United States
Environmental Protection
Agency

EPA 600/R-15/008

CITIZEN SCIENCE AIR MONITOR (CSAM)

Quality Assurance Guidelines

Office of Research and Development
National Exposure Research Laboratory

Contents

The Citizen Science Toolbox

Many communities in the United States are potentially impacted by a wide variety of environmental pollution sources. The U.S. Environmental Protection Agency (EPA) encourages communities to advocate for environmental and public health mitigations and to raise awareness of air pollution issues. To this end, EPA promotes citizen science to involve citizens in collecting environmental data of importance to their families and communities.

The Ironbound Community Corporation (ICC) Community Advisory Board (CAB) in Newark, NJ, is committed to improving air quality for thousands of Newark residents who suffer from potential cumulative impacts of major industrial and port-related pollution sources on human health and the environment. EPA Region 2, the EPA region that serves Newark, has been a leader in EPA's efforts to promote citizen science. For this project, these two groups—the ICC CAB and EPA Region 2—are working together to initiate a community-based environmental monitoring study.

As part of this study, EPA is developing a Citizen Science Toolbox that contains the tools and information needed for the ICC CAB citizens to collect pollution data for nitrogen dioxide (NO_2) and particulate matter (PM), two types of air pollution that can have significant adverse health effects. Citizen volunteers will use a monitoring device called the Citizen Science Air Monitor (CSAM), which was designed and constructed by EPA for use by citizen volunteers. The documentation in this project's Citizen Science Toolbox was created specifically for use of the CSAM and includes an operating procedure, which provides information on how to set up the instrument and collect and process data, and these quality assurance (QA) guidelines, which offer basic information and considerations for collecting meaningful data. EPA Region 2 personnel will provide technical support as needed to the ICC CAB throughout the project.

This collaborative project will benefit both the Newark community and EPA. It will help the ICC CAB identify pollutants in its community that are of concern for both human health and the environment. The effort also will further EPA's aims of building community capacity for conducting environmental monitoring studies and will form the foundation for Region 2's Air Sensor Loan Program that will enable other community groups with similar concerns about air pollution in their neighborhoods.

What Is Quality Assurance?

Quality assurance is the process by which you determine if the environmental data collected in your monitoring project are credible and usable. The quality assurance process involves several steps, which EPA has termed PIE—Planning + Implementing + Evaluating. Each piece of PIE is vital to achieving quality results from your project. These quality assurance guidelines focus on specific CSAM requirements and are not meant to fully capture everything you need to know about conducting a credible air monitoring study. To learn more about planning and implementing your project and assuring the quality of the collected data, visit the following EPA web pages:

- Air Sensor Toolbox for Citizen Scientists—general tools and information for conducting a Citizen Science air monitoring project (http://www.epa.gov/heasd/airsensortoolbox).
- EPA's *Air Sensors Guidebook*—what sensor users need to understand if they are to collect meaningful air quality data (http://www.epa.gov/airscience/docs/air-sensor-guidebook.pdf).
- EPA Region 2 Citizen Science—guidelines for planning–implementing–evaluating and developing a quality assurance project plan (http://www.epa.gov/region2/citizenscience)

CSAM Components

The CSAM simultaneously measures NO_2 and PM along with temperature and relative humidity (RH). NO_2 and PM are pollutants of concern in the ambient environment because of the adverse health risks they pose, as described below. (For more information on these air pollutants visit http://www.epa.gov/airquality/urbanair/ and http://www.epa.gov/air/criteria.html.) While the CSAM is designed for easy operation and retrieval of data for all measurements at once (see the CSAM Operating Procedure), the unit consists of several components that generate the data. Citizen volunteers will not need to operate each component of the CSAM separately, but a general knowledge of the components that make up the CSAM will aid in understanding the requirements for data quality. Figure 1 shows the inside of the CSAM unit and its separate components. Each of these components is described in detail in the following subsections. Table 1 lists the measurement units reported by each component.

