The errors appear on the ES-642 display and in the status output if the serial communications are used. Certificates of manufacturer calibrations for the particulate monitors are included in Appendix D. Every two years the ES-642s are swapped out in a cycle for calibration and recertification by the manufacturer.

9.3 VOC Sampling

Periodic VOC sampling will be conducted as described in Section 5.4 of this plan, using a VOC sampler system consisting of a batch-certified Summa canister equipped with a calibrated flow regulator. The VOC sampler system will be calibrated in the laboratory and operated according to EPA Method TO-15.

Following collection of the sample, the canisters will be packaged in a shipping container and sent to the analytical laboratory under Chain of Custody for immediate analysis. Method blanks, and laboratory control samples will be analyzed with all field samples. All samples will be spiked with surrogate compounds prior to sample analysis as per EPA Method TO-15. Accuracy and acceptance limits are specified in the method and laboratory SOPs (see Appendix A).

9.4 Handheld Monitoring Devices

Site survey monitoring will be conducted as described in Section 5.3 of this plan, using handheld monitoring devices, such as the Jerome meter and ATO-Sky2000. The Jerome meter is sent back to the manufacturer annually for certification and calibration against NIST traceable standards. While the ATO-Sky2000 undergoes quarterly calibration verifications on Site against a 10 ppm NIST traceable Protocol 1 Gas Standard.

9.5 On-Site Gas Chromatograph

The initial calibration of the GC will be conducted with a blank (hydrocarbon free air) and gaseous calibration standards. Standards for calibration of the GC that are stored in the on-Site trailer include: mixed BTEX, naphthalene, and mixed RSCs. Certificates of Analysis for the calibration gas standards are provided in Appendix C. Stock standards will be diluted to prepare the calibration curve. Calibration curves will be prepared at the start of the program and verified before and after each sample run with a mid-calibration standard. The calculated concentration of the mid calibration standard must be within ± 20% of the certified concentration. A new calibration curve will be prepared if the calibration check falls outside this criterion.

All calibration data will be recorded in the instrument logbook. The instrument logbook will be specific to GC operation and maintained on-Site throughout the duration of Site activities.

9.6 Meteorological Sensors

The R.M. Young Response One system has no moving parts and will be calibrated by the manufacturer prior to installation on-Site. The certification of calibration will last for one year, so the system will be swapped out annually with a freshly calibrated system. The quality control checks for the Response One System include:

- Visually inspecting (from ground level) the meteorological system daily;
- Weekly comparison of on-Site data to regional conditions (JFK and LaGuardia International Airport's NWS data)
- Daily checks for data completeness and valid values from the data logger; and

- Inspecting the Response One sensor for any damage if the data appear suspect.

The tipping bucket for precipitation measurements is calibrated at the start of monitoring and verified every six months with an RM Young Model 52260 Rain Gauge Calibrator.

9.7 Documentation

Field sampling documentation will be maintained during the CAMP program and is anticipated to include:

- Daily and weekly summary reports
- Daily calibration check sheets for ambient monitoring stations
- Job Hazard Analysis forms
- Equipment maintenance logs
- Analytical sample tracking
- Laboratory data packages
- Sample chain-of-custody forms
- Field Data Forms (e.g. Site Surveys, TO-15 sampling, and Meteorological Inspection)

All hardcopy information shall be filled out in indelible ink. Corrections shall be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly or by providing the information on a new line if the above is not possible. Copies of all field sampling data sheets and forms will be retained by the Air Monitoring Contractor. Completion of data entry forms, associated with all routine environmental data operations, are required even if logs or notebooks contain all appropriate and associated information required for the routine operation being performed.

10 Data Management Validation and Reporting

Continuous monitors (TVOC and PM_{10}) and meteorological sensors will be wirelessly connected to Campbell Scientific data loggers. The loggers will poll the monitors at one-minute intervals to calculate 15-minute averages. All values will be backed up and transmitted to a Campbell Scientific LoggerNet Database and backed up to a Microsoft SQL database for secure, off-Site storage. Data collected from periodic field sampling will be downloaded daily, directly from the monitors and loaded in the project database. Laboratory generated data packages and electronic data deliverables will be saved on secure servers.

Field generated data will be validated daily by the field manager prior to issuing daily summary reports. Data generated by the laboratory will be initially reviewed by the laboratory QA manager before data packages are forwarded to CAMP personnel. The data manager will verify that the data package is complete and contains all requested analyses, QC results, and raw data. In all cases, CAMP personnel will identify any missing information and will contact the laboratory project manager or the field manager to obtain this information. All QA/QC data will be compared to the data quality objectives and numerical control limits listed within SOPs. Any outliers will be identified and impacts on data quality and utility described.

Daily Reports

A data summary report will be prepared on a daily basis. These reports will summarize all data collected on a station specific basis. Measured concentrations above Action Levels (if any) will be noted, as well as, responses or corrective actions taken as a result of those elevated concentrations. The effectiveness of the response actions taken will also be addressed. These reports will be distributed to on-Site staff (e.g. remediation contractor, oversight engineer etc.) as directed by the Trust Representative.

Weekly Reports

Weekly Community Air Monitoring Reports will be generated summarizing the previous week's data collected, construction activities occurring on-Site during the period, concentrations above Action Levels, elevated measurements, meteorological data and corrective actions performed. These weekly reports will include all of the daily reports issued during each weekly reporting period. Tables and graphs will be included in the report that illustrate actual measurements (both daily maximum and average values) as compared to Action Levels. Volatile organics results from analyses of Summa canister samples will also be included in weekly reports as laboratory data are received and validated.

Appendix A – Laboratory Standard Operating Procedures for EPA Method TO-15

Test Method Standard Operating Procedure (SOP): Pace® Analytical Services

Pace ANALYTICAL SERVICES	**ENV-SOP-ELON-0050 v02_EPA TO-15**
	Effective Date: 07/26/2023

Management Approval:
Catherine Rouleau Approved on 7/17/2023 4:01:48 PM
Francis Derose Approved on 7/26/2023 8:07:23 AM
Tod Kopyscinski Approved on 7/24/2023 7:54:07 AM
Katherine Allen Approved on 7/26/2023 8:32:04 AM

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure used for the determination of Volatile Organic Compounds (VOCs) in air collected in specially prepared canisters and analyzed by Gas Chromatography/Mass Spectrometry (GC/MS) by Method EPA TO-15.

This method documents sampling and analytical procedures for the measurement of subsets of the 97 volatile organic compounds (VOCs) that are included in the 189 hazardous air pollutants listed in Title III of the Clean Air Act Amendments of 1990. The Air is collected in specially prepared canisters (silco steel, silonite or summa), separated by a gas chromatograph and measured by mass spectrometry. The VOCs in this method have been tested and determined to be stable in pressure and sub ambient canisters at low ppbv ranges.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

The target analytes that can be determined by this SOP and the associated LOQ is provided in Table 1, Appendix A.

2.0 SUMMARY OF METHOD

Air samples are collected in precleaned, evacuated Summa passivated stainless steel canisters either by sub-atmospheric pressure or pressurized sampling modes. Once the air sample is collected, the canister valve is closed and labeled and sent to the laboratory for analysis. Upon receipt of the sample, the sample is logged into the LIMS and delivered to the Air lab for analysis.

The pressure in the canister is checked and documented. All cans are pressurized 1.5X with compressed ultra-zero air or Nitrogen and recorded in the air dilution logbook located at F:\Lab\Air\Airlogbooks\4700 Pressure Log as an excel spreadsheet. (Summa cans are pressurized 1.5X unless lower RL's are needed. All new ultra-air gas cylinders are lot checked before use and stored on the F: F:\CTAL-Laboratory\Air\CLEANING CHECKS\02 TANK CHECKS. If using Nitrogen, which comes from the Liquid Nitrogen bulk tank, we monitor contamination through blanks. Some summa cans may need to be more pressurized more than 1.5X if below 10in. of Hg. Target pressure to run from can is 14-18psia). A specified amount of sample is then withdrawn from the canister and introduced on to the gas chromatograph for separation of the volatile organic compounds. The VOCs thus separated, are detected by a quadruple low-resolution mass spectrometer in full scan mode, or SIM or simultaneous SIM/SCAN. Upon completion of analysis and data review, the sample is removed from the auto sampler and held until data is reviewed and reported. When ready to clean, it is hooked up to the can cleaner for cleaning and then stored away for future use.

3.0 INTERFERENCES

Interferences may be caused by the following sources of contamination:

- purge gas

- contaminated sampling canister
- sample cross contamination: column or trap (bake-out to eliminate contamination)
- high methane and/or carbon dioxide levels in the sample

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- Gauge Pressure: Pressure measured with reference to the surrounding atmospheric pressure, usually expressed in psig.
- Absolute Pressure: Pressure measured with reference to absolute pressure, usually expressed in psia.
- Cryogen: A refrigerant used to obtain sub-ambient temperatures in the VOC concentrator 7100 from Entech. The cryogen used is Liquid Nitrogen.
- Fill gas: Is ultra-zero air. Usually used to dilute the air samples and blanks.
- Dynamic dilution: Is a process by which Calibration mixtures are prepared by blending fill gas continuously with standard gases from pressurized cylinders so that a flowing stream of calibration mixture is available at the inlet of the analytical system. We use Entech's 4700 Static Dilution System.
- MS-Scan: Is the mass spectrometric mode of operation in which a mass spectrometer is programmed to scan all ions over a specified mass range.

5.0 HEALTH AND SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001)
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.

- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 .SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

The laboratory provides Summa Canisters for the collection of samples upon client request.

The laboratory does not perform sample collection or field measurements for this test method. Samples should be collected in accordance with a sampling plan and sampling procedures appropriate to achieve the regulatory, scientific, and data quality objectives for the project.

Samples can be collected in the canisters by two techniques namely sub-atmospheric sampling and pressurized sampling.

Sub-atmospheric Sampling: In preparation to the sub-atmospheric sampling the canister is evacuated to 50mTorr. When the can is opened to the atmosphere containing the air to be sampled, the differential pressure causes the sample to flow into the canister. This technique could be used to collect grab samples or time-weighted average samples through a flow restrictive inlet with a critical orifice flow restrictor regulator.

Pressurized Sampling: Pressurized sampling is used when longer-term integrated samples or higher volume samples are required. The sample is collected in a canister using a pump and flow control arrangement to achieve a typical final canister pressure.

Time-Weighted-Average samples with flow regulators: Passive air sampling kits designed by Restek are used to collect time-weighted-average samples. These regulators are pre cleaned in the air laboratory by passing ultra-high pure Nitrogen at 10 psig and the flows are preset for various times from 1-24 hrs of sampling depending upon the volume of the canister.

Sample Collection: As explained earlier, samples are collected either by opening the valve on the summa canister (grab sample) and listen to a hissing noise (when air enters the evacuated zone) and closing the valve once the hissing noise stops or attaching a precleaned, preset flow regulator onto the canister and keeping the valve open for the duration of the sampling period. At the end of the sampling period the valves are closed, regulators are detached from the setup and the can, and the regulator are both sent back to the lab via a courier service. Flow regulators are calibrated before sending out to clients with flow meters and checked when received back in the laboratory.

Container Type, Minimum Sample Amount, Preservation, and Holding Time Requirements:

Matrix	Container Size & Type	Required Sample Amount[1]	Preservation	Holding Time
Air	Summa Canister – various sizes	400mL for Inst. G/H 200mL for Inst. J/K/L	Thermal: None Chemical: None	Collection to Analysis: 30 days

[1] *Amount of sample required for each discrete test.*

Tedlar bags must be analyzed as soon as possible, preferably within 72 hours of sampling. There is no documented holding time for Tedlar bags. Note: Sample collection in Tedlar bags for TO-15 is not permitted for New Jersey samples

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

7.1 Equipment

- Concentration System: Sys "G" - Entech 7100 Preconcentrator/ Sys "H" and "J" +" K" + "L" Entech 7200/A Preconcentrator
- Autosampler: Entech 16 position 7016 CA Canister Autosampler – for System "G". Entech 7016D Autosampler for System "H" and "J" and "K" and "L".
- Entech 4700 Static Diluter
- GC/MS System: HP 6890/ Agilent 7890B/5977B (System J and K), 7890A/HP5975C (sys G), Agilent 7890A/5975C (Sys H), and Agilent GC 8890/MS 5977B (System L).
- GC/MS Data System: Enviroquant/Windows NT/2000/Windows XP/Windows 10
- Dwyer NIST-certified test gauge
- Flow meters – Primary Flow Meter (Bios Dry Cell) is sent out for calibration at least every five years. Other flow meters are calibrated against the primary flow meter at least annually as well as every time the battery is changed.
- Passive Flow Controllers

7.2 Supplies

- Summa Canister-6L, 3L, 1L and 0.4L
- GC Column:

  For Instruments "G" and "H": Restek RXi-1ms 60m x 0.32mmID x 1um (or equivalent)

  For Instruments "J" and "K": Agilent Column DB-1 30m x 0.25mmID x 0.50um (or equivalent)

  For System "L": Agilent DB-1 30m x 0.25mmID x 0.25um (or equivalent)

8.0 REAGENTS & STANDARDS

8.1 Reagents

- Liquid Nitrogen
- Chromatographic grade Helium
- Compressed ultra-zero air.

