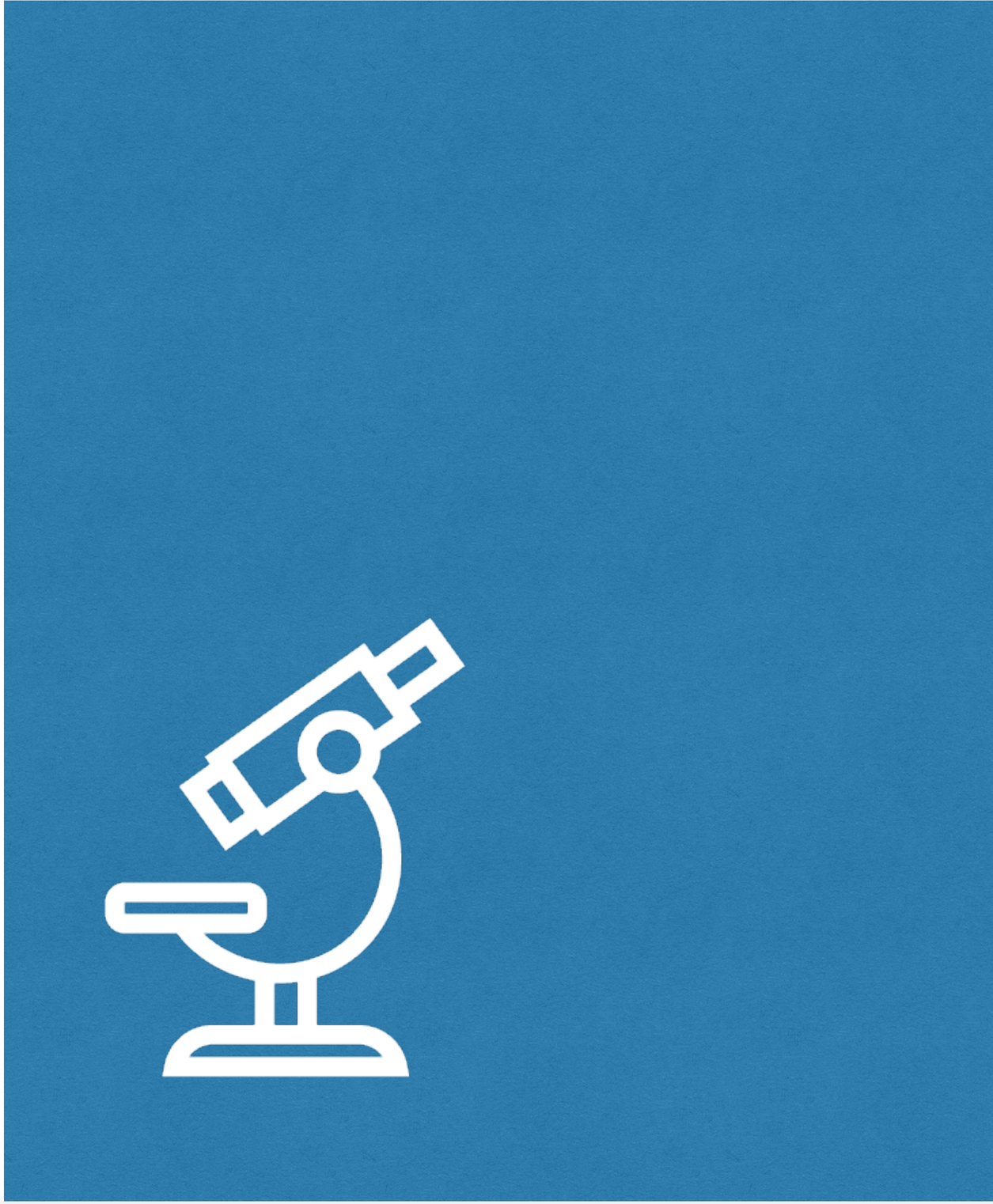
Air

TEST PROCEDURE

FOR
ACCREDITED MONITORS v2.0



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2.7.0 Preface

The **RESET™ Air Test Procedure for Accredited Monitors** specifies the test methodology and protocols in order to achieve the **RESET™ Air Standard for Accredited Monitors** (Section 2.6) accreditation.

