



National Institute for Occupational Safety and Health  
National Personal Protective Technology Laboratory  
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Procedure No. TEB-APR-STP-0007

Revision: 2.3

Date: 8 March 2019

DETERMINATION OF INHALATION RESISTANCE TEST,  
AIR-PURIFYING RESPIRATORS  
STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedure for ensuring that the inhalation breathing resistance of chemical cartridge respirators, particulate respirators, gas masks, and tight-fitting powered air-purifying respirators submitted for Approval, Extension of Approval, or examined during Certified Product Audits, meets the minimum inhalation resistance requirements set forth in 42 CFR, Part 84, Subpart I, Section 84.122, Subpart K, Section 84.180, Subpart L, Section 84.203 Subpart KK, Section 84.1149, Section 84.1156(a)(1)(2), the Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Full-Facepiece Air-Purifying Respirator (APR) Revision 2 dated 4-4-2003, and the Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Air-Purifying Escape Respirator (APER) dated 9-30-2003.

2. GENERAL

This STP describes the Determination of Inhalation Resistance Test, Air-Purifying Respirators test in sufficient detail that a person knowledgeable in the appropriate technical field can select equipment with the necessary resolution, conduct the test, and determine whether, or not the tested system meets the established requirements.

3. EQUIPMENT/MATERIAL

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

- 3.1.1. An anthropometric headform or fixture on which to mount the complete respirator assembly in the configuration as worn by the user. In addition, fixtures are required for mounting a canister only when testing full facepiece APR for CBRN and for mounting mouthpiece respirators.
- 3.1.2. A means of connecting the headform or test fixture to the flow controller. The respirator must be fitted to the test fixture with no leaks.
- 3.1.3. Vacuum source capable of delivering a minimum of 85 liters per minute (lpm).
- 3.1.4. Setra Datum 2000 Model 239 digital manometer with an accuracy of  $\pm 0.01\%R \pm 1$  digit. Connect manometer to a pressure tap on the line between the flow controller and headform or test fixture with mounted respirator.

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- 3.1.5. Brooks Instrument Co. model 5853S Mass Flow Controller with Brooks Control and Read-out Unit model 0154. Accuracy +/- 0.70%R +/- 0.20% f.s.
- 3.1.6. American Meter Co. Dry Test Meter Model DTM-325.
- 3.1.7. Rope caulk, glue gun with hot-melt glue, and beeswax as needed.
- 3.1.8. Heating plate, beaker, and small brush as needed.

#### 4. TESTING REQUIREMENTS AND CONDITIONS

Prior to beginning any testing, confirm that all measuring equipment employed has been calibrated in accordance with the testing laboratory's calibration procedure and schedule. All measuring equipment utilized for this testing must have been calibrated using a method traceable to recognized international standards when available.

#### 5. PROCEDURE

- 5.1. Follow individual instruction manuals for set up and maintenance of equipment used in this procedure prior to beginning any testing. Any equipment found to be malfunctioning must be repaired or replaced and properly set up and calibrated before starting any testing.
- 5.2. Turn on vacuum to start airflow, and using the calibrated mass flow controller adjust the flow to 85 lpm, tolerance +/- 1.4 lpm.
- 5.3. Insert the connection of the headform or test fixture to the connection of the resistance tester without the respirator mounted. Set the digital manometer to read zero.
- 5.4. Disconnect the headform or test fixture from the resistance tester, and mount the respirator facepiece on the headform or fixture. Using hot-melt glue and beeswax, filtering-facepiece respirators are sealed onto a flat plate with a joint for connection to the resistance apparatus. A 40 mm female adapter is used to connect the canister for testing APR for CBRN. For air purifying escape respirators for CBRN, spread the elastomeric neck dam, and pull the hood over the headform. The neck dam should seal tightly around the neck of the headform. Mouthpiece type respirators require a special adapter. Elastomeric half mask and full face respirators are carefully mounted on the headform to ensure good contact around the entire sealing flange. Rope caulk can be used to help seal the critical area around the nose and / or chin for half masks. Be careful not to block the mouth of the headform with the chin cup of full facepieces. For each particular model, the size that best fits the standard headform should be used. Other headforms from different manufacturers are available in the lab to obtain a better seal on a particular facepiece if problems are encountered in obtaining a good seal.
- 5.5. Insert the connection of the headform or test fixture to the connection of the resistance tester.
- 5.6. Read resistance in inches of water to the nearest hundredth of an inch on the digital manometer. Convert inches to millimeters by multiplying by 25.4.

- 5.7. Record the measurement.
- 5.8. Perform the test on three samples.

6. PASS/FAIL CRITERIA

- 6.1. The requirements for passing this test are derived from: 42 CFR, Part 84, Subpart I, Section 84.122, Subpart K, Section 84.180, Subpart L, Section 84.203 Subpart KK, Section 84.1149, Section 84.1156(a)(1)(2); the Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Full-Facepiece Air-Purifying Respirator (APR) Revision 2 dated 4-4-2003, and the Statement of Standard for Chemical, Biological, Radiological and Nuclear (CBRN) Air-Purifying Escape Respirator (APER) dated 9-30-2003.
- 6.2. The maximum allowable resistance requirements for gas masks are as follows.