8.2 Standards

- Calibration Mix: Spectra Gases TO-15 mix containing 65 compounds conc. 1 ppm, cat # 34436
- Internal Standard/Surrogate Stock: certified gas mix from Restek containing 4 compounds cat# 34408 - Statically dilute the standard by adding 60uL of purged H2O and filling with ultra- zero air; final pressure 35 psia, final concentration 40ppbv. Expires one month from preparation.
- Quality Control Std. – Purchased from Air gas – a mix with different vendor and different lot than calibration standards 1 ppm. The LCS is a separate secondary source TO-15 canister that has been prepared exactly like the 5ppbv standard used for calibration. It is analyzed at the 5ppbv level.

  Note: Working standards prepared in canisters are to only be stored for 30 days.

9.0 PROCEDURE

9.1 Canister Cleaning

All canisters are cleaned after sample analysis and prior to reusing them. They are cleaned on a 10-position heated Nutech Canister Cleaner 3650A, or a 24-position Holman Engineering Canister Cleaner. The canisters are heated to 75℃ on the 24-slot cleaner, or 75℃ on the 10-slot cleaner, valves are opened, and canisters are evacuated with a roughing pump. The roughing pump and molecular drag pump are both vented into hood ducting.

The canister cleaner is cycled four to six times of pressurization of the canisters with humidified synthetic air followed by evacuation of the canisters. At the completion of the final cycle, the molecular drag pump is activated, and the canisters are brought to a vacuum of < 50 millitorr. The pump-down with the molecular drag pump is typically 1.5hrs to 3 hrs.

At the completion of the process, one or more canisters are chosen for batch certification analysis as per the method. These cans are pressurized to 35psia on 4700 Precision Static Diluter with ultra-pure air or Nitrogen and sit for 12hours before being analyzed to age them. If there are no compounds detected above 0.2ppbV for a 400- ml sample, (except for ethanol, IPA, propene, and acetone as these are not on the TO-15 list, which must be below the reporting limit of 2.0ppbv, but are still documented if over 0.2ppbv); the batch is considered clean and the cleaning check can is put on the cleaner and pulled to < 50millitorr to be certified clean. However, if there are compounds above 0.2ppbv (or the reporting limit for acetone, ethanol and IPA) the cans go for a second round of cleaning and will be cleaned until all the targeted compounds in the can are below the detection limit. Once certified, clean the cans are labeled, documented in the cleaning log, and placed in storage at <50mTorr to await future sampling. Before cans are sent out, they are leak checked. All clean checks are documented at F:\Lab\air\Logbooks\Clean Check Log in an excel spreadsheet.

Additional Can Cleaning details found in ENV-SOP-ELON-0042_Can Cleaning.

9.2 Instrument Set Up Conditions

Entech 7100/7200/7200A Preconcentrator

Micro Scale Purge and Trap Cold Trap Dehydration

Module 1:	Trap at –130 ℃ to -160℃	Trap at –20 ℃ to -50℃
	Preheat to 0 ℃ to 20℃	Preheat to 0 ℃ to 15℃
	Desorb at 0 ℃to 20 ℃	Desorb at 0 ℃ to 15 ℃
Module 2:	Trap at –40 to -10 ℃	Trap at –50 to -60 ℃
	Desorb at 180 ℃ to 190 ℃	Desorb at 180 ℃ to 190 ℃
	Bake at 190 ℃	Bake at 190 ℃
Module 3:	Focus at –180 to –150 ℃	
	Inject for 1 min to 4 min	
	Bake for 3-10 min	
	Wait 20-28 minutes before starting next analysis	
Column:	For Instruments G+H: Restek RXi-1ms, 60m x 0.32mmI.D. x 1um	
	For Instruments J+K: Agilent DB-1 30m x 0.25mmID x 0.50um	
	For System “L”: Agilent DB-1 30m x 0.25mmID x 0.25um	

All Systems

GC 5890-7890

Oven equilibration time: 0.5 min

System “G” MS5975

Column program = 35℃ for 4 min., ramp at 8℃/min to 170℃, 30℃/min to 220℃ for 4.45 min

Run time: 24 min - 27 min
Split ratio: Splitless
Sampling rate: 2
Threshold: 200
Mass Range: 35-300 amu
Scans per second: 2.82
Scan start time: 4.0 min
Number of A/D samples: 4

System “H” MS 5975C

Column program = 35℃ for 4 min., ramp at 8℃/min to 170℃, 30℃/min to 220℃ for 5.0 min

Run time: 24 min - 28 min
Split ratio: 30:1
Sampling rate: 2
Threshold: 150
Mass Range: 35-300 amu

Scans per second: 2.73
Scan start time: 4.2 min
Number of A/D samples: 3

System "J" and "K" and "L" MS 5977B

Column program = 35℃ for 2 min., ramp at 25℃/min to 260℃, 50℃/min to 180℃ for 2 min.

Run time:14 min – 15 min
Split ratio: Splitless
Sampling rate: 1
Threshold: 50-100
Mass Range: 35-300 amu
Scans per second: 5.2-9.4
Scan start time: 1.5 min
Number of A/D samples: 4

9.3 Step by Step Start-up

9.3.1 Pressurizing Samples:

Open 4700 software 2) open Air, He or N2 valve 3) select pressurize 4) attach sample to 4700 5) Flush if necessary 6) select pressure by factor or pressure to absolute 7) select Start tab and wait until done. Record initial and final pressure in the Air Dilution Logbook 9) Be Sure to note the pressurization in the Misc Info in the GC sequence.

9.3.2 Setting up GC Sequence

- System G:

  Open GC software 2) open sequence 3) save as current date 4) edit in sequence vial #, sample name, method, file ID# and misc info/comment 5) save sequence 6) select position and run 7) select line to start on 8) change Data File Directory to current date 8) select Run Sequence to start and select No to run keywords.

- System H, J, K, L:

  Open GC software 2) open sequence 3) save as current date 4) edit in sequence vial #, sample name, method, file folder, file ID# and misc info/comment 5) save sequence 6) select position and run 7) select line to start on 8) change Data File Directory to current date 8) select Run Sequence to start and select No to run keywords

9.3.3 Setting up 7100/7200/7200A Concentrator

- System G:

  Open 7100 software 2) load last sequence 3) save sequence as current date 4) edit in sequence Sample Name, Samp Inlet #, Auto Pos #, Samp Vol, Method and Internal Std Vol 5) save sequence 6) highlight starting position 7) select Start (GO) tab 8) select View tab to see current state of 7100 concentrator.

- System H, J, K, L:

Open 7100/7200 software 2) load last sequence 3) save sequence as current date 4) edit in sequence Sample Name, Samp Inlet #, Auto Pos #, Samp Vol, Method, Internal Std Vol and set to Queue 5) save sequence 6) select Run to start.

9.4 MS Calibration and Tuning

Auto-tune with PFTBA with Instrument idle at 35℃.

Tuning is performed by injecting 28.6ng of BFB (for G+H) or 14.3ng of BFB (for J+K+L) in the gaseous state (like a regular sample) with column temperature ramped from 35℃ to 220℃ or 260℃ depending on system “J”, “K”, “L” and “F”, “G” and “H” respectively, with the following acceptance criteria:

Mass	m/z Abundance Criteria
50	8 to 40 % of Mass 95
75	30 to 66% of Mass 95
95	Base Peak, 100% relative abundance
96	5 to 9% of Mass 95
173	<2% of Mass 174
174	>50% but <120% of Mass 95
175	4 to 9% of Mass 174
176	>93% but <101% of Mass 174
177	5 to 9% of Mass 176

The mass spectrum of BFB that is evaluated against the acceptance criteria is obtained in the following manner: three scans (the peak apex and the scans immediately preceding and following the apex) are averaged, and a single scan no more than 20 prior to the BFB peak is subtracted. No part of the BFB peak itself may be background-subtracted. This is done through the software program “Autofind BFB”

The BFB relative abundance criteria must be met before any standards, samples, or quality control samples are analyzed at least once every 24 hours.

9.5 Scan Analysis Table

Compound Name	Ions Used	Compound Name	Ions Used
Propene	41,42,39	Cyclohexane	84,69,41
Dichlorodiflouromethane	85,87	1,2-Dichloropropane	63,62,76
Chloromethane	50,52	Bromodichloromethane	83,85,129
Freon 114	85,135,87	Trichloroethene	95,130,132
Vinyl Chloride	62,64	Heptane	57,71,100
1,3-Butadiene	54,53,50	MIBK	43,57,100
Bromomethane	94,96	Cis-1,3-Dichloropropene	75,110
Chloroethane	64,66	Trans-1,3-Dichloropropene	75,110
Acetone	43,58	1,1,2-Trichloroethane	97,83,85
Trichlorofluoromethane	101,103	Toluene	91,92
Ethanol	45,46	2-Hexanone (MBK)	43,57,100
1,1-Dichloroethene	61,63,96	Dibromochloromethane	129,127,131
Methylene Chloride	49,84,86	1,2-Dibromomethane	107,109

Freon 113	101,151	Tetrachloroethane	166,168,129
Carbon Disulfide	76,78	Chlorobenzene	112,77,114
Trans-1,2-Dichloroethene	61,96,98	Ethylbenzene	91,106
Methyl tert-butyl-ether	73,57	M/P-Xylenes	91,106
Isopropyl Alcohol	45,43,59	O-Xylene	91,106
2-Butanone (MEK)	43,72,57	1,1,2,2-Tetrachloroethane	83,131,85
Cis-1,2-Dichloroethene	61,98,96	4-Ethyltoluene	105,120
Vinyl Acetate	43,86	1,3,5-Trimethylbenzene	105,120
Hexane	41,56,86	1,2,4-Trimethylbenzene	105,120
Ethyl Acetate	61,70,88	1,3-Dichlorobenzene	146,148,111
Chloroform	83,85	Benzyl Chloride	91,126
Tetrahydrofuran	71,72	1,4-Dichlorobenzene	146,148,111
1,2-Dichloroethane	62,64,98	1,2-Dichlorobenzene	146,148,111
1,1,1-Trichloroethane	97,99,61	1,2,4-Trichlorobenzene	180,182,145
Bromoform	173,175	Styrene	104,78
Benzene	78,51,77	Hexachlorobutadiene	225,260
Carbon Tetrachloride	117,119	1,1-Dichloroethane	63,65,83
Acrylonitrile	53,52	*4-phenylcyclohexane(4-PCH)	104,158
Acrolein	56,55	Naphthalene	128,102
1,4-Dioxane	88,58,43		

Full scan parameters:

Low Mass: 35.0
High Mass: 300.0
Threshold: 200
Sample Number: 2
A/D samples: 4

9.6 Calibration

Static Dilution of Calibration standards for the initial calibration. Three precleaned canisters are picked for preparing the working standards. One canister is blended with the calibration mix to represent a lower concentration at 0.1ppbv, one is at 1.0ppbv and last one is the 20ppbv standard using the Entech4700 Static Diluter. (Other levels may be used). These three cans will be used to run the calibration curve. The first 4-5 points of the curve are run from the canister blended with the standard at 1.0ppbv level and the remainder from the 20ppbv and 0.1ppbv cans. These standards are prepared by opening the 4700 software. Once in the program open the saved files and use 0.1std, 20std and 1.0std for the appropriate stock standard. Attach the Summa canister to the 4700. Open the valve and fill the can up to 35psia for the 20ppbv can and 25psia for the 0.1ppbv and 1.0ppbv cans. The following amounts are used for each instrument.

When prepping a new calibration curve, typically the 20ppbv canister is prepped first, allowed to sit for 12hours, then the 1.0ppbv can is prepped from the 20ppbv can and allowed to sit for 12 hours, and then finally the 0.1ppbv can is prepped from the 1.0ppbv can and allowed to sit for 12 hours. The ICAL will then be analyzed. Each point is allowed to sit as it assures stability and better results.

All Systems (A minimum of five points used to establish initial calibration.)

Systems "G" and "H":

STD.	AMOUNT
0.025ppbv	10 mL of 1.0 ppbv
0.05ppbv	20 mL of 1.0 ppbv
0.10ppbv	40 mL of 1.0 ppbv
0.20ppbv	80 mL of 1.0 ppbv
0.5 ppbv	200 mL of 1.0 ppbv
1.0 ppbv	20 mL of 20 ppbv
2.0 ppbv	40mL of 20 ppbv
5.0 ppbv	100 mL of 20 ppbv
10 ppbv	200 mL of 20 ppbv
20 ppbv	400 mL of 20 ppbv
50 ppbv	1000mL of 20 ppbv

Note: Larger volumes may be injected to reduce RL's for samples.

Note: Calibration point 40ppbv not always analyzed.

Systems "J" + "K" + "L":

STD.	AMOUNT
5pptv	10mL of 0.1 ppbv
10pptv	20mL of 0.1 ppbv
20pptv	40mL of 0.1 ppbv
25pptv	50mL of 0.1 ppbv
50pptv	100 mL of 1.0 ppbv
100pptv	20 mL of 1.0 ppbv
200pptv	40 mL of 1.0 ppbv
250 pptv	50 mL of 1.0 ppbv
500 pptv	100 mL of 1.0 ppbv
1.0 ppbv	200 mL of 1.0 ppbv
2.0 ppbv	20 mL of 20 ppbv
5.0 ppbv	50 mL of 20 ppbv
10 ppbv	100 mL of 20 ppbv
20 ppbv	200 mL of 20 ppbv
50 ppbv	500 mL of 20ppbv

A 5ppbv Standard is used for the daily continuing calibration

9.7 Analysis

Samples upon receipt are logged into the laboratory LIMS by the sample management department. Once the Summa canisters and or the Tedlar bags are labeled, they are transported to the air laboratory for storage. Containers are generally shipped by courier or express service. Note: Tedlar bags are not permitted for New Jersey work by EPA TO-15.