CSAM-NO_2

NO_2 is a highly reactive gas that can irritate the lungs and cause bronchitis, pneumonia, and other respiratory problems. NO_2 pollution is both man-made and naturally occurring. It occurs naturally as a result of atmospheric processes. It also forms from fuel combustion and forms quickly from automobile emissions. Therefore, significant increases in NO_2 concentrations are often found near major roadways. Power plants and other industrial processes also emit NO_2.

CSAM measurements of NO_2 are made using a CairPol CairClip NO_2 sensor (http://www.cairpol.com/index.php?option=com_content&view=article&id=41&Itemid=156&lang=en). The CairClip uses a gas-specific inlet filter combined with dynamic air sampling in an integrated system to measure real-time gas concentration in parts per billion (ppb). The CSAM-NO_2 unit's detection limit—the lowest concentration the instrument is likely to detect is approximately 20 ppb NO_2.

CSAM-PM

PM consists of particles of various sizes such as soot, smoke, dirt, and dust. These particles are often generated and released into the air from sources such as power plants, industrial and agricultural processes, automobiles, and fires. PM can adversely affect breathing and aggravate respiratory and cardiovascular conditions, with the smallest particles posing the greatest health risk. PM also contributes to atmospheric haze that reduces visibility.

The CSAM-PM component measures real-time PM in micrograms per cubic meter ($\mu g/m^3$) using a Thermo Scientific *personal* DataRAM nephelometer, a device that uses light to measure the concentration of suspended particles in a liquid or gas. Air is pumped to the nephelometer by an SKC AirChek 52 personal sampling pump. The nephelometer uses a BGI sharp-cut cyclone inlet (SCC 1.062), which excludes particles with a diameter above a certain size. In this case, the CSAM-PM samples for $PM_{2.5}$, which consists of particles less than 2.5 micrometers in diameter, or "fine" particles. Fine particles come from all types of combustion activities, such as motor vehicles, power plants, and wood burning, and pose the greatest health risk because they can lodge deeply in the lungs. The CSAM-PM unit operates at a flow rate of 1.5 liters per minute (L/min). It is important to understand that a change in flow rate will change the diameter of the particles being sampled and thus affect data quality. If a change in flow rate is noted, the unit should be removed from operation, and an experienced operator should perform the flow rate check and adjustment detailed in the CSAM Operating Procedure. The CSAM-PM has a detection limit of 0.1 $\mu g/m^3$.

Temperature and Relative Humidity

The CSAM also contains a Honeywell temperature and RH sensor (HIH-4602-A/C series). Temperature (ºC) and RH (% at ºC) data are recorded along with the PM and NO_2 concentration data. The recommended operating ranges for temperature and RH are 0–40 ºC (32–104 ºF) and 0–90% RH (with no formation of water droplets), respectively. Abrupt changes in temperature and RH can affect the performance of your CSAM, particularly the CSAM-NO_2 sensor component. Therefore, temperature and RH data collected concurrently with concentration data can help you recognize any performance issues caused by environmental conditions.

Microprocessor

Data from all components—PM, NO_2, and temperature and RH—are collected and stored using an Arduino Uno microprocessor. The Arduino Uno has a USB connection and a power jack. This microprocessor uses software developed by EPA to allow operators to retrieve all data from the unit in one easy step. Data will be stored on a secure digital (SD) memory card located in the microprocessor that the citizen operators access and remove for data download as described in the CSAM Operating Procedure.