The intent of the **RESET™ Air Test Procedure for Accredited Monitors** is to:

- Evaluate monitor quality via a singular, standardized test protocol
- Standardization of the test methodologies and protocols as outlined, ensuring consistent replicability in laboratories, irrespective of geographic location.*

To accomplish the above, **RESET™ Air Test Procedure for Accredited Monitors** specifies the monitor test requirements, test environment setup, and the protocols required for the individual testing of the following air quality parameters:

- Particulate Matter 2.5 ($PM_{2.5}$)
- Total Volatiles Organic Compounds (TVOC)
- Carbon Dioxide (CO_2)
- Temperature
- Humidity

*At the time of publication, the **RESET™ Air Test Procedure for Accredited Monitors**, lacked sufficient consensus information regarding unilaterally-accepted laboratory test protocols and/or test methodologies. While the intent as stated remains, additional information is required in order to realize laboratory consistency and replicability.

2.7.0 Preface

Disclaimers

- **RESET™ Air Test Procedure for Accredited Monitors** applies to Grade B monitors only. The test procedure for Grade A monitors is under development.
- The **RESET™ Air Test Procedure for Accredited Monitors** will be revised and further developed as more information becomes available.

2.7.1 Approach

In order to be qualified as a **RESET™ Air Accredited Monitor** (Section 2.6), the monitor is evaluated on a parameter-by-parameter basis, where *parameters* refers to individual air pollutants, and accreditation is assigned accordingly.

An air quality monitor is deemed a **RESET™ Air Accredited Monitor** if it can demonstrate adherence to the **Basic Requirements** as outlined in the **RESET™ Air Standard for Accredited Monitors** (Section 2.6) and is able to meet the requirements of at least one of the five air quality parameters as outlined in the **RESET™ Air Building Standard's** (Section 2.2 or 2.4).

The testing approach consists of two parts:

1. **Documentation Specification**
   Review the specifications written for the air quality monitor being submitted.

2. **Intra-model Variability and Accuracy***
   Intra-model variability evaluates how monitors of the same model/SKU perform against one another. This includes comparison of monitor data over a range of exposure levels in order to assess sensor consistency.

   * Accuracy is defined as the proximity of data between the reference monitor and the monitor being evaluated.

2.7.1 Approach

1. **Documentation Specification**

a. **Sensor Information**
Verify the details of the monitor relative to the monitor specifications, including:

i. Confirmation that the sensor(s) in question is/are currently available.
i.e. Utilizing a CO_2 sensor for the detection/measurement of CO is not permitted.

ii. Confirm that all sensors as described in accompanying specifications/documentation are indeed those employed in the monitoring device.
i.e. If it is stated that the $PM_{2.5}$ sensor employs light-scatter technology, then the $PM_{2.5}$ sensor should not be an infrared sensor.

iii. Confirmation that data resolution and data range (of the data that is measured and displayed) are as described in the sensor's accompanying specifications.

2.7.1 Approach

1. **Documentation Specification**

b. **Basic Requirements**
Tests will be performed to verify that the monitor meets the basic requirements as outlined in the **RESET™ Air Standard for Accredited Monitors** (Section 2.6)

i. Can interface with a **RESET™ Air Accredited Data Provider** (Section 2.8)
ii. Data Resolution
iii. Data Loss
iv. Operating Range for Temperature
v. Operating Range for Humidity
vi. Installation Options
vii. Calibration Report

2.7.1 Approach

2. **Intra-model Variability and Accuracy**
   Of the monitors seeking accreditation, a minimum of five are required to be placed in a test environment where a reference monitor has also been placed. Each monitor, including the reference monitor, must be within close proximity of one another.

   Monitors seeking accreditation are required to be subject to low, medium, and high concentrations for each parameter. Reference gases will be used to simulate concentration.

   More information on reference gases and reference monitors are available in **Laboratory Preparation** (Section 2.7.2).

a. **Intra-model variability**
   Monitors seeking accreditation will be subject to a range of varying concentrations of pollutants for the purposes of evaluating intra-model variability in trend consistency and differences in y-intercepts between the monitors being tested.

b. **Accuracy**
   The data collected from the reference monitor will be used to determine the accuracy of the monitors being tested via comparison. Refer to the **RESET™ Air Standard for Accredited Monitors** (Section 2.6) for accuracy requirements.

