



National Institute for Occupational Safety and Health  
 National Personal Protective Technology Laboratory  
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Procedure No. RCT-APR-STP-0057, 0058, 0059	Revision: 1.1	Date: 24 August 2005
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DETERMINATION OF PARTICULATE FILTER PENETRATION  
 TO TEST AGAINST SOLID PARTICULATES FOR NEGATIVE PRESSURE,  
 AIR-PURIFYING RESPIRATORS  
 STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

- 1.1. This test establishes the procedure for ensuring that the level of protection provided by the particulate filter penetration to test negative pressure respirators against solid particulate requirements on N100, N99, and N95 filters and filter cartridges designed for negative pressure, air-purifying respirators submitted for Approval, Extension of Approval, or examined during Certified Product Audits meet the minimum certification standards set forth in 42 CFR, Part 84, Subpart G, Section 84.63(a)(c)(d); Volume 60, Number 110, June 8, 1995.
- 1.2. These filters and filter cartridges may be integral components; mounted individually; used in conjunction with cartridges and canisters for chin-style, front-mounted, and back-mounted gas masks; or used in combination with gas-and-vapor or supplied-air respirators.

2. GENERAL

This STP describes the Determination of Particulate Filter Penetration Procedure to Test Against Solid Particulates For Negative Pressure, Air-Purifying Respirators test in sufficient detail that a person knowledgeable in the appropriate technical field can conduct the test and determine whether or not the product passes the test.

3. EQUIPMENT/MATERIAL

- 3.1. The list of necessary test equipment and materials follows:



- 3.1.1. TSI Model 8130 Automated Filter Tester or equivalent instrument with a forward

Approvals:	1 <sup>st</sup> Level	2 <sup>nd</sup> Level	3 <sup>rd</sup> Level

light scattering detector.



3.1.2.

Particle sizing instrument (such as a Scanning or Differential Mobility Particle Sizer) capable of determining submicron particles according to count median diameter (CMD).



3.1.3.

Microbalance accurate to 0.0001 grams (g).



3.1.4.

Gelman 102 mm, type A/E glass filters or equivalent high efficiency filters with a 1 micron pore size.



3.1.5.

Timer (accurate to 0.01 second).

- 3.1.6. 2% Sodium Chloride solution in distilled water (NaCl) .



- 3.1.7. Temperature and humidity chamber capable of maintaining  $38 \pm 2^{\circ}\text{C}$  and  $85 \pm 5\%$  relative humidity.

- 3.1.8. Respirator filter holder for specific manufacturer type which is compatible with TSI filter tester. NIOSH will not be obligated to use these holders for actual certification testing.

- 3.1.9. Optional data acquisition system.

#### 4. TESTING REQUIREMENTS AND CONDITIONS

- 4.1. Prior to beginning any testing, all measuring equipment to be used must have been calibrated in accordance with the manufacturer's calibration procedure and schedule. At a minimum, all measuring equipment utilized for this testing must have been calibrated within the preceding 12 months using a method traceable to the National Institute of Standards and Technology (NIST).
- 4.2. Normal laboratory safety practices must be observed. This includes safety precautions described in the current ALOSH Facility Laboratory Safety Manual.
- 4.2.1. Safety glasses, lab coats, and hard-toe shoes must be worn at all times.
- 4.2.2. Workbenches must be maintained free of clutter and non-essential test equipment.
- 4.2.3. When handling any glass laboratory equipment, lab technicians and personnel must wear special gloves which protect against lacerations or punctures.

#### 5. PROCEDURE

Note: Reference Section 3 for equipment, model numbers and manufacturers. For calibration purposes use those described in the manufacturer's operation and maintenance manuals.

5.1. Respirator filters and filter cartridges will be tested as follows:

5.1.1. The filtering elements of the respirator, including the filter holders and gaskets will be tested for particle penetration.

5.1.2. When filters are not separable from the respirator body, the exhalation valves will be sealed to ensure that any leakage due to the exhalation valve is not included in the filter penetration measurement.

5.1.3. Filters used in conjunction with gas mask canisters and odd or unusually shaped filters may be tested on a headform assembly or assembly provided by manufacturer.

5.2. Respirator filters will be challenged by a NaCl aerosol at  $25 \pm 5^\circ\text{C}$  and a relative humidity of  $30 \pm 10\%$ . The particle size distribution will be a count median diameter of  $0.075 \pm 0.020$  micrometers and a geometric standard deviation not exceeding 1.86. Each respirator filter unit will be challenged with an aerosol concentration not exceeding  $200 \text{ mg/m}^3$ .

5.2.1 The following procedure will be routinely employed to insure that the NaCl particle size distribution will be a count median diameter of  $0.075 \pm 0.020$  micrometers with a geometric standard deviation of less than 1.86. A standard filter instantaneous penetration will be determined using DOP and NaCl aerosols. Initial penetration values with the sodium chloride aerosol will be correlated to the DOP penetration results. The standard filter test will be run routinely during NaCl testing (at least twice during each 8 to 10 hour test period) to verify that the NaCl aerosol characteristics are optimized and have not changed.