CSAM

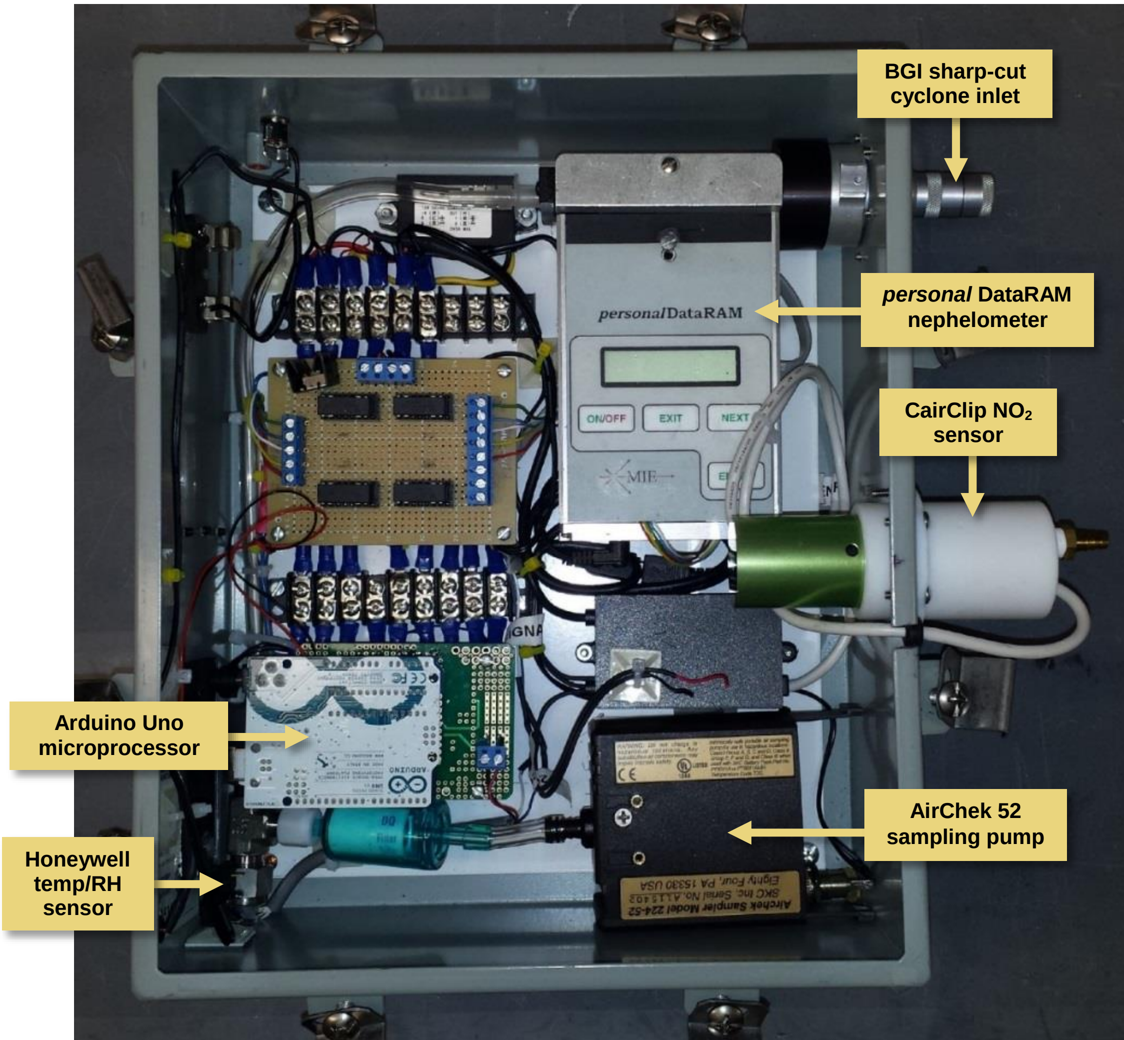

Figure 1

Measurement	Reporting Unit
NO_2 concentration	Parts per billion (ppb)
PM concentration	Micrograms per cubic meter (µg/m^3)
Temperature	Degrees Celsius (°C)
Relative humidity (RH)	Percent (%) at °C

Table 1

Important Considerations for Air Monitor Placement

Appropriate placement of air monitoring devices is critical for collecting useful data. Air pollution concentrations can vary considerably due to factors such as proximity of the pollutant sources, buildings and other obstructions, and atmospheric conditions. For these reasons, you must plan monitoring locations carefully to make sure the collected data are representative of the community you are monitoring and that meet your study objectives. EPA Region 2 and the Ironbound CAG will work together to identify the CSAM locations for this study. The following are some important considerations for choosing representative sampling sites:

