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# Environmental Technology Verification Test Protocol

## General Ventilation Filters

Prepared by

Research Triangle Institute

Under a Cooperative Agreement with

U.S. Environmental Protection Agency

ETV ETV ETV

## Notice

This document has been subjected to the U.S. Environmental Protection Agency's quality assurance and administrative reviews and has been approved for publication.

The EPA, through its Office of Research and Development (ORD), partially funded and managed the extramural research described here under Cooperative Agreement No. CR 822870.

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## Foreword

The Environmental Technology Verification Test Protocol, General Ventilation Filters provides guidance for verification tests. This work was conducted under Cooperative Agreement No. CR 822870 with the U. S. Environmental Protection Agency.

Reference is made in the protocol to the ASHRAE 52.2P "Method of Testing General Ventilation Air-cleaning Devices for Removal Efficiency by Particle Size" Fourth Composite Working Draft issued in May 1998. The ASHRAE 52.2P document was issued solely for the purpose of soliciting review comments and is **not** a standard. As a result, ASHRAE 52.2P is not currently available from ASHRAE. However certain test specifications such as particle size distribution parameters and quality assurance requirements from ASHRAE 52.2P are used in this protocol with attribution and appropriate caveats. The reason for this approach is that it is believed that the ASHRAE 52.2P standard will likely not be substantially modified in these fundamental areas before being issued in 1999. It is important to support our industrial stakeholders by ensuring that the data developed under the ETV program will be consistent with eventual commercial practice. This approach has been implemented with approval by ASHRAE.

There are two technical points of exception between this ETV test protocol and the ASHRAE 52.2P method:

a) The first dust loading step in ASHRAE 52.2P or "conditioning step" has been the subject of review and research during the last 6 months. In particular, it was found that ASHRAE loading dust appeared to enhance the performance of certain kinds of media filters over that experienced when filtering ambient or indoor particulate matter. As a result the first loading step has been modified to use a submicrometer aerosol for conditioning.

b) The "Minimum Efficiency Reporting Value" (MERV) is unique to ASHRAE 52.2P and for that reason it is inappropriate to include this reporting method in the protocol. The protocol will not include the MERV but information will be available in the verification report to calculate this result if desired.

## TABLE OF CONTENTS

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## 1 SCOPE

1.1 This test protocol covers the determination of the fractional efficiency of in-duct ventilation filters. The protocol is not applicable to portable room air cleaners.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for informational purposes only.

## 2 REFERENCED DOCUMENTS

2.1 FEDERAL DOCUMENTS

- U.S. EPA, *Environmental Technology Verification Program: Quality and Management Plan for the Pilot Period (1995-2000)*, EPA/600/R-98/064, NRMRL/NERL/ORD, Cincinnati, OH, May 1998. This is available on the EPA website at http://www.epa.gov/etv/.
- U.S. EPA, *EPA Requirements for Quality Management Plans*, EPA QA/R-2. Draft interim final, Region 6, Dallas, TX, August 1994.
- U.S. EPA, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5. Draft, Region 6, Dallas, TX, October 1997.
- U.S. EPA, *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5. EPA/600/R-98/018, ORD, Washington, DC, February 1998.

(Unless otherwise noted, copies are available on the EPA Web site at http://es.epa.gov/ncerqa/qa/qa_docs.html.)

2.2 NON-FEDERAL DOCUMENTS

- Research Triangle Institute, *Environmental Technology Verification Test Method for General Ventilation Filters*, RTI, RTP, NC. 1999. (http://etv.rti.org/iap/filter/index.cfm)

(Copies of the test method may also be ordered from RTI, PO Box 12194, RTP, NC 27709-2194. )

- ANSI/ASQC. *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Program*; ANSI/ASQC E4. American Society for Quality Control, Milwaukee, WI, 1994.
- ANSI/ASQC. *Quality Systems—Model for Quality Assurance in Designing, Development, Protection, Installing and Servicing*; ANSI/ASQC Q9001-1994, American Society for Quality Control, Milwaukee, WI, 1994. This is the most recent U.S. version of the International Organization for Standards ISO 9001 standard.