Each canister pressure is recorded upon arrival in psia. The pressure in the canister should be between 0-15 inches of Hg to obtain a significant amount of sample for analysis by the 7100 preconcentrator. All cans are pressurized 1.5X with compressed ultra-zero air or Nitrogen and recorded in the air dilution logbook. (Summa cans are pressurized 1.5X unless lower RL's are needed. Some summa cans may need to be more pressurized more than 1.5X if below 10in. of Hg. Target pressure to run from can is 14-18psia). The canister will be pressurized with the fill gas through the 4700 Entech static dilutor and the resulting dilution factor is recorded for result calculations in (F:/CTAL Laboratory/Air/Air logbooks/Airdilutionlogbook.xl). Prior to analysis all positions are flushed with purge gas to prevent contamination of lines. The canisters or tedlar bags are then attached to a 16-position auto-sampler for analysis.

Analysis of samples begins after an acceptable performance standard, calibration, blanks and QCs are run. A sequence for the 7100 system is written and saved to the Entech operating system. This is done by opening the 7100 through the smartlab menu. Put in sample description, sample volume and method. All systems are based on a 400ml injection. A GC run sequence is also needed to be written and saved in the HP Chemstation/Enviroquant software.

Initially, Module 1 on the 7100 is cooled down to approximately –40 to -20℃, the empty SC Trap for Cold Trap Dehydration (see section 9.2 for CTD parameters) and 100mL for G+H and 50mL for J+K+L (of the Internal Standard and Surrogate mix is collected and the defined volume of air sample (400mL for G+H and 200mL for J+K+L for standard injections) is trapped. The concentrated sample is then transferred to Module 2 (Tenax) at approximately -30 to –50℃. The cryogenic trapping system acts as the third module prior to the GC. Water is removed at the transfer from Module #1 to Module #2. CO2 is removed at Module #2 to Module #3. The third Module is cooled to approximately -150 to -180℃ and focuses the plug onto the column improving chromatography. The GC temperature is ramped for separation of components. Prior to switching from autosampler#1 to autosampler#2 a cleanup blank is run on the auto-sampler being switched too. (clup)

All the sample results are checked for Surrogate, Internal Standard criteria and saturation of compounds following analysis. If targeted compounds exceed linear range of the curve, a dilution of the sample is necessary.

A minimum 5-point calibration curve is used to calibrate the system for all target analytes and surrogates. The low concentration initial calibration standard must be less than or equal to the reporting limit (RL). Target analytes detected in a sample at concentrations below the concentration of the low initial calibration standard should not be reported as quantitative results. If reported, they must be qualified as estimates.

The percent relative standard deviation (%RSD) for all target analytes over the working calibration range must be <30% (with an allowance for up to two analytes to have %RSDs as high as 40%) for the average relative response factor (RRF) to be used for subsequent calculations. All analytes that do not meet the <30% RSD criteria will be narrated. (MA MCP allows %RSD for Naphthalene to be <40%).

If %RSD is >30% for any target analyte, then a linear regression must be established using the calibration data for that compound. For the linear regression to be acceptable for quantitative purposes, the correlation coefficient must be greater than or equal to 0.99. If this criterion is met, the linear regression analysis must be incorporated into the curve used to calculate results. This is done by the software by setting the curve fit of analyte in question to linear regression instead

of average response. If these criteria are not met, the analytes that do not meet these criteria will be narrated. If linear regression is used, the low and mid calibration points must be calculated for %RE. Low point must calculate back at least 50-150% recovery and the midpoint 70-130%.

If any initial calibration standard analysis is determined to be unusable (e.g., a bad injection), the standard may be re-analyzed within eight hours of the last initial calibration standard analyzed and before any samples are run. The re-analysis results may be incorporated into the initial calibration in their entirety, in place of the original analysis. If the initial calibration still does not meet acceptance criteria, even with the replacement standard, then the entire initial calibration should be performed again.

If the initial calibration still does not meet acceptance criteria for a particular analyte, the analyst may consider dropping the lowest or highest point for that analyte and recalculating the average RRF and %RSD or linear regression. Note that ONLY the lowest or highest data point may be dropped – a data point from the middle of the calibration range may NOT be dropped. Note also that if the low standard is dropped, the RL for that analyte must be adjusted so that the lowest standard used for the calibration is less than or equal to the RL.

When the instrument data system is updated to reflect the new initial calibration, the analyst verifies that it has been properly set up to calculate each target analyte according to the actual model used to establish the initial calibration (i.e., average RRF or linear regression) and to reflect any abbreviated ranges established for individual analytes.

At the start of each 24-hour analysis sequence, before any samples are analyzed, a 5-10ppbv calibration check standard is analyzed to check the calibration curve. The percent difference or percent drift must be <30% for all target analytes.

If the minimum percent difference/drift criteria are not met for any target analyte, then the analytical system should be evaluated for problems and corrective action taken as appropriate (change septa, compressed gas cylinders, syringes, column fittings, etc.; clean the MS source, changing an injector port or filament, cleaning the inlet, etc.). If corrective action that may affect instrument response is taken, then the calibration verification standard must be rerun before samples are analyzed. If the corrective actions do not resolve the problem(s) with the calibration verification standard, then a new initial calibration must be performed.

If two calibration check standards are run in succession, one immediately following the other, and neither is deemed to have been a bad injection, then the one closest in injection time to the associated sample analyses, or both standards, must be evaluated for and pass method performance criteria for sample analyses to continue. In addition, the two calibration check standards are documented by the analyst for evaluation of reproducibility.

The use of selected ion monitoring (SIM) is acceptable in situations requiring detection limits below the normal range of full EI spectra. However, SIM may provide a lesser degree of confidence in the compound identification unless multiple ions are monitored for each compound, and compounds quantitated by SIM must be noted in the final report.

9.8 SIM Analysis Summary

Synchronous SIM/Scan Analysis:

With the extremely low reporting limits required by new federal and state regulations for air analysis, the Air lab at ELON has implemented new procedures using synchronous SIM/Scan to meet the criteria. With Agilent 5973/5975/5977B MSD coupled with the 6890/7890/8890 GC and properly chosen acquisition parameters, both scan data and SIM data are collected in a single run using the MSD ChemStation D.02.00.275. Fast scan rates of up to 6250 amu/s by 5973/5975 MSD enables analysts to acquire high quality full scan data which are library searchable against NIST spectral data base and to collect SIM data with significantly high sensitivity.

The synchronous SIM/Scan takes advantages of the fast electronics in the 5973/5975 MSD to collect SIM and full scan signals in a single analysis without sacrificing performance. Full scan data covers all 65 compounds specified in EPA TO-15 method, 20 chlorinated and aromatic target compounds have been chosen for SIM analysis. Table 1 shows the compounds and the ions in SIM/Scan run method.

Table 1:

➢ Compound Name	➢ Ions used in SIM	➢ SIM Group Number
Bromochloromethane (IS)	49, 130	Group 2
Vinyl Chloride	62,64	Group 1
1,1-Dichloroethene	61,96	Group 2
Trans-1,2-Dichloroethene	61,96	Group 2
1,1-Dichloroethane	63,65	Group 2
Cis-1,2-Dichloroethene	61,96	Group 2
Chloroform	83,85	Group 2
1,2-Dichloroethane	62,64	Group 3
1,4-Difluorobenzene (IS)	114, 88	Group 4
Carbon Tetrachloride	117,119	Group 4
1,2-Dichloropropane	63,62	Group 5
Bromodichloromethane	83,85	Group 5
Trichloroethene	95,130	Group 5
Cis-1,3-Dichloropropene	75,110	Group 6
Trans-1,3-Dichloropropene	75,110	Group 6
1,2-Dibromoethane	107,109	Group 6
Chlorobenzene-D5 (IS)	117, 82	Group 7
1,1,2-Trichloroethane	97,83	Group 6
Naphthalene	128,102	Group 9
1,1,2,2-Tetrachloroethane	83,85	Group 7
4-Bromofluorobenzene (Surr)	95, 174	Group 8

Table 2: SIM

➢ **Group Number**	Ion	Dwell Time (msec)	Star Time (min)
1	62,64	30	1.38
2	49,61,63,65,83,85, 96, 130	10	2.10

3	62, 64	30	3.09
4	88, 114, 117, 119	20	3.30
5	62,63,83,85,95,130	10	3.60
6	75, 83, 97, 107, 109, 110	10	3.95
7	82, 83, 85, 117	20	5.00
8	95, 174	30	5.70
9	102, 128	30	7.60

10.0 Data Analysis & Calculations

10.1 Qualitative Identification

A minimum signal-to- noise ratio of 3:1 (based on peak height) must be achieved for any peak used in a calibration standard, client sample, or quality control sample.

10.1.1 Tentatively Identified Compounds (TICs)

Initially include all the non-target compounds that have a peak area count of ≥ 10% of the nearest internal standard.

- Use the following guidelines for making tentative identification:
- Check the spectral library match to make tentative identification.
- The relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within ± 20%.
- The special library match should be >85% or based on Analyst interpretation for a tentative identification to be made.
- Molecular ions present in the reference spectrum should be present in the sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- Ions present in the reference spectrum, but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks.
- Experience of the analyst is also considered when small molecule fragments are not apparent in the spectrum due to scan range limitations.

Quantitative analysis:

- The nearest internal standard shall be the one that is used to calculate concentration, and the RF for the compound should be assumed to be 1.
- The resulting concentration should be reported indicating that the value is an estimate.

10.1.2 Manual Integration

Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are justified and proper all manual integrations must be performed, documented, reviewed, and approved in accordance with corporate SOP ENV-SOP-CORQ-0006, *Manual Integration.* Refer to this SOP for guidance on manual integration techniques and required procedures.

When performing manual integration of any peak in a calibration standard, client sample, or quality control sample, the integration must be performed in conformance with the procedures outlined in the SOP for chromatographic integration procedures. In summary:

The most appropriate instrument parameters should be used during method development to allow for automatic integration by the data system in most cases.

All data must be integrated consistently for all standards, samples and QC samples.

In those instances when the automated software does not integrate a peak correctly, manual integration may be used to correct the improper integration performed by the data system. Manual integration should always be performed to create the analyst's best estimate of the actual peak area discerned from the chromatogram.

All manual integrations must be documented by printing, initialing, and dating the manual integrations as well as by recording the reasons for the manual integrations.

10.2 Data Processing

10.2.1 Reporting Package

The reporting package that is delivered to clients consists of the sample results, the surrogate results, and any quality control measures that the client has specifically asked for.

10.2.2 Data Filing

Data to be saved on CD

All the runs, methods, and standards, from each day of analysis.

Sequence and bench sheets to be filed in Data Boxes and all raw data stored electronically on the Archive drive (A: drive). Including:

BFB tuning files
Daily method blanks
Calibration curves
Daily calibration checks
Surrogate recoveries
Lab spikes

Duplicate results
Quality control spikes

10.3 Calculations

All calculations are based on the internal standard technique.

Results must be reported in ppbv as well as ug/m3

Cx = AxCisDF/AisRRF

Cx = Compound concentration, ppbv
Ax = Area of the characteristic ion for the compound to be measured, counts
Ais = Area of the characteristic ion for the specific internal standard, counts
Cis = Concentration of the internal standard spiking mixture, ppbv
RRF= Relative Response Factor is the average Response factor for the compound from the initial calibration
DF = Any applicable dilution factors

10.3.1 Relative Retention Times (RRT)

Calculate the RRTs for each target compound over the initial calibration range using the following equation:

$$RRT = \frac{RTc}{RTis}$$

Where: RTc= Retention time of the target compound, seconds

Rtis= Retention time of the internal standard, seconds.

10.3.2 Mean of the Relative Retention Times $\overline{(RRT)}$

Calculate the mean of the relative retention times for each analyze target compound over the initial calibration range using the following equation:

$$\overline{RRT} = \sum_{i=1}^{n} \frac{RRT}{n}$$

Where: $\overline{RRT}$ = Mean relative retention time for the target compound for each initial calibration standard.

RRT= Relative retention time for the target compound at each calibration level.

10.3.3 Mean Retention Times (RT)

Calculate the mean of the retention times (RT) for each internal standard over the initial calibration range using the following equation:

$$\overline{RT} = \sum_{i=1}^{n} \frac{RTi}{n}$$

Where: $\overline{RT}$ = Mean retention time, seconds

RT= Retention time for the internal standard for each initial calibration standard, seconds.

10.3.4 Conversions

ppbv to ug/m3

ug/m3 = (ppbv)(MW)/24.45

10.3.5 Relative Error (%RE)

Relative error is minimally checked at the concentration of the lowest standard in the curve and at the standard near the mid-point of the curve. %RE is calculated as follows:

$$\% \text{ Relative Error} = \frac{x`i - xi}{Xi}$$

xi = True Value of the Calibration Standard

x`i = Measured Concentration of the Calibration Standard

% RE must be ≤30% for the midpoint standard and ≤ 50% for the low-point standard.