- **Local atmospheric conditions.** Factors such as rain, wind, sunlight, clouds, temperature, and humidity can affect your CSAM data.
    - Make sure the unit is protected from the effects of weather using the individual EPA-developed aluminum shields that accompany your CSAM unit.
    - Temperature and humidity can particularly affect the performance of the CSAM. The recommended operating ranges for temperature and RH are 0–40 ºC (32–104 ºF) and 0–90% RH (with no formation of water droplets), respectively.
    - Wind speed and direction can also affect CSAM measurements. For example, stagnant air can lead to pollutant concentrations that gradually increase, whereas strong winds can decrease concentrations by spreading pollutants over a larger area. Higher winds can also lead to higher concentrations of other pollutants such as dust. Wind direction can affect your results by increasing or decreasing concentrations depending on whether your air monitor is located upwind or downwind of the prevailing wind at the time of data collection. Understanding the effects of wind can aid in choosing a monitoring site and in recognizing when your results might have been affected by wind.
- **Primary or secondary source.** Some pollutants are emitted directly by a source (primary pollutants), while others are formed as the products of chemical reactions in the air (secondary pollutants). Primary pollutants are often more localized (i.e., near the source) and can have a greater variability over distances than secondary pollutants. It is important to consider whether a pollutant of interest is primary or secondary when deciding where and how to collect monitoring data. More information can be found at: http://www.epa.gov/air/criteria.html.
- **Location of pollutant sources relative to the pollutant of interest.** NO_2 and PM, for instance, might have much higher concentrations closer to a roadway as both come from automobile emissions. If you want to find out how a roadway influences NO_2 and PM concentrations, you could locate one CSAM close to the road and one some distance downwind of the roadway to determine the changes in concentrations.
- **Location of the air monitor relative to the exposed population.** If the aim of your study, for example, is to measure the impact of industrial emissions of NO_2 and PM on a

particular neighborhood, the CSAMs could be placed within the neighborhood at varying distances from the facility rather.

- **Air flow.** Make sure air flows freely to your CSAM unit by placing it far enough away from the ground (at least 1 meter above the surface) and away from building surfaces, trees, or any other obstructions to flow (ideally at least 1 meter away).
- **Reactions and interferences.** Sensors can experience interference from other chemicals in the atmosphere, as well as heat and cold, which can lead to erroneous concentration estimates. Avoid placing the CSAM near sources of heat or cold and gases that can react with the pollutant of interest. Possible interferences for the CSAM-NO_2 component include high concentrations of chlorine (a commonly used disinfectant for swimming pools) and ozone (often formed during warm, dry, and cloudless days with low wind speeds).

EPA's *Air Sensor Guidebook* provides additional details and considerations for choosing sites for air monitoring studies (http://www.epa.gov/airscience/docs/air-sensor-guidebook.pdf).

Performance Goals

The performance of an air sensor or instrument describes its overall ability to measure air pollution. For your data to be useful in meeting any objective, be sure your expectations for the data collected with the CSAMs are well defined. These expectations are the *performance goals* of the measurement system. The quality of data collected with sensors can vary greatly depending on sensor design and performance characteristics as well as your deployment strategy. In addition, acquiring meaningful data relies on proper operation and response of the air monitoring instrument, which must be checked and maintained regularly to continuously produce quality results. The following subsections describe general performance considerations you should keep in mind while conducting an air monitoring study, the level of quality assurance needed based on your intended application, and specific CSAM performance requirements.

Performance Characteristics That Affect Data Quality

A broad range of performance-related characteristics can affect data quality. The performance characteristics listed in Table 2 are applicable to air monitoring systems in general. A familiarity with these characteristics will allow you to assess if your air monitoring device is generating usable data throughout the study.

Evaluating Data Quality	
Performance Characteristic	**Assessment**
Bias	Is measurement routinely high or low with respect to the true value?
Precision	How repeatable is the measurement?
Calibration	Does device respond in a systematic fashion as concentration changes?
Detection limit	How low and high will the device measure successfully?
Response time	How fast does the response vary with concentration change?
Linearity of response	What is the linear or multilinear range?
Measurement duration	How much data do you need to collect?
Measurement frequency	How many collection periods are needed?
Data aggregation	Value in aggregating data (e.g., 1 second, 1 minute, 1 hour)
Selectivity/specificity	Does it respond to anything else?
Interferences	How does heat and cold affect response?
Sensor poisoning and expiration	How long will the sensor be useful?
Concentration range	Will the device cover expected highs and lows?
Drift	How stable is the response?
Accuracy of timestamp	What response output relates to the event?
Climate susceptibility	Does RH, temperature, direct sun, etc., impact data?
Data completeness	What is the uptime of the sensor?
Response to loss of power	What happens when it shuts down?