5.2.2. If the instantaneous filter penetration changed, abort testing and add 100 mL of distilled water to the NaCl generator. Run another standard filter; if the results are acceptable continue running tests. If the results are not acceptable, check the aerosol particle size.

5.3. Respirator filters will be pre-conditioned at  $85 \pm 5\%$  relative humidity and  $38 \pm 2.5^\circ\text{C}$  for  $25 \pm 1$  hour. After conditioning, the filters shall be sealed in a gas tight container and tested within 10 hours.

5.3.1 Filters will be mounted and sealed on holders to prevent leakage around the filter holder. Single air purifying respirator filters will be tested at a challenge flow rate of  $85 \text{ Lpm} \pm 5\%$ . Filters used as a pair on respirators will be tested using a single filter of the pair at  $42.5 \text{ Lpm} \pm 5\%$  challenge flowrate.

- 5.3.2. The challenge flow rate must be checked for stability for at least 30 seconds prior to testing.
- 5.4. A sample of 20 filters will be tested against the NaCl solid aerosol. Three filters will be loaded to 200 mg and evaluated to determine the method for the remaining 17 filters.
- 5.4.1. Type 1. If preliminary testing of all three initial test filters consistently results in a straight line (Figure 1), for the remaining 17 filters, record the initial penetration reading.
- 5.4.2. Type 2. If filter testing of all three initial test filters consistently results in increased efficiency during the complete run (Figure 1), for the remaining 17 filters, record the initial penetration reading.
- 5.4.3. Type 3. If filter testing of all three initial test filters consistently results in a curve which indicates degradation over time (Figure 1), load the remaining 17 filters with NaCl and record the maximum penetration reading. When testing a single filter, preload the filter with  $200 \pm 5$  mg NaCl.
- 5.4.4. Type 4. If filter testing of all three initial test filters consistently results in increased efficiency (see Type 2), then a decrease in efficiency (see Type 3), and then flattens out during the remainder of the complete run (see Type 1), for the remaining 17 filters, record the maximum penetration reading after reaching and maintaining a flat line for a period of 20 minutes following the decrease segment in efficiency.
- 5.4.5. For any other filter type, determine loading at which maximum penetration consistently occurs and test at that loading value for the remaining 17 filters.
- 5.4.6. If any one of the 20 filters has a penetration greater than the designated limit, further testing of that filter will be terminated. Any filter that exceeds the specified limit shall be remounted and retested to ensure that leakage was not caused by a faulty mounting or leak. If retesting eliminates the excessive leakage, that sample will be considered an invalid sample.
- 5.5. The NaCl aerosol concentration will be determined daily by the following gravimetric method and calculated as milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ).
- 5.5.1. Weigh a Gelman 102 mm filter to the nearest 0.0001 g, mount in the gravimetric filter holder, subject it to the generated aerosol, and reweigh the filter. Use a timer to monitor the duration of the test. Record the pre- and post-weights, time, and average flow rate on the Filter Penetration Test Data Sheet (Figure 2) and calculate the aerosol concentration in  $\text{mg}/\text{m}^3$ . The weight change should be a significant value over the pre-weight.

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5.5.2. The NaCl aerosol concentration can be monitored by a calibrated photometer placed in line on the mixing chamber exhaust.

5.6. The NaCl particle size will be monitored routinely with an appropriate particle sizing instrument to ensure the particle size distribution count median diameter remains in the range of  $0.075 \pm 0.020$  micrometers with a geometric standard deviation of not more than 1.86.

5.7. The penetration of the first three filters will be measured, recorded, and printed at approximately 1 minute intervals during the test period. The highest penetration observed throughout the test of each filter will be recorded as the maximum penetration of that filter. An optional data acquisition system can be used for data collection and evaluation.

5.8. Determine and record the maximum filter penetration for each of the 20 filters.

## 6. PASS/FAIL CRITERIA

6.1. The criterion for passing this test is set forth in 42 CFR , Part 84, Subpart G, Section 84.63(a)(c)(d); Volume 60, Number 110, June 8, 1995.

6.2. This test establishes the standard procedure for ensuring that:

84.63 Test requirements; general.

(a) Each respirator and respirator component shall when tested by the applicant and by the Institute, meet the applicable requirements set forth in subparts H through L of this part.