11.0 QUALITY CONTROL & METHOD PERFORMANCE

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.
RL Verification	RL	Daily
Sample Duplicate	SD	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.
Surrogate	SSTD	Added to all samples and QC samples.
Internal Standards	ISTD	Added to all samples and QC samples.

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix B for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Tune (MS Only)		Daily
Initial Calibration Verification	ICV	After each new calibration
Continuing Calibration Verification	CCV	Daily

11.3 Method Performance

An analytical batch is defined as up to 20 client samples of a similar matrix for the same analysis. All quality control samples are assigned to and associated with a particular analytical batch, which is designated at the time client samples are logged-in or at the time of sample preparation. All quality control samples must be traceable to the associated analytical batch for review and evaluation purposes.

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011 for general requirements and procedures for method validation.

Establish detection limits (DL) and limits of quantitation (LOQ) at initial method set up and verify the DL and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for DL and LOQ requirements and procedures.

11.3.2 Calibration Curve

A minimum 5point calibration curve is used to calibrate the system. Please refer to section 9.6 of this document for exact concentrations. An extra point at the low (MDL) level (0.5ppbv) is also run for demonstration purposes and all NJ-based clients. The lowest point in the curve is used as the RL. The response factor variation over the working range must be ≤30 %RSD, with two compounds allowed to 40%. (MA MCP allows Naphthalene to be <40%) If linear calibration is used for any compound, it must be $\geq$ 0.99 or better. If linear regression is used, then calculate the Relative Standard Error (%RE) for the low and mid calibration points. The low point must recover 50-150% and the midpoint must recover between 70-130%. Refer to ENV-POL-CORQ-0005 for additional information on calculating the relative error.

The relative retention time (RRT) for each target compound must be within 0.06 units of the mean RRT for the compound over the initial calibration. The area response for each Internal Standard at each calibration level must be within 40% of the mean area response over the initial calibration range.

An ICV, second source is analyzed immediately after the calibration and all compounds must recover 70-130%.

11.3.3 Calibration Check Verification (CCV)

Each working day, a 5ppbv calibration check standard is analyzed to check the calibration curve. The calibration check standard is inspected and the response factor for each analyte must be within $\pm$30% for the calibration curve. The retention time shift of each of the internal standards in all calibration check standards must be within 20 secs of the mean response over the Initial Calibration for each Internal Standard. If

these criteria are not met, the analytes that do not meet these criteria will be narrated. MA MCP allows 20% of the list compounds to be outside criteria, needs to be qualified.

11.3.4 Method Blank (MB)

A Laboratory Method Blank is prepared by hooking up a clean evacuated canister to the 4700static diluter and pressurizing it with fill gas to a final pressure of 35psia. This is pressurized from the canister cleaner.

The Laboratory Method Blank must be an unused certified canister that has not left the laboratory. It must contain the same amount of Internal Standard as the samples. One LMB must be run every 24 hours or per batch of analysis.

The LMB is analyzed with each batch prior to sample analysis to prove that the instrument is free of any contamination. Any background contamination should be <MDL. Low levels of <2ppbv (less than 5 times the MDL) for common laboratory contaminants (Methylene chloride, Ethanol, Acetone) are acceptable.

11.3.5 Laboratory Control Sample (LCS)

Daily a 5ppbv QC Check standard, prepared from a different stock, is analyzed to check the calibration curve. All compounds must be within the ±30% for NJ and CT RCP samples. All other samples follow 70-130% except for the deemed 11 difficult compounds which have limits of 50-150%. (Difficult compounds include Acetone, 1,4-Dioxane, Hexachlorobutadiene, Naphthalene, 1,2,4-Trichlorobenzene, Propene, Isopropanol, Ethanol, 2-Hexanone, 1,2-Dichloro-1,1,2,2-tetrafluoroethane, and Cyclohexane) QC Check samples are analyzed after the continuing calibration and before samples. AIHA samples use control chart limits that need to be at least as tight as method control limits.

An LCS that fails on the low side or fails on the high side with samples having detections must be rerun. If LCS still fails, then qualify the outlier. Analyst should perform corrective actions to ensure failure doesn't happen again. Any LCS that fails on the high side, with all samples being non-detected can be qualified.

11.3.6 Sample Duplicate

Duplicates are analyzed with every sequence. Results will be reported in LIMS with RPD values. The allowable criterion for an acceptable duplicate is the percent RPD being ≤ 25.

11.3.7 Surrogate

4-Bromofluorobenzene at 8ppbv is the single surrogate spike added to each analysis. A combined mix of three internal standards and a surrogate (4-BFB) are added to each analysis automatically at the beginning of the purge cycle of the 7100 run. The recovery of this spike must be within ±30%.

11.3.8 Internal Standard

Three Internal standards namely Bromochloromethane, 1,4-Difluorobenzene and Chlorobenzene-D5 are used to quantitate the blanks and samples. Internal standards are monitored throughout the analysis. Acceptable criteria for the internal standard area

responses are ± 40% of the most recent calibration standard. The retention time criteria for all the internal standards are + or – 0.33min from the mean retention time of the most recent calibration.

11.3.9 MDL and On-going RL/LOQ Verification

An MDL study must be performed as per 40 CFR 136 Appendix B Rev2. The MDL Definition is as follows, "The method detection limit (MDL) is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results" The value calculated from the spike samples is called the MDLS. The MDL spikes are both prepared and analyzed over a three-day period. The MDLS calculation is the same as the MDL calculation in Revision 1.11. The method blank samples are used to calculate the MDLb, which is a very similar calculation that also calculates 99% confidence level that the result is derived from the sample rather from contamination/noise. The MDL is the higher of the two values (either the MDLs calculated using spiked samples or the MDLb, calculated using method blanks). EPA considers this change important because as detector sensitivity improves, the background contamination of the laboratory, consumable supplies, and equipment can be more important in determining the detection limit than the sensitivity of the instrument.

The MDL now requires that the samples used to calculate the MDL are representative of laboratory performance throughout the year, rather than on a single day.

A laboratory has the option to pool data from multiple instruments to calculate one MDL that represents multiple instruments.

Additionally, a streamlined approach to determine whether a new instrument can be added to a group of instruments with an already established MDL, and Laboratory have the option to use only the last six months of method blank data or the fifty most recent method blanks, whichever yields the greatest number of method blanks to calculate the MDL value derived from method blanks (MDLb)

After initial MDL is established, every year thereafter quarterly 2 RL/LOQ samples are performed. At the end of the year the points are tabulated in an MDL-S and compared to current MDL.

Note: For method EPA TO-15 the calculated MDL must be < 0.5ppbv for each analyte listed in the method.

*For AIHA-LAP, LLC a daily RL/LOQ verification is analyzed with limits of 50-150%. Quarterly, each canister type has an RL/LOQ verification performed that is analyzed just like a sample would be run. This shall be spiked at the reporting limit.

11.3.10 Mechanical Gauges

All pressure on outbound and inbound canisters (before and after sampling) are checked and the pressures recorded in the Outbound-Inbound log.

11.3.11 Qualifiers

Any data that fails to meet method requirements will be qualified. For example, if cans return with a pressure of zero.

12.0 Data Review & Corrective Action

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-ELON-0035_Data Review for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix B for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

13.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have not been modified from the reference test method(s) cited.

When applicable, comparability and/or equivalency studies necessary to validate the modification as required per corporate SOP ENV-SOP-CORQ-0011 are retained by local quality personnel for historical reference.

15.0RESPONSIBILITIES

- All employees of Pace® Analytical Services that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- Local quality personnel are responsible for tracking the currency of the R&A on this SOP for employees at the locations they are assigned to and for notifying the General Manager (GM), however named, when R&A are overdue or outstanding. The GM and the employee's direct supervisor are responsible for ensuring the employee completes the R&A assignments as required.
- The supervisors and managers of Pace® Analytical Services, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP the work area(s) they oversee.
- All employees of Pace® Analytical Services are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local Quality Manager and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual change to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015 *Document Managemen*t and ENV-SOP-CORQ-0016 *SOP for Creation of SOP and SWI*.

- Local quality personnel are responsible for monitoring conformity to this SOP during routine internal audits of work areas that utilize this SOP and for communicating gaps and deviations found during monitoring to the work area supervisor, who is responsible for correction of the situation.

16.0 ATTACHMENTS

- Appendix A: Routine Analyte List and LOQ
- Appendix B: QC Summary & Corrective Action Table

17.0 REFERENCES

- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *SOP for SOP and SWI,* current version.
- ENV-TMP-CORQ-0007, *Quality Manual Template*, current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- ENV-MAN-ELON-0001*, Quality Assurance Manual*, current version.
- Compendium of methods for the determination of toxic organic compounds in Ambient Air, 2nd Edition, USEPA JAN 1999, Method TO-15.
- MA DEP Bureau of Waste Site Cleanup, “Quality Control Requirements and Performance Standards for the Analysis of Volatile Organic Compounds in Air Samples (TO-15) by Gas Chromatography/Mass Spectrometry (GC/MS) in Support of Response Actions under the Massachusetts Contingency Plan (MCP”, Rev 0, July 1, 2010.
- CT DEP QA/QC Work Group, “State of CT Dept. of Environmental. Protection Recommended Reasonable Confidence Protocols Quality Assurance and Quality Control Requirements Volatile Organics by Method TO-15”, Version 2.0, December 2006.
- HP 5890/6890/7890 Series Gas Chromatograph Operating Manuals.

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
2.0	Addition of Nitrogen.
7.1	Addition of Sys “L” and replace Ashcroft gauge with Dwyer gauge.
7.2, 9.3, 9.6	Addition of Sys “L”.
8.1	Addition of Ultra Compressed Air.
9.1	Addition of Nitrogen.
9.2	Addition of 7200/7200A, changed parameters, and added Sys “L”.
9.4	Addition of Sys “L” and added new parameters.
9.7	Added Nitrogen, Sys “L” and added %RE for linear.
9.8	Added 5977B/8890 and updated Table 1 and Table 2.
10.3.5	Added %RE calculation.
11.3.2	Added %RE for linear.
11.3.5+ App B	Added AIHA samples use control chart limits at least as tight as method limits.

Document Succession: This version replaces the following documents:

Document Number & Version	Document Title	Effective Date:
ENV-SOP-ELON-0050 v01	EPA TO-15	09/02/2022

Appendix A: Target Analyte List and LOQ

Table 1: Standard Analyte List and LOQ

Analyte	CAS #	LOQ[1] Air (ppbv)	LOQ1 Air (ppbv) Sim
Propene *	115-07-1	2.0	
Dichlorodifluoromethane (Freon 12)	75-71-8	0.05	
Chloromethane	74-87-3	0.1	
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	76-14-2	0.05	
Vinyl Chloride	75-01-4	0.05	0.01
1,3-Butadiene	106-99-0	0.05	
Bromomethane	74-83-9	0.05	
Chloroethane	75-00-3	0.05	
Acetone *	67-64-1	2.0	
Trichlorofluoromethane (Freon 11)	75-69-4	0.2	
Ethanol *	64-17-5	2.0	
1,1-Dichloroethene	75-35-4	0.05	0.01
Methylene Chloride	75-09-2	0.5	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	0.2	
Carbon Disulfide	75-15-0	0.5	
trans-1,2-Dichloroethene	156-60-5	0.05	0.01
Methyl tert-butyl-ether (MTBE)	1634-04-4	0.05	
Isopropyl Alcohol (Isopropanol) *	67-63-0	2.0	
2-Butanone (MEK)	78-93-3	2.0	
cis-1,2-Dichloroethene	156-59-2	0.05	0.01
Vinyl Acetate	108-05-4	1.0	
Hexane	110-54-3	2.0	
Ethyl Acetate *	141-78-6	0.5	
Chloroform	67-66-3	0.05	0.01
Tetrahydrofuran *	109-99-9	0.5	
1,2-Dichloroethane	107-06-2	0.05	0.01
1,1,1-Trichloroethane	71-55-6	0.05	
Bromoform	75-25-2	0.05	
Benzene	71-43-2	0.05	
Carbon Tetrachloride	56-23-5	0.05	0.01
Acrylonitrile *	107-13-1	0.288	
Acrolein	107-02-8	1.0	
1,4-Dioxane	123-91-1	0.5	
Cyclohexane *	110-82-7	0.05	
1,2-Dichloropropane	78-87-5	0.05	0.01
Bromodichloromethane	75-27-4	0.05	0.01
Trichloroethene	79-01-6	0.05	0.01
Heptane *	142-82-5	0.05	
4-Methyl-2-pentanone (MIBK)	108-10-1	0.05	
cis-1,3-Dichloropropene	10061-01-5	0.05	0.01
trans-1,3-Dichloropropene	10061-02-6	0.05	0.01

1,1,2-Trichloroethane	79-00-5	0.05	0.01
Toluene	108-88-3	0.05	
2-Hexanone (MBK) *	591-78-6	0.05	
Dibromochloromethane	124-48-1	0.05	
1,2-Dibromomethane (EDB)	106-93-4	0.05	0.01
Tetrachloroethylene	127-18-4	0.05	
Chlorobenzene	108-90-7	0.05	
Ethylbenzene	100-41-4	0.05	
m/p-Xylenes	179601-23-1	0.1	
o-Xylene	95-47-6	0.05	
1,1,2,2-Tetrachloroethane	79-34-5	0.05	0.01
4-Ethyltoluene *	622-96-8	0.05	
1,3,5-Trimethylbenzene	108-67-8	0.05	
1,2,4-Trimethylbenzene	95-63-6	0.05	
1,3-Dichlorobenzene	541-73-1	0.05	
Benzyl Chloride	100-44-7	0.05	
1,4-Dichlorobenzene	106-46-7	0.05	
1,2-Dichlorobenzene	95-50-1	0.05	
1,2,4-Trichlorobenzene	120-82-1	0.05	
Styrene	100-42-5	0.05	
Hexachlorobutadiene	87-68-3	0.05	
1,1-Dichloroethane	75-34-3	0.05	0.01
*4-phenylcyclohexane(4-PCH)	4994-16-5	0.097	
Naphthalene	91-20-3	0.05	
* Not listed in Method TO-15 Table 1, considered “difficult analytes”			
**Reporting limits subject to change based on calibration.			