Table 2

All of the concepts described above are discussed in detail in the Air Sensor Guidebook (http://www.epa.gov/airscience/docs/air-sensor-guidebook.pdf).

An understanding of the following terms is helpful in setting your performance goals and assessing whether the collected data meet these goals:

- **Accuracy:** Accuracy is the overall agreement of an instrument's measurement to the true value obtained with an accepted reference method. Accuracy is a measure of the *bias*, or systematic error, in a system.

  Accuracy = average value - true value

- **Precision:** Precision refers to how well the sensor reproduces the measurement of a pollutant under identical circumstances.

  Precision = (standard deviation / average of replicates) x 100,

  where standard deviation is the range of variation in the measurements taken and replicate samples are two or more samples taken from the same place at the same time.

You should be aware that a sensor's accuracy and precision can change over time. For example, exposure to rapidly changing temperatures or humidity might lead to a gradual change in response, also known as *drift*.

Tables 3,4,and 5 show manufacturer's specifications for the CairClip NO_2 sensor, the *personal* Data RAM (PDR) PM sensor, and the AirChek 52 sampling pump.

Table 3

AIR POL
MINIATURE AIR QUALITY MONITORING SYSTEMS
P061D.OZ.Technical.Data Sheet.NO2.160812

Technical Data Sheet CairClip NO_2 (preliminary version)

(document prone to modifications)

Range	0-250 ppb (0-240 ppb analog)
Limit of detection (1, 2)	20 ppb
Repeatability at zero (1, 2)	+/- 7 ppb
Repeatability at 40% of range (1, 2)	+/- 15 %
Linearity (1, 2)	< 10%
Uncertainty	< 30% (2, 3)
Short term zero drift (1, 2, 4)	< 5 ppb / 24 H
Short term span drift (1, 2, 4)	< 1% FS (5) / 24 H
Long term zero drift (1, 2, 4)	< 10 ppb / 1 month
Long term span drift (1, 2, 4)	< 2% FS (5) / 1 month
Rise time (T10-50) (1, 2)	< 90s (180s if large variation of RH)
Fall time (T10-50) (1, 2)	< 90s (180s if large variation of RH)
Effect of interfering species (1)	Cl_2: around 80% Reduced sulphur compounds : negative interference O_3 : possible interferences if high concentration
Temperature effect on sensitivity (2)	< 0.5 % / °C
Temperature effect on zero (2)	+/- 50 ppb maximum under operating conditions
Maximum exposure	50 ppm
Annual exposure limit (1 hour average)	780 ppm (NO_2)
Annual exposure limit (1 hour average)	180 ppm of oxidant species (O_3 eq.)
Operating conditions	- 20°C to 40°C / 10 to 90% RH non-condensing 1013 mbar +/- 200 mbar
Recommended storage conditions	Temperature: between 5°C and 20°C Air relative humidity: > 15% non-condensing Ambient air free from O_3
Power supply (6)	5 VDC/200 mA (rechargeable by USB via PC or 100 V-240 V/5 V 0.8 A-1.0 A with adapter)
Communication interface	USB, UART Analog (UART & 4-20 mA / 0-5 V converter)
Dimensions	Diameter: 32mm - Length: 62mm
Weight	55g
Protection	IP42 (according IEC60529)
Electrical certification	Intertek 4003892 Conform to UL Std. 61010-1 Certified to CSA Std. C22.2 N°. 61010-1 CE
Parameters Set up / Downloading	CairSoft

[1] According to our operating conditions during tests in laboratory: 20°C +/- 2°C / 50% RH +/- 10% / 1013 mbar +/- 5%
[2] Values possibly affected by exposures to high gradients of concentration
[3] In accordance with the Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe
[4] Full scale continuous exposure
[5] FS = Full Scale
[6] The complete discharge of a device (screen turned off) can lead to a deterioration of its performances
For an optimal quality of use, please keep the Cairclip in a vertical position in accordance with indications on the device

Any use of the sensor not complying with the conditions specified in herein, including exposures, even short ones ,to environments other than ambient air, to dry and / or devoid of oxygen air or other atmosphere not composed in majority of air, even during calibration, will invalidate the warranty.