(Copies may be ordered from the American Society for Quality Control, 611 E. Wisconsin Ave., PO Box 3005, Milwaukee, WI 53201-3005, USA, Tel: 414-272-8575.)

# 3 TERMINOLOGY

## 3.1 DEFINITIONS

Definitions from RTI *Environmental Technology Verification Test Method for General Ventilation Filters*, Section 4 (cited above).

## 3.2 ACRONYMS

| | |
|---|---|
| ANSI | American National Standards Institute |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| ASQC | American Society for Quality Control |
| EPA | U.S. Environmental Protection Agency |
| ETV | Environmental Technology Verification |
| QA | Quality Assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| QMP | Quality Management Plan |
| RTI | Research Triangle Institute |
| SOP | Standard Operating Procedure |

# 4 SUMMARY OF PRACTICE

The test duct operates under positive pressure to minimize infiltration of room aerosol. Aerosol injection is located upstream of a mixing baffle to provide aerosol mixing with the airstream. Aerosol concentration is measured both upstream and downstream of the test section to obtain the challenge and penetrating aerosol concentrations, respectively. The test duct is designed to allow the use of a single set of aerosol instrumentation to perform both the upstream and downstream aerosol concentration measurements with a minimum of particle losses.

# 5 SIGNIFICANCE AND USE

A fractional filtration efficiency test is needed for several reasons. First, there is a growing concern with indoor air quality. Second, there is a growing concern with the possible health effects of respirable particles, generally classified as those smaller than 10 µm in diameter, especially those smaller than 2.5 µm. Third, filtration efficiency is often highly dependent on particle size for particles smaller than 10 µm in diameter. Finally, standard filtration efficiency tests fail to differentiate performance as a function of particle size.

The test method provides a more realistic assessment of filter performance than measuring efficiency using particles of a single size or weight arrestance tests.

## 6 SAMPLING

Test samples (filters) shall be randomly selected from commercial stock available "off-the-shelf."

## 7 NUMBER OF TESTS AND RETESTS

One filter is sufficient to obtain a single, adequate set of test results for all properties to be measured. Retesting is permitted only if the measured qualification parameters of the test fall outside limits prescribed in the RTI *Environmental Technology Verification Test Method for General Ventilation Filters*.

## 8 SPECIMEN CONDITIONING

The conditioning step has been added for the ETV program. The conditioning step shall be as specified in the RTI *Environmental Technology Verification Test Method for General Ventilation Filters*, Section 8.

## 9 TEST APPARATUS

The test apparatus shall be as specified in the RTI *Environmental Technology Verification Test Method for General Ventilation Filters*, Section 5.

The test apparatus shall meet qualification tests specified in the RTI *Environmental Technology Verification Test Method for General Ventilation Filters*, Section 6.

## 10 TEST METHOD

The test method shall be as specified in the RTI *Environmental Technology Verification Test Method for General Ventilation Filters*, Section 7.

## 11 QUALITY MANAGEMENT/QUALITY ASSURANCE

### 11.1 QUALITY MANAGEMENT

11.1.1 As part of the ETV program, EPA has developed a quality management plan (QMP) for EPA and the verification partners. This document follows the ANSI/ASQC E4 guidelines. The ETV Indoor Air Pilot program is being operated under RTI's Environmental Sciences and Engineering Quality System, which also follows the ANSI/ASQC E4 guidelines.

11.1.2 It is expected that all laboratories participating in this program will meet the QA/QC requirements defined below and have an adequate system to manage the quality of work performed. Documentation and records management must be performed in accordance with the EPA ETV QMP. Laboratories must also perform assessments and allow audits by RTI and EPA corresponding to those specified in the EPA ETV QMP.

### 11.2 QUALITY ASSURANCE

11.2.1 For testing conducted as part of this ETV program, an EPA Quality Assurance Project Plan (QAPP) must be prepared. Elements of the plan are described in *EPA Requirements for Quality Assurance Project Plans*. The QAPP will address all aspects of the measurement

program from selection and acquisition of filters to final review and data reporting. Important elements of the QAPP include:

11.2.1.1 Test Method and Description

A brief description of the test program shall include objectives, identification of the filters to be tested, and how the testing is to be conducted. The test conditions should be described, including the test temperature, air exchange rate, and material loading; sample collection schedule, procedures, equipment, and materials; and analytical system procedures and equipment.