[1] *Values as of effective date of this SOP. LOQ are subject to change, contact quality personnel for most current information.*

Appendix B: QC Summary and Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
ICAL	At instrument set up, after CCV failure	Must meet one of curve fit options presented in Section 11.3.2. For any curve fit other than Average RF (RSD), curve must also pass RSE test at the low and midpoint calibration standard.	Identify and correct source of problem, repeat	None. Do not proceed with analysis
ICV	After Each ICAL	All analytes must be within ± 30% of the true value. (%R)	Identify source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	Qualify analytes with ICV out of criteria.
CCV	Daily, before sample analysis	All analytes within 70-130%	See Section 11.3.3 for required corrective actions based on circumstance.	Qualify analytes with CCV out of criteria.
Internal Standards	Every field sample, standard and QC sample	Must meet criteria specified in Section 11.3.8. 60-140%	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Surrogate	Every field sample, standard and QC sample	Must meet criteria specified in Section 11.3.7. 70-130%	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Method Blank	1 per batch of 20 or less samples	Must meet criteria specified in Section 11.3.4. <MDL	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
LCS	1 per batch of 20 or less samples	Must meet criteria specified in Section 11.3.5. 70-130% and 50-150% for difficult compounds. AIHA samples use control chart limits at least as tight as method limits.	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Sample Duplicate	1 per batch of 20 or less samples	Must meet criteria specified in Section 11.3.6. RPD ≤25	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Tune Standard	Daily	Must meet criteria specified in Section 9.4	Identify and correct source of problem, repeat	None. Do not proceed with analysis

Appendix B – TRC Standard Operating Procedures- Canister Sampling

Title: **Indoor and Ambient Air Sampling**	Procedure Number: **ECR 024**
	Revision Number: **1**
	Effective Date: **January 2020**

Authorization Signatures

Technical Reviewer Stacy Metz	Date 1/1/20	Environmental Sector Quality Director Elizabeth Denly	Date 1/1/20

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Page No.

ATTACHMENTS

1.0 INTRODUCTION

1.1 Scope and Applicability

This Standard Operating Procedure (SOP) was prepared to provide guidance to TRC personnel in the logistics, collection techniques, and documentation requirements for collecting representative indoor air and ambient air samples for volatile organic compounds (VOCs) using sampling canisters. These are standard (*i.e.*, typically applicable) operating procedures that may be changed, as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In addition, other local, state or federal regulatory requirements may be above and beyond the scope of this SOP and should be followed, if applicable. In all instances, the actual procedures used should be thoroughly documented and described in the field notes. The project-specific work plan (or equivalent) should be consulted to verify sampling requirements and details as specified by the contractual agreement with the client.

There are other methods that can be used for the collection of indoor and ambient air samples for VOCs and other parameters including Tedlar® bags and sorbent tubes. In addition, some canisters can be used for the collection of analytical parameters other than VOCs (*e.g.*, fixed gases, non-methane organic compounds, methane, etc.). However, this SOP focuses only on the use of sampling canisters for VOCs.

1.2 Summary of Method

The objective of indoor and ambient air sampling is to obtain a representative sample of air for laboratory analysis of chemical constituents of interest at a given site. This objective requires that the sample be of sufficient quantity (*i.e.*, volume) and quality for analysis by the selected analytical method. Indoor and ambient air samples are typically collected with sampling canisters for VOC analysis. Sampling canisters under vacuum are commonly fitted with flow controllers to restrict the air intake to a pre-determined rate.

This sample collection method involves the use of a flow controller or a sampler containing a flow controller to slowly meter the flow of air entering a canister. With this method, a sample is collected over a longer period of time than with a grab sample. If a constant flow rate is maintained, the resulting sample will have a constituent content that is the average of the constituent concentrations during the sampling interval.

1.3 Equipment

The following list of equipment may be utilized when conducting indoor or ambient air sampling for chemical constituents. Project-specific conditions or requirements may warrant the use of additional equipment and/or deletion of items from this list.

- Appropriate level of personal protective equipment (PPE), such as nitrile gloves and safety glasses, as set forth in a site-specific health and safety plan (HASP) or job safety analysis (JSA).
- Barometric Pressure Meter – Extech® Instrument, or equivalent (optional – see site-specific work plan).

- Clean 5-gallon buckets, tripod, or box – For elevating sampling equipment to the breathing zone.

- Portable organic vapor analyzer equipped with a photoionization detector (PID) and/or flame ionization detector (FID) (optional).

- Air Flow Velocity Meter – TSI® 964 Straight Air Velocity Probe for use with Q-Trak™ Indoor Air Quality Monitor Model 7575, or equivalent (optional).

- Pre-cleaned, evacuated, passivated stainless-steel canister (hereafter - sampling canister), at least one extra for every 20 samples recommended in case of leakage.

- Flow controller(s)/regulators are generally pre-calibrated by the laboratory to regulate flow for sample collection times of 1-hour, 3-hours, 8-hours, 12-hours, or 24-hours as requested. Sample collection time is typically set based on project objectives. For example, 24 hours to evaluate residential exposure versus 8 hours or 12 hours to evaluate non-residential exposure.

- Vacuum gauge to verify readings on canister's flow controller (should be supplied by the laboratory and connected to the flow controller/regulator).

- Stainless-steel, Teflon®, or nylon tubing (sometimes used to extend equipment into the breathing zone).

- Moisture filter (may be needed for ambient air sampling).

1.4 Definitions

Individual Certification — A laboratory will clean several sampling canisters at once. Each canister from the batch is certified as clean.

Batch Certification — A laboratory will clean several sampling canisters at once. One randomly selected canister from that group of canisters, *i.e.*, the batch, is used to certify that all of the canisters in that batch are clean.

1.5 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. TRC personnel will use appropriate PPE. The Project Manager, Office Safety Coordinator (OSC), TRC ECR Safety Manager, or TRC National Safety Director can address questions or safety concerns. Project-specific safety considerations should be documented in the project-specific work plan (or equivalent).

1.6 Cautions and Potential Problems

- When collecting air samples having high constituent concentrations, try to stay upwind of vapors during sample collection to minimize exposure. Respiratory protection may be required in certain instances depending upon site conditions and concentrations encountered.

- Sampling canisters should not be used for the collection of outdoor ambient air samples in moderate to heavy rain, as the moisture may compromise the sample. If the sampling event must occur when rain is forecasted, then the laboratory should be consulted to evaluate the limitations of the equipment.

- Factors, such as atmospheric conditions or dust/dirt blockage, can affect the actual flow rate through the calibrated flow controllers. Conditions should be properly noted in the field notes.

- For time-weighted sampling periods, it is important that the sample canister vacuum not equilibrate with atmospheric pressure in order to demonstrate that the sampling apparatus was functioning properly and collecting a representative sample over the prescribed time period.

- It is also important that the vacuum on the sample canisters does not exceed a maximum vacuum at the conclusion of the sampling period. Typically, if the vacuum is greater than 10 inches Hg, the laboratory will need to pressurize the samples with clean air, resulting in a slight dilution factor and, thus, elevated reporting limits.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that may entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project-specific work plan. These requirements may include:

- Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers and 8-hour annual HAZWOPER refresher training.
- OSHA 10-hour Construction Industry Outreach Training.
- Site-specific safety training.

2.0 PROCEDURES

2.1 Pre-sampling Activities

1. Review regulatory requirements to ensure program requirements meet local regulations, which may specify collection of a concurrent ambient outdoor air sample, certain quality control (QC) samples, and/or specific ancillary measurements.

2. Based on project needs, a prescreening survey with a portable organic vapor analyzer may be helpful in determining preferential pathways or areas with high concentrations of VOCs.

3. Conduct a building condition assessment including a visual survey of basements, crawl spaces, slab-on-grade configurations and conditions; determine if sumps, wells, or cisterns are associated with the structure; evaluate the condition of floors and walls; and describe the HVAC system and operating status/conditions.

4. Verify if a pre-sampling survey of the building is required and if products containing compounds on the analyte list can be removed from the building in advance of sampling. Complete an Indoor Air Sampling Inventory using a form specified by the applicable regulatory agency (where applicable).

5. Verify if batch certification of sampling canisters is sufficient or if one or more sampling canisters require individual certification. This will be dependent on project objectives.

6. The flow controller sampling period should be specified in the sampling plan or project-specifc work plan and confirmed with the Project Manager. Sample collection time is typically set based on project objectives. For example, 24 hours to evaluate residential exposure versus 8 hours or 12 hours to evaluate non-residential exposure.

7. Perform site reconnaissance to plan potential ambient outdoor air sampling locations. If collecting an ambient outdoor air sample for background purposes, place the sampling apparatus upwind of the study area, and set the intake of the flow controller in the breathing zone (3 to 5 feet above the ground). Safety, access, and security variables should be considered.

8. Typically, the intake of the sampling apparatus should be within the breathing zone (3 to 5 feet above the floor) so the sampling apparatus should be placed on an elevated surface. If a sufficient elevated surface is not present in the sampling area, one should be mobilized to the site (*e.g.*, buckets, tripod or cardboard boxes without VOC-containing tape). NOTE: Review regulatory requirements for the proper height of the samplers; New Jersey guidance recommends the intake be biased near cracks or openings and not the breathing zone when sampling in basements.

   CAUTION: Be sure that the elevated surface is secure and stable, especially in active work areas. Sampling canisters are fragile and are likely to break if knocked to the ground, costing time (especially if damage occurs near the end of the sampling period) and money (sampling canisters cost thousands of dollars).

9. Verify the required sampling volume, minimum/maximum flow rates, minimum/maximum sampling duration, and the number and location of samples needed. These variables will be dependent upon project objectives, sampling method limitations, and required reporting limits. Consult with the Project Manager or the project-specific work plan.

10. Determine the appropriate sampling canister size with the selected analytical laboratory and ensure the laboratory will have enough volume to perform reanalyses and dilutions, if required. Note that smaller volume canisters limit the volume of sample available to laboratories. However, large sampling canisters can be expensive to ship and difficult to manage and transport in the field, particularly for large scale projects.

11. Field Measurement Equipment: If ancillary measurements are required, the associated equipment must be calibrated appropriately. Check with the Project Manager to establish whether ancillary measurements are required.

    a. Temperature and humidity: If erratic measurements are observed, consult the manufacturer for calibration requirements.

    b. Barometric pressure: If erratic measurements are observed, consult the manufacturer for calibration requirements.

c. Air flow velocity: Equipment should be pre-calibrated by the rental company. If erratic measurements are observed, consult the rental company or manufacturer for calibration requirements. Records of calibrations should be provided by the rental company and maintained in the project file.

NOTE: Weather Underground (www.wunderground.com) or other online weather service providers can also be used as a potential resource for atmospheric condition measurements.

2.2 Sampling Procedures

1. The connection between the air-flow controller and the sampling canister is likely to vary between laboratories. Be sure to follow the laboratory-provided directions when connecting the flow controller to the sampling canister. Quick-connect fittings are typically simple and trouble-free, whereas compression type fittings are more common, but may also be more troublesome due to preexisting imperceptible damage, *i.e.*, minor abrasions caused by dust/dirt and/or deformation caused by overtightening. Common suggestions for connecting the flow controller to the sampling canister using compression-type fittings are as follows:

   (a) Confirm the valve is closed (knob should already be tightened clockwise) before unthreading the stainless-steel plug from the top of the canister.

   (b) Check to see that the O-ring is still in place prior to making the connection. Ensure extra O-rings and ferrules are shipped with the flow controller in case they are damaged or missing.

   (c) If present, remove the plastic cap from the flow controller outlet (male threads) before attempting to connect to the inlet on the sampling canister.

   (d) Do not over-tighten compression fittings.

2. Set the sampling apparatus intake in the breathing zone (3 to 5 feet above the floor). Do not set canister on a structure or materials that may off-gas constituents of potential concern. NOTE: Review regulatory requirements for the proper height of the samplers; New Jersey guidance recommends the intake be biased near cracks or openings and not the breathing zone when sampling in basements. Record the sample collection location and height.

3. Open the sampling canister valve to begin sampling. Record the start time, flow controller rate, initial vacuum, and sampling canister size. Also record the flow controller and sampling canister identification numbers.

4. Observe the sampling apparatus for 5 to 10 minutes to verify that the vacuum is dropping at a reasonable rate based on the target flow rate. If access is available, check the vacuum gauges at regular intervals over the sampling duration to ensure the vacuum is dropping appropriately.

5. To the extent feasible, ensure that the sampling apparatus remains undisturbed during prolonged sampling. At residential properties, ask occupants to not disturb the sampling apparatus and to avoid using chemicals in the area of the sampling apparatus that could affect sample results. In industrial settings, periodically check the sampling apparatus to ensure it remains undisturbed.