Maximum Inhalation Resistance  
[Millimeter water column]

Type of gas mask	Initial	Final <sup>1</sup>
Front-mounted or back-mounted (without particulate filter)	60	75
Front-mounted or back-mounted (with approved particulate filter)	70	85
Chin-style (without particulate filter)	40	55
Chin-style (with approved particulate filter)	65	80
Escape (without particulate filter)	60	75
Escape (with approved particulate filter)	70	85

<sup>1</sup>Measured at end of the service life specified in Tables 5, 6, and 7 of this subpart.

- 6.3. The resistance for non-powered, air-purifying particulate respirators upon initial inhalation shall not exceed 35 mm water-column height.

- 6.4. The maximum allowable resistance requirements for chemical cartridge respirators are as follows.

Maximum Inhalation Resistance  
[Millimeter water column]

Type of chemical-cartridge respirator	Initial	Final <sup>1</sup>
Other than single-use vinyl chloride respirators:		
For gases, vapors, or gases and vapors	40	45
For gases, vapors, or gases and vapors, and particulates	50	70
Single-use respirator with valves:		
For vinyl chloride	20	25
For vinyl chloride and particulates	30	45
Single-use respirator without valves:		
For vinyl chloride	15	20
For vinyl chloride and particulates	25	40

<sup>1</sup> Measured at end of service life specified in Table 11 of this subpart.

- 6.5. The maximum allowable resistance requirements for tight fitting powered air-purifying respirators (PAPR) are as follows.

Maximum Inhalation Resistance  
[Millimeter water column]

Type of tight-fitting PAPR	Initial	Final <sup>1</sup>
With HE particulate filter(s) only	50	70
With chemical cartridge(s) and HE particulate filter(s)	50	70
With chin-style canister and HE particulate filter	65	80
With front or back mounted canister and HE particulate filter	70	85

<sup>1</sup> Measured at end of silica dust test specified in section 84.1152 (b) of this subpart.

- 6.6. The maximum allowable resistance requirements for CBRN Full Facepiece Air Purifying Respirators are as follows.

Maximum Inhalation Resistance  
[Millimeter water column]

CBRN Full Facepiece Air-Purifying Respirators	Initial	Final <sup>1</sup>
Chin-style canister	65	80
Non facepiece-mounted canister	70	85
Canister only	50	NA

<sup>1</sup> Measured at end of service life

- 6.7. For CBRN Air-Purifying Escape Respirators, the inhalation resistance prior to environmental conditioning shall not exceed 70 mm, water column.

7. RECORDS/TEST SHEETS

- 7.1. Record the test data in a format that shall be stored and retrievable. Data shall be reported as shown in attached data sheet.

8. ATTACHMENTS

- 8.1. Sample Data Sheet

8.1. Sample Data Sheet

**National Institute for Occupational Safety and Health  
Respirator Branch  
Test Data Sheet**



**Task Number:** TN-NNNNN

**Reference No.:** CFR 84.180; 84.203

**Test:** Inhalation Resistance Test

**STP No.:** 7

**Manufacturer:**

**Item Tested:** P/N of Respirator

**Filter Type:**

Sample	Maximum Allowable Resistance (MM of H <sub>2</sub> O)	Actual Resistance (MM of H <sub>2</sub> O)	Result
	Inhalation	Inhalation	
1	35	15.9	PASS
2	35	16.5	PASS
3	35	15.3	PASS
<b>Overall Result: PASS</b>			

**Signature:**

**Engineering Technician**

**Date:** \_\_\_\_\_

## Revision History

<b>Revision</b>	<b>Date</b>	<b>Reason for Revision</b>
1.0	7 March 2004	Historic document
1.1	3 June 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method
2.0	30 March 2009	Document name change from RCT-APR-STP-0007, to TEB-APR-STP-0007. Significant rewrite incorporating changes which affect form and provide clarification of technical content as follows: -Addition of alternate method using digital manometer and mass flowmeter -Addition of precision and accuracy data for standard and alternate methods -New tables added for clarification, removal of obsolete respirator types and incorporation of CBRN APR, APER and industrial PAPR types -New instructions on fitting respirators to headforms and fixtures -Specifications added to equipment list
2.1	19 September 2012	Update description of mass flow controller called out in 3A1.5. Formatting check for web accessibility
2.2	25 March 2014	Modified specification in sections 5.6 and 5.A.4 from “flat aluminum plate” to “flat plate”. Editorial change to section 6.1.
2.3	8 March 2019	-Section 3, Updated list of equipment to recognize use of mass flow meter and electronic, digital manometer (formerly called out as an alternate procedure). -Section 4, Updated to current laboratory standards omitting P and A exercise and practices for lab safety in favor of those employed by the lab. -Section 5, Eliminate information on procedure using old instruments, essentially adopting the “Alternate Procedure” identified in rev 2.2 as the standard procedure. -Section 6, Normalized tables used to communicate the pass/fail values for the various classes of respirators.