Main options	CairTub: autonomy 21 days CairNet: wireless communication & battery powered by solar panel Software: CairSoft, CairMap, CairWeb

Office : CAIRPOL
ZAC du Capra
55, avenue Emile Antoine
30340 Méjannes les Alès - France

Tel: +33 (0)4 66 83 37 56
Fax: +33 (0)4 66 61 82 53
info@cairpol.com
Web site: www.cairpol.com

SARL au capital de 354 200€ - N° Siren : 492 976 253

_personal_DataRAM (PDR) Manufacturer's Suggested Specifications

Concentration Measurement Range	0.0001 to 400 mg/m^3
Scattering Coefficient Range	1.5 x 10^{-6} to 0.6 m^{-1} (approx.) @ λ=880 nm
Precision / Repeatability Over 30 Days (2-sigma)	±2% of reading or ±0.005 mg/m^3, whichever is larger, for 1-sec averaging time ±0.5% of reading or ±0.0015 mg/m^3, whichever is larger, for 10-sec averaging time ±0.2% of reading or ±0.0005 mg/m^3, whichever is larger, for 60-sec averaging time
Accuracy	±5% of reading ± precision
Resolution	0.1% of reading or 0.001 mg/m^3, whichever is larger
Particle Size Range of Maximum Response	0.1 to 10 µm
Operating Environment	14 to 122 F (-10 to 50 C), 10 to 95% RH non condensing

Table 4

AirChek 52 Personal Sample Pump Manufacturer's Suggested Specifications

Flow Range	1000 to 3000 ml/min
Flow Control	Holds constant flow to ± 5% of set-point after calibration
Compensation Range	1000 ml/min up to 25 ins water back pressure 2000 ml/min up to 25 ins water back pressure
Temperature	Operating: 32 to 113 F (0 to 45 C)
Humidity	0 to 95% non-condensing
Noise Level	62.5 dBA – pump without case

Table 5

Sensor Performance Goals for Citizen Science Applications

The aim of your project and the intended use of its data will dictate your performance goals. EPA has suggested the following broad application areas, or tiers, for citizen science projects:

- Education and information (Tier I): uses sensors as teaching tools

- Hotspot identification and characterization (Tier II): uses fixed locations and/or mobile sensor systems to map pollutants and determine emission sources
- Supplementary network monitoring (Tier III): uses air sensor systems to complement an existing network of air quality monitors
- Personal exposure monitoring (Tier IV): uses sensors in applications to monitor a person's exposure to air pollution, often to evaluate the impact of air pollution on health
- Regulatory monitoring (Tier V): uses sensors to monitor pollutants to determine if an area is in compliance with the National Ambient Air Quality Standards

Each tier requires progressively more detailed technical considerations and higher data quality expectations. These tiers are listed and briefly described in Table 6. Note that only Tiers I through IV are listed and discussed here as no low-cost sensors, including the CSAM unit, meet the regulatory monitoring requirements. For more information on these tiers and potential air monitoring applications, see EPA's *Air Sensors Guidebook* (http://www.epa.gov/airscience/docs/air-sensor-guidebook.pdf).