6. Close the sampling canister valve after the designated time period has been completed, and replace the cap. Record the final vacuum and the time sampling was completed prior to disconnecting the flow controller. It is typically recommended that the canister vacuum not be allowed to drop to zero and a residual vacuum should remain in the canister. The final canister vacuum should typically be between 5- and 8-inches Hg. This vacuum, when verified by the analytical laboratory upon receipt, provides evidence that the sample canister did not leak during the return shipment.

7. Complete the chain-of-custody (COC) form. See Attachment B for an example COC form.

8. Transport the samples to the analytical laboratory for processing. Note that sampling canisters do not need to be stored on ice. Consequently, overnight shipment is not required to maintain sample integrity. Using 2-day shipping or even ground transport can substantially reduce project costs.

2.3 Ancillary Measurements

Field measurements may be required in association with indoor air sampling. Continuous temperature, barometric pressure, and/or humidity measurements may be required at each sampling location using appropriate sensors and logging devices. Air flow velocity measurements may be required for supply and exhaust (or return) air vents in each room.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

The following list is a summary of quality assurance/quality control (QA/QC) procedures that can be used to help ensure the accuracy and precision of the sampling method. The process and requirements for the collection of specific field QC samples will be specified in the project-specific planning documents.

3.1 Field Duplicates

Field duplicates are collocated samples. Collocated samples are two samples collected next to each other in the same position at the same location, at the same time, and for the same amount of time. Field duplicates are used to assess the precision of the sampling and analytical methodologies. Field duplicates, when required, are typically collected at a frequency of one per day of sampling or one per 20 samples.

3.2 Media Certification Checks

Media for all analyses are typically certified as clean from the laboratories. The certifications are performed as batch checks, and results are stored in the project files.

Sampling canisters that are individually certified should have the certification attached to the final laboratory report.

4.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Information relevant to the indoor sampling location should be recorded during each sampling period (*e.g.*, number of interior and exterior doors and windows, number of windows open and closed, type of ventilation system and its status during each sampling period, room temperature, and any other conditions that might affect concentrations in air over time, such as site operations, material storage, or motorized vehicle storage and/or operation).

If ancillary measurement equipment is used, the applicable calibration information (*i.e.*, date, times, equipment make/model/serial number, and calibration results) should also be recorded.

Record the following information:

- Sampling location;
- Sampling canister size;
- Pre-set flow rate on flow controller;
- Height of sampling canister;
- Laboratory canister ID;
- Laboratory flow controller ID;
- Atmospheric conditions (*e.g.*, dusty, dirty);
- Sampling start time and vacuum (inches of Hg);
- Sampling end time and vacuum (inches of Hg); and
- Indoor and outdoor barometric pressure (optional).

Example Field Sampling Data Sheets and an example COC form are presented in Attachments A and B, respectively.

5.0 REFERENCES

American Society for Testing and Materials (ASTM). November 2014. ASTM D1945-14. *Standard Test Method for Analysis of Natural Gas by Gas Chromatography*.

United States Environmental Protection Agency (USEPA). January 1999. Compendium Method TO-10A: *Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using Low Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)*. EPA/625/R-96/010b.

USEPA. August 2017. Method 25C. *Determination of Nonmethane Organic Compounds (NMOC) in Landfill Gases*.

6.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	FEBRUARY 2019	NOT APPLICABLE.
1	JANUARY 2020	TRC RE-BRANDING

Attachment A

Example Field Sampling Data Sheets

PAGE _____ OF _____

AIR / VAPOR SAMPLE LOG

PROJECT NAME:	PREPARED	CHECKED
PROJECT NUMBER:	BY: DATE:	BY: DATE:

SAMPLE INFORMATION			
SAMPLE TYPE: ☐ COMPOSITE ☐ GRAB	**SAMPLE ID:**		
SAMPLE MEDIA: ☐ INDOOR AIR ☐ SOIL VAPOR ☐ SYSTEM PERFORMANCE ☐ OTHER	LOCATION:	LOCATION COORDINATES: N: E:	
SAMPLE DURATION:	SAMPLE HEIGHT / (DEPTH):		
SAMPLE CONTAINER TYPE: ☐ SUMMA CANISTER ☐ TEDLAR BAG ☐ OTHER:			
FLOW VALVE ID / SERIAL NUMBER:	CANISTER SERIAL NUMBER:		

READING	TIME	VACUUM (INCHES - Hg / PSIG)	DATE	INITIALS	COMMENTS
INITIAL VACUUM CHECK					
INITIAL FIELD VACUUM					
FINAL FIELD VACUUM					

SAMPLE START TIME:	**SAMPLE STOP TIME:**

NOTES AND OBSERVATIONS
MOTORIZED VEHICLE STORAGE :
MOTORIZED VEHICLE TRAFFIC:
OPERATIONS (e.g., painting, oil recovery):
CLEANERS / SOLVENTS IN USE:
MATERIAL STORAGE (e.g., paint, gasoline):
NOTICEABLE ODORS:
AUDIBLE OR NEARBY HVAC OPERATION:
OTHER:

ADDITIONAL COMMENTS:

SHIPPING METHOD: _____	DATE SHIPPED: _____	AIRBILL NUMBER: _____
COC NUMBER: _____	SIGNATURE: _____	DATE SIGNED: _____

REVISED 06/2011

AIR MONITORING DATA SHEET
CLIENT:_____

DATE: _____ INSTRUMENT SERIAL NO.: _____
TECHNICIAN: _____ INSTRUMENT MODEL NO.: _____

LOCATION ID	SAMPLING TIME		CANISTER DATA			BAROMETRIC PRESSURE (in. Hg)	AMBIENT AIR TEMP. (°F)	BUILDING CLOSED? (i.e., windows/ doors closed) (YES/NO)
	START	FINISH	CAN NO.	INITIAL PRESSURE (in. Hg)	FINAL PRESSURE (in. Hg)			
INDOOR AIR MONITORING LOCATIONS								
AMBIENT AIR MONITORING LOCATIONS								

NOTE:

Attachment B

Example Chain-of-Custody Form

Mobile Geochemistry Inc.
2470 Impala Drive, Carlsbad, CA 92010
& Field Office - Signal Hill, CA
W handpmg.com E info@handpmg.com
P 760.804.9678 F 760.804.9159

VAPOR / AIR Chain of Custody

DATE:_____
Page ____of_____

Lab Client and Project Information	
Lab Client/Consultant:	Project Name / #:
Lab Client Project Manager:	Project Location:
Lab Client Address:	Report E-Mail(s):
Lab Client City, State, Zip:	
Phone Number:	

Reporting Requirements	Turnaround Time	Sampler Information
☐ Standard Report ☐ Level III ☐ Level IV	☐ 5-7 day Stnd ☐ 24-Hr Rush	Sampler(s):
☐ Excel EDD ☐ Other EDD:_____	☐ 3-day Rush ☐ Mobile Lab	Signature:
☐ CA Geotracker Global ID:_____	☐ 48-Hr Rush ☐ Other:____	Date:

Sample Receipt (Lab Use Only)	
Date Rec'd:	Control #:
H&P Project #	
Lab Work Order #	
Sample Intact: ☐ Yes ☐ No ☐ See Notes Below	
Receipt Gauge ID:	Temp:
Outside Lab:	
Receipt Notes/Tracking #:	
Lab PM Initials:	

Additional Instructions to Laboratory:

** Preferred VOC units (please choose one):*
☐ µg/L ☐ µg/m^3 ☐ ppbv ☐ ppmv

SAMPLE NAME	FIELD POINT NAME (if applicable)	DATE mm/dd/yy	TIME 24hr clock	SAMPLE TYPE Indoor Air (IA), Ambient Air (AA), Subslab (SS), Soil Vapor (SV)	CONTAINER SIZE & TYPE 400mL/1L/6L Summa, Tedlar, Tube, etc	CONTAINER ID (####)	Lab use only: Receipt Vac	VOC's Standard Full List ☐ TO-15 ☐ 8260SV	VOC's Short List / Project List ☐ TO-15 ☐ 8260SV	Oxygenates ☐ TO-15 ☐ 8260SV	Naphthalene ☐ TO-15 ☐ 8260SV	TPHv as Gas ☐ TO-15m ☐ 8260SVm	Aromatic/Aliphatic Fractions ☐ TO-15m ☐ 8260SVm	Leak Check Compound ☐ DFA ☐ IPA ☐ He	Methane by EPA 8015m	Fixed Gases by ASTM D1945 ☐ CO2 ☐ O2 ☐ N2				

Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:

**Approval constitutes as authorization to proceed with analysis and acceptance of conditions on back*

Appendix 6A1, Rev 5/23/2016, Effective 5/23/2016

Appendix C – Calibration Gas Standard Certificates

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X02NI99C15AC925	Reference Number:	160-403023578-1
Cylinder Number:	CC496820	Cylinder Volume:	140.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Apr 25, 2024	Valve Outlet:	350
Lot Number:	160-403023578-1		

Expiration Date: Apr 25, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	1.000 PPM	1.003 PPM	+/- 5%
NITROGEN	Balance		
Impurities Analyzed			
THC	0.1000 PPM	< 0.1000 PPM	

Notes:PO number: C574486

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X02NI99C15AC925	Reference Number:	160-403023578-1
Cylinder Number:	CC162009	Cylinder Volume:	140.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Apr 25, 2024	Valve Outlet:	350
Lot Number:	160-403023578-1		

Expiration Date: Apr 25, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	1.000 PPM	1.046 PPM	+/- 5%
NITROGEN	Balance		
Impurities Analyzed			
THC	0.1000 PPM	< 0.1000 PPM	

Notes:PO number: C574486

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X02NI99C15A0817	Reference Number:	160-403023579-1
Cylinder Number:	CC243021	Cylinder Volume:	144.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Apr 25, 2024	Valve Outlet:	350
Lot Number:	160-403023579-1		

Expiration Date: Apr 25, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	500.000 PPB	559.000 PPB	+/- 10%
NITROGEN	Balance		

Notes:PO number: C574486

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP,		
Part Number:	X05NI99C15AC045	Reference Number:	160-403023577-1
Cylinder Number:	EB0146295	Cylinder Volume:	129.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2016 PSIG
Analysis Date:	Apr 25, 2024	Valve Outlet:	350
Lot Number:	160-403023577-1		

Expiration Date: Apr 25, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	1.000 PPM	1.038 PPM	+/-5%
ETHYL BENZENE	1.000 PPM	1.031 PPM	+/-5%
O XYLENE	1.000 PPM	1.018 PPM	+/-5%
TOLUENE	1.000 PPM	1.010 PPM	+/-5%
NITROGEN	Balance		

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X07NI99C15A0016	Reference Number:	160-403023576-1
Cylinder Number:	ALM010822	Cylinder Volume:	144.0 CL
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Apr 26, 2024	Valve Outlet:	350
Lot Number:	160-403023576-1		

Expiration Date: Apr 26, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	2.000 PPM	2.216 PPM	+/- 5%
ETHYL BENZENE	2.000 PPM	2.279 PPM	+/- 5%
M XYLENE	2.000 PPM	2.216 PPM	+/- 5%
O XYLENE	2.000 PPM	2.280 PPM	+/- 5%
P XYLENE	2.000 PPM	2.216 PPM	+/- 5%
TOLUENE	2.000 PPM	2.252 PPM	+/- 5%
NITROGEN	Balance		

Notes:PO number: C574486

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X07NI99C15ACFW8	Reference Number:	160-403023575-1
Cylinder Number:	EB0119577	Cylinder Volume:	144.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Apr 25, 2024	Valve Outlet:	350
Lot Number:	160-403023575-1		

Expiration Date: Apr 25, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	500.000 PPB	533.000 PPB	+/- 10%
ETHYL BENZENE	500.000 PPB	534.000 PPB	+/- 10%
M XYLENE	500.000 PPB	539.000 PPB	+/- 10%
O XYLENE	500.000 PPB	529.000 PPB	+/- 10%
P XYLENE	500.000 PPB	525.000 PPB	+/- 10%
TOLUENE	500.000 PPB	537.000 PPB	+/- 10%
NITROGEN	Balance		

Notes:PO number: C574486

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
616 Miller Cut Off Road
La Porte, TX 77571
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP - N223 ISLANDIA, NY		
Part Number:	X05NI99C15A00P4	Reference Number:	126-403027641-1
Cylinder Number:	SG9163263BAL	Cylinder Volume:	144.0 CF
Laboratory:	124 - La Porte Mix - TX	Cylinder Pressure:	2015 PSIG
Analysis Date:	May 14, 2024	Valve Outlet:	350
Lot Number:	126-403027641-1		

Expiration Date: May 14, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	5.000 PPM	5.003 PPM	± 5%
ETHYL BENZENE	5.000 PPM	4.960 PPM	± 5%
O XYLENE	5.000 PPM	5.046 PPM	± 5%
TOLUENE	5.000 PPM	4.939 PPM	± 5%
NITROGEN	Balance		

Notes:.
PO NUMBER: C574486

Signature on file
Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP,		
Part Number:	X05NI99C15A4930	Reference Number:	160-403029060-1
Cylinder Number:	ALM026159	Cylinder Volume:	144.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	May 07, 2024	Valve Outlet:	350
Lot Number:	160-403029060-1		