2.7.2 Laboratory Preparation

RESET™ Air Accredited Monitors (Section 2.6) must be evaluated in an appropriately prepped test environment; a test laboratory, inclusive of all equipment and accessories necessary to properly execute the tests as outlined. Laboratory preparation includes careful consideration and inclusion of:

1. **Reference Monitors**
   devices or monitors used for comparison purposes against the air quality monitor(s) being tested.

2. **Reference Sources**
   the Particulate Matter 2.5 ($PM_{2.5}$), Total Volatiles Organic Compounds (TVOC), and Carbon Dioxide (CO_2) sources being used to test the air quality monitors at low, medium, and high concentrations.

3. **Test Chamber**
   the space in which the monitors are tested. Requirements for the test chamber include chamber size, air tightness, and connectivity.

2.7.2 Laboratory Preparation

1. **Reference Monitors**

A reference monitor is required in order to establish a base line for each of the following air parameters:

a. **Particulate Matter 2.5 ($PM_{2.5}$)**
The TSI DustTrak II Aerosol Monitor 8530.

b. **Total Volatile Organic Compound (TVOC)**
The TSI Q-Trak 5757 with TSI IAQ Probe 986.

c. **Carbon Dioxide (CO_2)**
The TSI Q-Trak 5757 with TSI IAQ Probe 986.

d. **Temperature**
The TSI Q-Trak 5757 with TSI IAQ Probe 986.

e. **Humidity**
The TSI Q-Trak 5757 with TSI IAQ Probe 986.

2.7.2 Laboratory Preparation

2. **Reference Sources**

Reference sources are required for each of the following air parameters:

a. **Particulate Matter 2.5 ($PM_{2.5}$)**
   1. Particulates from outdoor air (if available)
   2. Cigarettes
   3. Mosquito Coils

b. **Total Volatile Organic Compound (TVOC)**
   1. Wet Paint
   2. Ethanol

c. **Carbon Dioxide (CO_2)**
   CO_2 is to be utilized as the reference source. CO_2 is to be generated with sodium bicarbonate and acetic acid.

d. **Temperature**
   Temperature; to be adjusted and controlled in-chamber.

e. **Humidity**
   Humidity; to be adjusted and controlled in-chamber with a humidifier.

2.7.2 Laboratory Preparation

3. **Testing Chamber**

a. **Chamber Size**
The test chamber must be sized appropriately. It must accommodate both a reference monitor and at minimum, five of the monitors being evaluated.

b. **Airtightness**
It is recommended that the test chamber have the capability of air tightness to 0.05 ACH. Airtightness will allow for a more stable environment once sources have been added to the chamber.

c. **Air Mixing**
The chamber must be appropriately designed for air mixing.

2.7.3 Testing Pre-requisites

Prior to commencing the monitor test, a preliminary review of the air monitor specification sheet is required.

The air monitor specification sheet must include specifications for all parameters seeking accreditation as outlined in the **RESET™ Air Standard for Accredited Monitor** (Section 2.6), including information on all sensors employed in the device.

In addition, the air monitor specification must acknowledge the following requirements found in **Basic Requirements** from **RESET™ Air Standard for Accredited Monitor** (Section 2.6.2):

a. Can interface with a **RESET™ Air Accredited Data Provider** (Section 2.8)
b. Data Resolution
c. Data Loss
d. Operating Range for Temperature
e. Operating Range for Humidity
f. Installation Options
g. Calibration Report

The **RESET™ Air Test Procedure for Accredited Monitors** will verify all of the points listed above before testing begins. If a monitor's specifications does not fulfill the requirements in the **RESET™ Air Standard for Accredited Monitor** (Section 2.6), then it is not valid for testing.

2.7.4 Testing Procedure

The testing procedure describes how the testing is done for **RESET™ Air Standard for Accredited Monitors** (Section 2.6).

This section consists of the following:

1. Preparation
2. Testing Process
3. Testing Thresholds for Grade A (Reference Only)
4. Testing Thresholds for Grade B

2.7.4.1 Preparation

Set Up

a. Ensure all monitors are physically undamaged and in proper working order.
b. Place all monitors and the reference monitor into the test chamber.
c. Arrange the monitors in the test chamber, positioning them in such a way as to avoid directing a monitor's output fan towards an adjacent monitor's input fan. Failing to properly position all monitors can adversely effect and/or influence test results.
d. Attach all accessories to the monitors according to manufacturer's instructions. (Accessories may include, but are not exhaustive of: power cables (correct voltage); regulated power supplies.)
e. Confirm that all the monitors are connected to a data provider and pushing data properly.