Tier	Application Area	Pollutants	Precision and Bias Error	Data Completeness	Rationale
I	Education, information, and community organizing and advocacy	All	< 50%	≥ 50%	Measurement error is not as important as simply demonstrating that the pollutant exists in some wide range of concentration.
II	Hotspot identification and characterization	All	< 30%	≥ 75%	Higher data quality is needed here to ensure that not only does the pollutant of interest exist in the local atmosphere, but also at a concentration that is close to its true value.
III	Supplementary network monitoring	Criteria pollutants and air toxics including VOCs	< 20%	≥ 80%	Supplemental monitoring might have value in potentially providing additional air quality data to complement existing monitors. To be useful in providing such complementary data, it must be of sufficient quality to ensure that the additional information is helping to "fill in" monitoring gaps rather than making the situation less understood.
IV	Personal exposure monitoring	All	< 30%	≥ 80%	Many factors can influence personal exposures to air pollutants. Precision and bias errors suggested here are representative of those reported in the scientific literature under a variety of circumstances. Error rates higher than these make it difficult to understand how, when, and why personal exposures have occurred.

Table 6

CSAM Performance Checks

The CSAM requires several performance checks, conducted by Region 2 technical staff, to make sure the instrument will produce the desired results during the study. It is recommended that these checks be performed before deploying the instrument in the field and after it is removed from the field at the end of the study. If at any time, an operator suspects a CSAM is not functioning properly, it should be removed from operation and returned to Region 2 technical staff.

Table 7 identifies the three recommended checks—zero and span drift for the CSAM-NO_2 and flow rate and zero drift for the CSAM-PM—and the acceptable ranges for accuracy and precision for CSAM applications. This information is being provided to citizen scientists for informational purposes only. Only an experienced operator should perform these procedures before sensors are distributed. Zero and span drift checks verify that the monitor is functioning within the operating range and that it responds with the desired sensitivity to changes in input concentration. The flow rate check verifies the rate at which the sample gas flows through the instrument. The flow rate is checked using a flow meter to ensure that the monitor is receiving the proper amount of air to collect a representative sample.

Measurement (Sensor)	Performance Check	Accuracy	Precision	Corrective Action (by an Experienced Operator)
NO_2 concentration (CSAM-NO_2)	Zero/span drift	± 20%	± 20%	Perform calibration and troubleshooting
PM concentration (CSAM-PM)	Flow rate Zero drift	1.5 L/min ± 10% < 20% of ambient	± 10% ± 10%	Adjust set screw on pump Perform troubleshooting
Temperature/RH (Honeywell sensor)	Compared with local data*	± 5% (temp) ± 10% (RH)	± 2% (temp) ± 5% (RH)	Perform troubleshooting

*The following web sites are sources of local weather data:
http://www.weather.com/weather/hourbyhour/l/USNJ0355:1:US
http://w1.weather.gov/obhistory/KEWR.html

Table 7

Range

Environmental pollutants are often present in very low concentrations, particularly when measurements are being made far from the source of the pollution. The CSAM is most useful when it is able to measure its target pollutants over the full range of concentrations commonly found in the atmosphere. The expected operational range for the CSAM-NO_2 is 20–200 ppb, and for the CSAM-PM it is 0.1–200 $\mu g/m^3$. If you think your CSAM is not functioning properly, return the instrument to EPA Region 2 for assessment.

Calibration

Some sensors come with an “expiration date,” after which its measurements are likely no longer accurate. The expiration date indicates when the device requires *calibration*. Calibration is the process of checking and adjusting an instrument’s measurements to ensure it is reporting accurate data. During the calibration process, the response of the instrument is compared with a known reference value.

The life expectancy of the CSAM is 1 year. After this time, the unit might begin producing unreliable results. The CSAM-NO_2 (CairClip) is delivered calibrated and does not need recalibration for 1 year as long as the sensor maintains the operating conditions listed in its data sheet (Table 3). The CSAM-PM is also delivered calibrated. Remember, however, that the CSAM-PM operates at a flow rate of 1.5 L/min and that a change in the flow rate will change the diameter of the particles being sampled. If you detect a change in the flow rate, return the instrument to EPA Region 2 for a flow rate adjustment.

Service Schedule

Air monitoring devices require careful care and maintenance to ensure proper functionality and reliable performance. The rate that an air monitoring device requires service depends on its power supply (battery) capabilities and the amount of data that can be safely stored before data are overwritten or lost. Once the CSAM is set up and attached to a power source, it is expected to sample continuously until a volunteer operator returns to the site to download data. The CSAM is designed to run for one week (continuously for 7 days) on a fully charged battery. Therefore, an operator should visit the test site at least once a week to download data, inspect the unit's functionality, and replace and/or recharge the battery.