Expiration Date: May 07, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	7.500 PPM	7.824 PPM	+/- 5%
ETHYL BENZENE	7.500 PPM	7.860 PPM	+/- 5%
O XYLENE	7.500 PPM	7.798 PPM	+/- 5%
TOLUENE	7.500 PPM	7.806 PPM	+/- 5%
NITROGEN	Balance		

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI99E15A0411	Reference Number:	160-403024843-1
Cylinder Number:	CC210891	Cylinder Volume:	144.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
PGVP Number:	A12024	Valve Outlet:	330
Gas Code:	H2S,BALN	Certification Date:	Apr 30, 2024

Expiration Date: Apr 30, 2027

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
HYDROGEN SULFIDE	15.00 PPM	14.30 PPM	G1	+/- 2.0% NIST Traceable	04/23/2024, 04/30/2024
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
GMIS	122401592524107	CC424677	27.73 PPM HYDROGEN SULFIDE/NITROGEN	+/-1.4%	Jul 25, 2026
NTRM	06114A	KAL002675	20.38 PPM HYDROGEN SULFIDE/NITROGEN	+/-0.29%	Dec 21, 2024
GMIS	122402224494103	CC252723	19.67 PPM HYDROGEN SULFIDE/NITROGEN	1.6%	Dec 29, 2024
RGM	12334	CC206043	20.14 PPM HYDROGEN SULFIDE/NITROGEN	+/- 1.0%	Jan 30, 2022

The SRM, NTRM, PRM, or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
AAI-OMA406-AA210275	NDUV	Apr 01, 2024

Triad Data Available Upon Request

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI99E15A04F1	Reference Number:	54-403024847-1
Cylinder Number:	EB0108523	Cylinder Volume:	144.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12024	Valve Outlet:	705
Gas Code:	NH3,BALN	Certification Date:	May 01, 2024

Expiration Date: May 01, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
AMMONIA	10.00 PPM	9.745 PPM	G1	+/-3% NIST Traceable	04/23/2024, 05/01/2024
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
GMIS	04172024102	CC438673	9.060 PPM AMMONIA/NITROGEN	+/- 3.0%	Feb 22, 2025
PRM	12412	D043958	30.8 PPM AMMONIA/NITROGEN	+/- 2.9%	Feb 22, 2024

The SRM, NTRM, PRM, or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
MKS Multigas 017707558	FTIR	Apr 04, 2024

Triad Data Available Upon Request

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP,		
Part Number:	X05NI99C15A4930	Reference Number:	160-403029060-1
Cylinder Number:	ALM026159	Cylinder Volume:	144.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	May 07, 2024	Valve Outlet:	350
Lot Number:	160-403029060-1		

Expiration Date: May 07, 2027

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	7.500 PPM	7.824 PPM	+/- 5%
ETHYL BENZENE	7.500 PPM	7.860 PPM	+/- 5%
O XYLENE	7.500 PPM	7.798 PPM	+/- 5%
TOLUENE	7.500 PPM	7.806 PPM	+/- 5%
NITROGEN	Balance		

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP,		
Part Number:	X06NI99C15W0036	Reference Number:	160-403024418-1
Cylinder Number:	CC512055	Cylinder Volume:	144.0 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Apr 23, 2024	Valve Outlet:	330
Lot Number:	160-403024418-1		

Expiration Date: Apr 23, 2025

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
CARBONYL SULFIDE	10.00 PPM	10.75 PPM	+/-5%
DIMETHYL SULFIDE	10.00 PPM	11.20 PPM	+/-5%
ETHYL MERCAPTAN	10.00 PPM	10.70 PPM	+/-5%
HYDROGEN SULFIDE	10.00 PPM	11.83 PPM	+/-5%
METHYL MERCAPTAN	10.00 PPM	10.85 PPM	+/-5%
NITROGEN	Balance		

Signature on file

Approved for Release

Appendix D – Manufacturer Calibration Verifications

(ES642s & Jerome Meter)

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708-2 Firmware Rev:** *R1.2.0*

Serial Number: *D19172*

Calibrated By: ***Brandon James*** AT **Cal. Date:** *1/05/2024*

Quality Inspector: [signature] **Date:** *1-5-2024*

Calibration Hrz/ug: 7.22 **Laser Current ma:** 24.0

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output	(Pass) / Fail	**4-20 ma Output:**	(Pass) / Fail
Serial Communication:	(Pass) / Fail	**Inlet Heater:**	(Pass) / Fail

ES-642 Conc.: 408 Standard Conc.: *408*

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	May 05, 2024
RH &TEMPERATURE	Rotronic	HC2-S3	61247814	February 04, 2024
BAROMETRIC PRESSURE	Met One Instruments	092	A23858	January 24, 2024
Primary Flow Meter	TSI	4040H	4040 1938 002	December 21, 2024
LD-3B	SIBATA	LD-3B	6X7759	May 06, 2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708-2 Firmware Rev:** *R1.2.0*

Serial Number: *D19171*

Calibrated By: *Brandon James* AT7 **Cal. Date:** *1/05/2024*

Quality Inspector: [signature] **Date:** 1-5-2024

Calibration Hrz/ug: 7.39 **Laser Current ma:** 27.0

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output	(Pass) / Fail	**4-20 ma Output:**	(Pass) / Fail
Serial Communication:	(Pass) / Fail	**Inlet Heater:**	(Pass) / Fail

ES-642 Conc.: 402 Standard Conc.: *402*

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	May 05, 2024
RH &TEMPERATURE	Rotronic	HC2-S3	61247814	February 04, 2024
BAROMETRIC PRESSURE	Met One Instruments	092	A23858	January 24, 2024
Primary Flow Meter	TSI	4040H	4040 1938 002	December 21, 2024
LD-3B	SIBATA	LD-3B	6X7759	May 06, 2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 80708-2 **Firmware Rev:** *R1.2.0*

Serial Number: *D19170*

Calibrated By: *Brandon James* AT7 **Cal. Date:** *1/5/2024*

Quality Inspector: [signature] **Date:** 1-5-2024

Calibration Hrz/ug: 6.82 **Laser Current ma:** 26.1

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output	(Pass) / Fail	**4-20 ma Output:**	(Pass) / Fail
Serial Communication:	(Pass) / Fail	**Inlet Heater:**	(Pass) / Fail

ES-642 Conc.: 400 Standard Conc.: *401*

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	May 30, 2024
RH &TEMPERATURE	Rotronic	HC2-S3	61247814	February 04, 2024
BAROMETRIC PRESSURE	Met One Instruments	092	A23858	January 24, 2024
Primary Flow Meter	TSI	4040H	4040 1938 002	December 21, 2024
LD-3B	SIBATA	LD-3B	6X7759	May 06, 2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: W12870

Calibrated By: Brycee Fry AT5 **Cal. Date:** 02/06/2024

Quality Inspector: AT14 **Date:** FEB 13 2024

Calibration Hrz/ug: 6.65 **Laser Current mA:** 27.6

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 412 Standard Conc: 410

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 80708 **Firmware Rev:** 1.3.1

Serial Number: P22922

Calibrated By: Brycee Fry AT5 **Cal. Date:** 02/06/2024

Quality Inspector: AT14 **Date:** FEB 13 2024

Calibration Hrz/ug: 7.80 **Laser Current mA:** 29.1

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 401 Standard Conc: 401

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: X13888

Calibrated By: Brycee Fry AT5 **Cal. Date:** 01/02/2024

Quality Inspector: AT1 **Date:** JAN 17 2024

Calibration Hrz/ug: 6.70 **Laser Current mA:** 28.8

Final Test

ES-642 Temperature Sensor: (Pass) / Fail
ES-642 BP Sensor: (Pass) / Fail
ES-642 Flow (2.0 L/M): (Pass) / Fail
ES-642 RH Sensor: (Pass) / Fail
0-10 Volts Output: (Pass) / Fail
4-20 ma Output: (Pass) / Fail
Serial Communication: (Pass) / Fail
Inlet Heater: (Pass) / Fail

ES-642 Conc.: 395 Standard Conc: 396

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: U18907

Calibrated By: Brycee Fry AT5 **Cal. Date:** 01/02/2024

Quality Inspector: AT1 **Date:** JAN 17 2024

Calibration Hrz/ug: 6.38 **Laser Current mA:** 25.2

Final Test

ES-642 Temperature Sensor: (Pass) / Fail
ES-642 BP Sensor: (Pass) / Fail
ES-642 Flow (2.0 L/M): (Pass) / Fail
ES-642 RH Sensor: (Pass) / Fail
0-10 Volts Output: (Pass) / Fail
4-20 ma Output: (Pass) / Fail
Serial Communication: (Pass) / Fail
Inlet Heater: (Pass) / Fail

ES-642 Conc.: 387 Standard Conc: 384

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: P22922

Calibrated By: Brycee Fry AT5 **Cal. Date:** 07/20/2022

Quality Inspector: AT14 **Date:**

Calibration Hrz/ug: 8.05 **Laser Current mA:** 29.2

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 363 Standard Conc: 360

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: W12870

Calibrated By: Brycee Fry AT5 **Cal. Date:** 09/02/2022

Quality Inspector: AT2 **Date:** SEP 28 2022

Calibration Hrz/ug: 6.88 **Laser Current mA:** 27.7

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 431 Standard Conc: 432

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	04/22/23

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model:	**ES-642**	**80708 Firmware Rev:**	**1.2.0**
Serial Number:	**W12872**		
Calibrated By:	**Alice M.**	**Cal. Date:**	**Jul 1, 2022**
Quality Inspector:	AT8	**Date:**	JUL 0 1 2022
Calibration Hz/ug:	**7.94**	**Laser Current mA:**	**28.8**

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **434** Standard Conc: **432**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X11140

Calibrated By: Brycee Fry AT5 **Cal. Date:** 08/15/2022

Quality Inspector: AT14 **Date:** AUG 16 2022

Calibration Hrz/ug: 7.89 **Laser Current mA:** 28.0

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 362 Standard Conc: 364

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X13888

Calibrated By: Brycee Fry AJS **Cal. Date:** 09/02/2022

Quality Inspector: **Date:** SEP 28 2022

Calibration Hrz/ug: 6.79 **Laser Current mA:** 28.9

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 440 Standard Conc: 434

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	04/22/23

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model:	**ES-642**	**80708 Firmware Rev:**	**1.2.0**
Serial Number:	**X13962**		
Calibrated By:	**Alice M.**	**Cal. Date:**	**Jul 1, 2021**
Quality Inspector:	AT8	**Date:**	JUL 0 1 2022
Calibration Hz/ug:	**7.27**	**Laser Current mA:**	**28.8**

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **404** Standard Conc: **402**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X13963

Calibrated By: Brycee Fry AJS **Cal. Date:** 08/15/2022

Quality Inspector: ATH **Date:** AUG 16 2022

Calibration Hrz/ug: 7.78 **Laser Current mA:** 28.8

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 399 Standard Conc: 398

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: W12869

Calibrated By: Robert Falbo **Cal. Date:** 05/16/2024

Quality Inspector: **Date:** MAY 30 2024

Calibration Hrz/ug: 8.26 **Laser Current mA:** 28.5

Final Test

ES-642 Temperature Sensor: (Pass) / Fail — ES-642 BP Sensor: (Pass) / Fail

ES-642 Flow (2.0 L/M): (Pass) / Fail — ES-642 RH Sensor: (Pass) / Fail

0-10 Volts Output: (Pass) / Fail — 4-20 ma Output: (Pass) / Fail

Serial Communication: (Pass) / Fail — Inlet Heater: (Pass) / Fail

ES-642 Conc.: 387 Standard Conc: 388

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	03/14/25
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	476795	11/7/2024
Flow Meter	TSI	4040 H	40401945007	12/21/2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: X13964

Calibrated By: Robert Falbo **Cal. Date:** 05/16/2024

Quality Inspector: **Date:** MAY 30 2024

Calibration Hrz/ug: 7.19 **Laser Current mA:** 28.6

Final Test

ES-642 Temperature Sensor: (Pass) / Fail

ES-642 Flow (2.0 L/M): (Pass) / Fail

0-10 Volts Output: (Pass) / Fail

Serial Communication: (Pass) / Fail

ES-642 BP Sensor: (Pass) / Fail

ES-642 RH Sensor: (Pass) / Fail

4-20 ma Output: (Pass) / Fail

Inlet Heater: (Pass) / Fail

ES-642 Conc.: 390 Standard Conc: 391

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	03/14/25
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	476795	11/7/2024
Flow Meter	TSI	4040 H	40401945007	12/21/2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: T22316

Calibrated By: Robert Falbo **Cal. Date:** 05/16/2024

Quality Inspector: **Date:** MAY 30 2024

Calibration Hrz/ug: 8.48 **Laser Current mA:** 29.2

Final Test

ES-642 Temperature Sensor: (Pass) / Fail
ES-642 BP Sensor: (Pass) / Fail
ES-642 Flow (2.0 L/M): (Pass) / Fail
ES-642 RH Sensor: (Pass) / Fail
0-10 Volts Output: (Pass) / Fail
4-20 ma Output: (Pass) / Fail
Serial Communication: (Pass) / Fail
Inlet Heater: (Pass) / Fail

ES-642 Conc.: 391 Standard Conc: 389

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	03/14/25
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	476795	11/7/2024
Flow Meter	TSI	4040 H	40401945007	12/21/2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 80708-2 **Firmware Rev:** *R1.2.0*