Documentation Specification Check

f. Confirm all air parameters exist in the data collected
g. Confirm data resolution
h. Confirm data loss. Full evaluation of data loss will occur after the completion of the chamber test.
i. Confirm Operating Range for Temperature. Full evaluation will occur after the completion of the chamber test.
j. Confirm Operating Range for Humidity. Full evaluation will occur after the completion of the chamber test.

2.7.4.2 Test Process

The monitor test period consists of 14-days of continuous operation. 14-days of continuous operation for testing purposes is designed to be representative of how the monitor(s) is/are expected to perform when deployed for longer periods of time.

For Particulate Matter 2.5 ($PM_{2.5}$), Total Volatiles Organic Compounds (TVOC), and Carbon Dioxide (CO_2), testing is to be performed under conditions of 25 °C and 50% RH.

During the 14-days continuous test period, different pollutant sources will be introduced into the test chamber. The pollutant sources are required to generate pollutant levels reaching concentration levels of low, medium, high, and peak levels (if available) for each parameter being tested according to the reference monitor. Concentration levels can be found in **Testing Thresholds for Grade A** (Section 2.7.4.3) and **Testing Thresholds for Grade B** (Section 2.7.4.4).

2.7.4.3 Test Thresholds for Grade A Monitors (in progress)

Prospective test requirements for Grade A monitors are outlined below. The test procedure for Grade A monitors is under development.

The table below is for reference only.

	$PM_{2.5}$	TVOC	CO_2	Temperature	Humidity
Low	15 µg/m³	0.05 mg/m³	400 ppm	0 °C	15 %RH
Medium	60 µg/m³	0.5 mg/m³	1000 ppm	20 °C	50 %RH
High	125 µg/m³	1 mg/m³	3000 ppm	40 °C	90 %RH
Peak	450 µg/m³	2 mg/m³	N/A	N/A	N/A

2.7.4.4 Test Thresholds for Grade B Monitors

Test requirements for Grade B monitors are outlined below. During the 14-day continuous test period, the reference monitor must hit all thresholds as outlined by the table below for all parameters.

	$PM_{2.5}$	TVOC	CO_2	Temperature	Humidity
Low	15 µg/m³	0.15 mg/m³	400 ppm	0 °C	20 %RH
Medium	60 µg/m³	0.5 mg/m³	1000 ppm	20 °C	50 %RH
High	125 µg/m³	1 mg/m³	3000 ppm	40 °C	80 %RH
Peak	250 µg/m³	2 mg/m³	N/A	N/A	N/A

2.7.5 Results and Analysis

Upon completion of the 14-day test period and all associated evaluations as outlined in the **RESET™ Air Test Procedure for Accredited Monitor**, all test data results will be organized and analyzed in accordance with the performance criteria as outlined in the **RESET™ Air Standard for Accredited Monitors** (Section 2.6).

Analysis will be performed for each parameter individually.

a. **Graphing and Data Tables**
   Test data results will be exported into a graph and data table. Final numbers used will be based on 30 minute averages of the data.

b. **Monitors exceeding data loss**
   If a test monitor exceeds the permissible allowance for data loss, it will constitute test failure. Refer to **Basic Requirements** (Section 2.6.2) for permissible data loss threshold(s).

2.7.5 Results and Analysis

c. **Trend consistency**
Compare the test data results for each parameter, as collected from all five of the test monitors, against the data results as collected from the reference monitor. Determine if there is a common trend line between the test monitors and the reference monitor. A pass for the trend consistency requires demonstration of a common trend line between the test monitors and the reference monitor.

d. **Trend accuracy**
Determine trend accuracy of the five monitors being tested by comparing the data points as reported by each monitor against the data points as reported by the reference monitor. If the data points are within the accuracy requirements as stated in **RESET™ Air Standard for Accredited Monitors** (Section 2.6), this constitutes passing the trend accuracy requirement.

In the event that any one of, or all of the monitors being evaluated fail to meet the accuracy performance criteria, but are consistent with respect to trend consistency, monitors are permitted to be resubmitted for testing within 3 months of issuing the formal laboratory test results.

End of RESET™ Air TEST PROCEDURE
for Accredited Monitors