The filter in the CSAM-NO_2 (CairClip) needs to be changed every 4 months if it is regularly exposed to dust (or more frequently if exposed to large quantities of dust). The filter should be changed only by an experienced operator, as described in the CSAM Operating Procedure.

Documents and Records

Each activity associated with a monitoring project influences the value of the project's results. Therefore, it is important to maintain thorough documentation in order to use the results to make meaningful technical interpretations and judgments. This project requires experienced operators to carry out certain project activities, such as conducting performance checks at the beginning and end of the study, while other activities, such as field site visits and data downloads, will be performed by citizen volunteer operators. All project participants are responsible for carefully documenting their activities throughout the study.

Briefly described here are the types of records you should keep to ensure your project is well documented. These suggestions and examples provide a starting point for record keeping, but your project team should determine the documentation requirements for the project as an integral part of the planning process. Developing a quality assurance project plan, or QAPP, is recommended during the planning stages. A QAPP provides a "blueprint" for conducting and documenting a study that produces quality results. EPA Region 2's Citizen Science web page (http://www.epa.gov/region2/citizenscience) provides helpful information and a template for developing a Citizen Science QAPP.

At a minimum, you should consider the following documentation as crucial to producing meaningful results:

- A Microsoft Excel spreadsheet created specifically for processing the CSAM data is included in the Citizen Science Toolbox for this project. Data collected by both experienced operators and citizen volunteers should be entered in this spreadsheet. The CSAM Operating Procedure details how to use the spreadsheet to enter data for both performance checks and routine field data collection.
- Performance-check activities should be recorded in a bound notebook by the experienced operator performing the check. All notebook entries should be made in black, permanent ink and initialed and dated by the person making the entry. Changes or corrections to data should be indicated with a single line through the original entry so that the original entry remains legible. All changes should be explained, dated, and initialed. In addition, all performance-check information, both pre- and post-test, should be provided to the citizen scientists so they can enter that information in the sampling log sheet, as shown in the example in Table 8.
- Field data collection records for each CSAM unit and site should be kept in a bound notebook as for the performance checks and entered on a prepared sampling log sheet stored in a loose-leaf binder. The example log sheet shown in Figure 5 can be used or modified as needed for your project. The experienced operator will provide the pre- and post-test information for instrument performance and this information will be a part of the macro that is provided with each CSAM unit.
- All equipment maintenance and calibration forms should be kept in a project file by the project leader until the end of the project or a date determined during project planning.

All hard-copy and electronic files of project data and documents should be maintained by the project leader. Records stored or generated by computers should have hard-copy or write-protected electronic backup copies. The project leader is responsible for making sure each project participant has the most current versions of any pertinent documents they need to carry out their assigned tasks, such as these quality assurance guidelines and the operating procedure.

Table 8

CSAM Monitoring Record

CSAM unit #: ____________ Date: ____________ Data recorded by: ____

Test location (description): ____

Fresh batteries installed? Yes ☐ No ☐

If yes, date: ____________

Data logging interval: _______ min Operation mode: AC power ☐ Battery ☐

Start date: ____________ End date: ____________

Start time: ____________ End time: ____________

Total run time: ___________ hours

Pre-test Instrument Setup

$PM_{2.5}$ zero check	Performed by: ________________________	Date: ____________
$PM_{2.5}$ flow rate check	Performed by: ________________________	Date: ____________
NO_2 zero and span check	Performed by: ________________________	Date: ____________

Post-test Instrument Operations

Data downloaded Yes ☐ No ☐ File name: ______________________________________

Performed by: ____ Date: _____________

Comments

For Additional Help

CairPol, Technical Data Sheet CairClip NO_2, http://www.cairpol.com/images/pdf/NO2/technical%20datasheet%20no2%2015072013.pdf, last accessed October 30, 2014.

Thermo Scientific Personal DataRAM pDR-1000AN Monitor brochure, http://www.thermoscientific.com/en/product/personal-dataram-pdr-1000an-monitor.html, last accessed October 30, 2014.

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