11.2.1.2 Project Organization and Description

A project organizational chart shall be provided that designates a Project Leader, a Sample Custodian, an Analysis Supervisor, and a QA Officer. The QA Officer should be independent of the technical effort of the project to avoid real or perceived conflicts of interest. The responsibility of all individuals should be defined.

11.2.1.3 Data Quality Indicator Goals/Acceptance Criteria

The QA/QC plan shall include data quality objectives and acceptance criteria. Data quality objectives shall be established for the following parameters prior to beginning the testing program:

- Time and Environmental Conditions for Product Acquisition, Packaging, Shipping, and Storage. Limits for the elapsed time from sample packaging to testing under an acceptable range of specified environmental conditions.
- Test Duct Conditions and Test Results. Precision, accuracy, and completeness limits, as set forth in the RTI *Environmental Technology Verification Test Method for General Ventilation Filters*, Section 6, shall be met for the following parameters:
  — Air velocity uniformity in the test duct,
  — Aerosol uniformity in the test duct,
  — Downstream mixing of aerosol,
  — Overload tests of the particle counter,
  — 100% efficiency test,
  — Correlation ratio,
  — Aerosol generator response time, and
  — Duct leakage test.
- Record Keeping and Logs. Various logging requirements shall be implemented for all test parameters including chamber and analytical performance. Additionally, personnel conducting each procedure should be identified. Records of the devices used, date and time of tests, and the test results should be part of the QA/QC recording process. The completeness of records indicates the care and attention given the QC process.

- Sample Management and Custody. Procedures for labeling and tracking product samples, as well as chamber air samples, shall be described. Chain of custody documents shall be used to document all product and sample transfers and operations. A Sample Custodian shall be designated.

11.2.1.4 Internal Performance and System Audits

All major components of the test shall be audited at least once, by the QA Officer. These may include but not be limited to the preparation of samples, laboratory systems, analytical measurement systems, data entry, and processing.

11.2.1.5 Corrective Action

The need for corrective action may be identified through reviews, internal QC checks, audits, or observations made during routine sampling and analysis activities by project staff. All corrective actions will be documented. No further work may be performed until the problem has been satisfactorily resolved, and the QA Officer has acknowledged approval.

11.2.1.6 Quality Assurance Reporting

All data reported on this project shall be accompanied by the applicable QA/QC data, including the results of internal QC checks, audit results, and any necessary corrective actions. The QA Officer will maintain current records of all QA/QC activities.

11.3 STANDARD OPERATING PROCEDURES

11.3.1 The laboratory shall prepare Standard Operating Procedures (SOPs) for all aspects of the analytical procedures. The SOPs should be specific and readily available to those involved in the analysis and testing. A copy of the method shall be retained in the laboratory. The SOPs should address:

- Assembly, calibration, and operation of the sampling system;
- Description and operation of the instrumentation systems including the sampling device, sample introduction system, and data system; and
- All aspects of data recording and processing.

## 12 REPORTING

The report shall consist of:

- Title Page
- Abstract
- Abbreviations and Acronyms (if necessary)
- Description of Technology
- Description of Test Method

- Data Quality Objectives
  - — Precision
  - — Accuracy
  - — Representativeness
  - — Completeness
  - — Comparability
- Raw Data
  - — Upstream particle count
  - — Downstream particle count
  - — Upstream particle count, background
  - — Downstream particle count, background
- Calculated data
  - — Observed penetration
  - — Corrected penetration
  - — Sample standard deviation
  - — Coefficient of variation
- Reported data
  - — Testing date and location
  - — Physical description of filter
  - — Filtration efficiency curves from each test and their averages
  - — Tabulated efficiency data
  - — Efficiencies at particle sizes
  - — Results of control tests
  - — Raw upstream/downstream particle counts
  - — Pressure drop across the filter