Serial Number: *D19172*

Calibrated By: ***Brandon James*** AT7 **Cal. Date:** *1/05/2024*

Quality Inspector: R Jen **Date:** 1-5-2024

Calibration Hrz/ug: 7.22 **Laser Current ma:** 24.0

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output	(Pass) / Fail	**4-20 ma Output:**	(Pass) / Fail
Serial Communication:	(Pass) / Fail	**Inlet Heater:**	(Pass) / Fail

ES-642 Conc.: 408 Standard Conc.: *408*

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	May 05, 2024
RH &TEMPERATURE	Rotronic	HC2-S3	61247814	February 04, 2024
BAROMETRIC PRESSURE	Met One Instruments	092	A23858	January 24, 2024
Primary Flow Meter	TSI	4040H	4040 1938 002	December 21, 2024
LD-3B	SIBATA	LD-3B	6X7759	May 06, 2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708-2 Firmware Rev:** *R1.2.0*

Serial Number: *D19171*

Calibrated By: *Brandon James* AT7 **Cal. Date:** *1/05/2024*

Quality Inspector: [signature] **Date:** 1-5-2024

Calibration Hrz/ug: 7.39 **Laser Current ma:** 27.0

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output	(Pass) / Fail	**4-20 ma Output:**	(Pass) / Fail
Serial Communication:	(Pass) / Fail	**Inlet Heater:**	(Pass) / Fail

ES-642 Conc.: 402 Standard Conc.: *402*

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	May 05, 2024
RH &TEMPERATURE	Rotronic	HC2-S3	61247814	February 04, 2024
BAROMETRIC PRESSURE	Met One Instruments	092	A23858	January 24, 2024
Primary Flow Meter	TSI	4040H	4040 1938 002	December 21, 2024
LD-3B	SIBATA	LD-3B	6X7759	May 06, 2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 80708-2 **Firmware Rev:** *R1.2.0*

Serial Number: *D19170*

Calibrated By: *Brandon James* AT7 **Cal. Date:** *1/5/2024*

Quality Inspector: [signature] **Date:** 1-5-2024

Calibration Hrz/ug: 6.82 **Laser Current ma:** 26.1

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output	(Pass) / Fail	**4-20 ma Output:**	(Pass) / Fail
Serial Communication:	(Pass) / Fail	**Inlet Heater:**	(Pass) / Fail

ES-642 Conc.: 400 Standard Conc.: *401*

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	May 30, 2024
RH &TEMPERATURE	Rotronic	HC2-S3	61247814	February 04, 2024
BAROMETRIC PRESSURE	Met One Instruments	092	A23858	January 24, 2024
Primary Flow Meter	TSI	4040H	4040 1938 002	December 21, 2024
LD-3B	SIBATA	LD-3B	6X7759	May 06, 2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: W12870

Calibrated By: Brycee Fry AT5 **Cal. Date:** 02/06/2024

Quality Inspector: AT14 **Date:** FEB 13 2024

Calibration Hrz/ug: 6.65 **Laser Current mA:** 27.6

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 412 Standard Conc: 410

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 80708 **Firmware Rev:** 1.3.1

Serial Number: P22922

Calibrated By: Brycee Fry AT5 **Cal. Date:** 02/06/2024

Quality Inspector: AT14 **Date:** FEB 13 2024

Calibration Hrz/ug: 7.80 **Laser Current mA:** 29.1

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 401 Standard Conc: 401

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: X13888

Calibrated By: Brycee Fry AT5 **Cal. Date:** 01/02/2024

Quality Inspector: AT1 **Date:** JAN 17 2024

Calibration Hrz/ug: 6.70 **Laser Current mA:** 28.8

Final Test

ES-642 Temperature Sensor: (Pass) / Fail
ES-642 BP Sensor: (Pass) / Fail
ES-642 Flow (2.0 L/M): (Pass) / Fail
ES-642 RH Sensor: (Pass) / Fail
0-10 Volts Output: (Pass) / Fail
4-20 ma Output: (Pass) / Fail
Serial Communication: (Pass) / Fail
Inlet Heater: (Pass) / Fail

ES-642 Conc.: 395 Standard Conc: 396

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: U18907

Calibrated By: Brycee Fry AT5 **Cal. Date:** 01/02/2024

Quality Inspector: AT1 **Date:** JAN 17 2024

Calibration Hrz/ug: 6.38 **Laser Current mA:** 25.2

Final Test

ES-642 Temperature Sensor: (Pass) / Fail
ES-642 BP Sensor: (Pass) / Fail
ES-642 Flow (2.0 L/M): (Pass) / Fail
ES-642 RH Sensor: (Pass) / Fail
0-10 Volts Output: (Pass) / Fail
4-20 ma Output: (Pass) / Fail
Serial Communication: (Pass) / Fail
Inlet Heater: (Pass) / Fail

ES-642 Conc.: 387 Standard Conc: 384

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/19/24
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	6X7759	05/06/24
Flow Meter	TSI	4040 H	40402111007	03/22/24

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: P22922

Calibrated By: Brycee Fry AT5 **Cal. Date:** 07/20/2022

Quality Inspector: AT14 **Date:**

Calibration Hrz/ug: 8.05 **Laser Current mA:** 29.2

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 363 Standard Conc: 360

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model:	**ES-642**	**80708 Firmware Rev:**	**1.2.0**
Serial Number:	**T22316**		
Calibrated By:	**Alice M.**	**Cal. Date:**	**Apr 20, 2022**
Quality Inspector:	AT1	**Date:**	APR 2 2 2022
Calibration Hz/ug:	**8.51**	**Laser Current mA:**	**28.9**

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **391** Standard Conc: **387**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** R1.2.0

Serial Number: U18908

Calibrated By: DAMIEN **Cal. Date:** 2/11/22

Quality Inspector: AT21 **Date:** FEB 21 2022

Calibration Hrz/ug: 6.85 **Laser Current mA:** 25.8mA

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 423 Standard Conc: 419

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	289	23700150	05/14/22
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	03/17/22

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: W12870

Calibrated By: Brycee Fry AT5 **Cal. Date:** 09/02/2022

Quality Inspector: AT2 **Date:** SEP 28 2022

Calibration Hrz/ug: 6.88 **Laser Current mA:** 27.7

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 431 Standard Conc: 432

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	04/22/23

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model:	**ES-642**	**80708 Firmware Rev:**	**1.2.0**
Serial Number:	**W12872**		
Calibrated By:	**Alice M.**	**Cal. Date:**	**Jul 1, 2022**
Quality Inspector:	AT8	**Date:**	JUL 0 1 2022
Calibration Hz/ug:	**7.94**	**Laser Current mA:**	**28.8**

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **434** Standard Conc: **432**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model:	**ES-642**	**80708 Firmware Rev:**	**1.2.0**
Serial Number:	**X11138**		
Calibrated By:	**Alice M.**	**Cal. Date:**	**Apr 20, 2022**
Quality Inspector:	AT1	**Date:**	APR 22 2022
Calibration Hz/ug:	**7.56**	**Laser Current mA:**	**28.5**

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **477** Standard Conc: **473**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X11140

Calibrated By: Brycee Fry AT5 **Cal. Date:** 08/15/2022

Quality Inspector: AT14 **Date:** AUG 16 2022

Calibration Hrz/ug: 7.89 **Laser Current mA:** 28.0

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 362 Standard Conc: 364

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X13888

Calibrated By: Brycee Fry AJS **Cal. Date:** 09/02/2022

Quality Inspector: **Date:** SEP 28 2022

Calibration Hrz/ug: 6.79 **Laser Current mA:** 28.9

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 440 Standard Conc: 434

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	04/22/23

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model:	**ES-642**	**80708 Firmware Rev:**	**1.2.0**
Serial Number:	**X13962**		
Calibrated By:	**Alice M.**	**Cal. Date:**	**Jul 1, 2021**
Quality Inspector:	AT8	**Date:**	JUL 0 1 2022
Calibration Hz/ug:	**7.27**	**Laser Current mA:**	**28.8**

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **404** Standard Conc: **402**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X13963

Calibrated By: Brycee Fry AJS **Cal. Date:** 08/15/2022

Quality Inspector: ATH **Date:** AUG 16 2022

Calibration Hrz/ug: 7.78 **Laser Current mA:** 28.8

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: 399 Standard Conc: 398

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X14320

Calibrated By: Brycee Fry **Cal. Date:** 05/19/2022

Quality Inspector: _____ **Date:** _____

Calibration Hrz/ug: 7.47 **Laser Current mA:** 28.6

Final Test

ES-642 Temperature Sensor:	(Pass) / Fail	ES-642 BP Sensor:	(Pass) / Fail
ES-642 Flow (2.0 L/M):	(Pass) / Fail	ES-642 RH Sensor:	(Pass) / Fail
0-10 Volts Output:	(Pass) / Fail	4-20 ma Output:	(Pass) / Fail
Serial Communication:	(Pass) / Fail	Inlet Heater:	(Pass) / Fail

ES-642 Conc.: **405** Standard Conc: **404**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: W12869

Calibrated By: Robert Falbo **Cal. Date:** 05/16/2024

Quality Inspector: **Date:** MAY 30 2024

Calibration Hrz/ug: 8.26 **Laser Current mA:** 28.5

Final Test

ES-642 Temperature Sensor: (Pass) / Fail — ES-642 BP Sensor: (Pass) / Fail

ES-642 Flow (2.0 L/M): (Pass) / Fail — ES-642 RH Sensor: (Pass) / Fail

0-10 Volts Output: (Pass) / Fail — 4-20 ma Output: (Pass) / Fail

Serial Communication: (Pass) / Fail — Inlet Heater: (Pass) / Fail

ES-642 Conc.: 387 Standard Conc: 388

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	03/14/25
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	476795	11/7/2024
Flow Meter	TSI	4040 H	40401945007	12/21/2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: X13964

Calibrated By: Robert Falbo **Cal. Date:** 05/16/2024

Quality Inspector: **Date:** MAY 30 2024

Calibration Hrz/ug: 7.19 **Laser Current mA:** 28.6

Final Test

ES-642 Temperature Sensor: (Pass) / Fail

ES-642 Flow (2.0 L/M): (Pass) / Fail

0-10 Volts Output: (Pass) / Fail

Serial Communication: (Pass) / Fail

ES-642 BP Sensor: (Pass) / Fail

ES-642 RH Sensor: (Pass) / Fail

4-20 ma Output: (Pass) / Fail

Inlet Heater: (Pass) / Fail

ES-642 Conc.: 390 Standard Conc: 391

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	03/14/25
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	476795	11/7/2024
Flow Meter	TSI	4040 H	40401945007	12/21/2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.3.1

Serial Number: T22316

Calibrated By: Robert Falbo **Cal. Date:** 05/16/2024

Quality Inspector: **Date:** MAY 30 2024

Calibration Hrz/ug: 8.48 **Laser Current mA:** 29.2

Final Test

ES-642 Temperature Sensor: (Pass) / Fail
ES-642 BP Sensor: (Pass) / Fail
ES-642 Flow (2.0 L/M): (Pass) / Fail
ES-642 RH Sensor: (Pass) / Fail
0-10 Volts Output: (Pass) / Fail
4-20 ma Output: (Pass) / Fail
Serial Communication: (Pass) / Fail
Inlet Heater: (Pass) / Fail

ES-642 Conc.: 391 Standard Conc: 389

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	03/14/25
Temp/Humidity/BP	Met One Instruments	597	Y13061	05/19/24
LD-3B	SIBATA	LD-3B	476795	11/7/2024
Flow Meter	TSI	4040 H	40401945007	12/21/2024

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

ISO 9001:2015 CERTIFIED
BROOKFIELD
AMETEK
INSTRUMENTATION & SPECIALTY CONTROLS DIVISION

CERTIFICATE NUMBER 350673

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11 Commerce Blvd. | Middleboro, MA 02346
P: 508.946.6200 | F: 508.946.6262

CERTIFICATE OF INSTRUMENT CALIBRATION

MODEL	SERIAL NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
J605-0001	60500093	4/11/2024	4/10/2025

To the NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY within the limitations of the Institute's calibration services, or have been derived from accepted values of natural physical constants, or have been derived by the ratio type of self-calibration techniques. Disclaimer: Any unauthorized adjustments, removal or breaking of QC seals, or other customer modifications on your Jerome Analyzer WILL VOID this factory calibration. Because any of the above acts could affect the calibration and readings of the instrument, their certification will no longer be valid and, further, AMETEK Brookfield WILL NOT be responsible for any liabilities created as a result of using the instrument after such adjustments, seal removal, or modifications. This document shall not be reproduced, except in full, without the written approval of AMETEK Brookfield.

REFERENCE EQUIPMENT USED TO CALIBRATE THE EQUIPMENT

TYPE/MODEL	SERIAL/LOT NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
Cal Set	CC514916	6/28/2022	6/28/2025
TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Alicat	60245	2/1/2024	2/2/2025
TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Alicat	437338	2/1/2024	2/2/2025
TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Fluke	16070753	12/6/2023	12/6/2024

NIST TRACE # SRM 2730; 65-D-035; CAL013399 **PROCEDURE #:** 730-0099

All reference equipment used to calibrate the instrument listed upon this certificate have calibrations that are traceable to the National Institute of Standards and Technology (NIST).

APPROVAL SIGNATURE

Todd Place

TODD PLACE, QUALITY ENGINEER

CALIBRATION PERFORMED BY GM