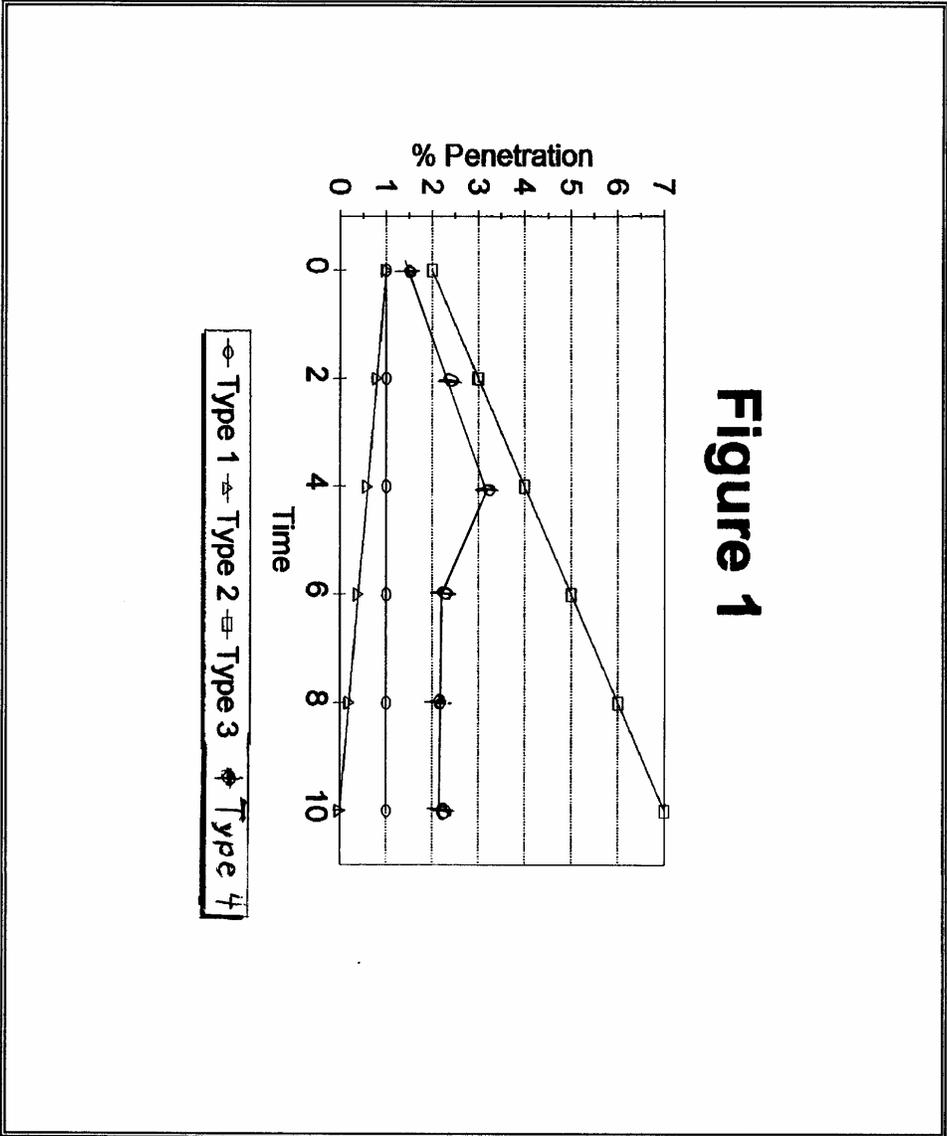
(c) In addition to the minimum requirements set forth in subparts H through L of this part, the Institute reserves the right to require, as a further condition of approval, any additional requirements deemed necessary to establish the quality, effectiveness, and safety of any respirator used as protection against hazardous atmospheres.

(d) Where it is determined after receipt of an application that additional requirements will be required for approval, the Institute will notify the applicant in writing of these additional requirements, and necessary examinations, inspections, or tests, stating generally the reasons for such requirements, examinations, inspections, or tests.

6.3. For the sample of 20 filters or filter cartridges to demonstrate acceptable performance, each filter must meet or exceed the specified collection efficiency limit ( $\geq 95\%$ ,  $\geq 99\%$ ,  $\geq 99.97\%$ ).

## 7. RECORDS/TEST SHEETS

- 7.1. All test data will be recorded on the PARTICULATE FILTER PENETRATION TO TEST NEGATIVE PRESSURE RESPIRATORS AGAINST SOLID PARTICULATES test data sheet.
- 7.2. All videotapes and photographs of the actual test being performed, or of the tested equipment shall be maintained in the task file as part of the permanent record.
- 7.3. All equipment failing any portion of this test will be handled as follows:
  - 7.3.1. If the failure occurs on a new certification application, or extension of approval application, send a test report to the RCT Leader and prepare the hardware for return to the manufacturer.
  - 7.3.2. If the failure occurs on hardware examined under an Off-the-Shelf Audit the hardware will be examined by a technician and the RCT Leader for cause. All equipment failing any portion of this test may be sent to the manufacturer for examination and then returned to NIOSH. However, the hardware tested shall be held at the testing laboratory until authorized for release by the RCT Leader, or his designee, following the standard operating procedures outlined in Procedure for Scheduling, and Processing Post-Certification Product Audits, RB-SOP-0005-00.







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### Revision History

<b>Revision</b>	<b>Date</b>	<b>Reason for Revision</b>
1.0	7 March 2002	Historic document
1.1	24 August 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method