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

1. PURPOSE

This document establishes the procedure for ensuring that the performance exhibited by air-purifying respirators (APRs) submitted for Approval, Extension of Approval, or examined during Certified Product Audits, meets the minimum exhalation resistance requirements set forth in 42 CFR, Part 84, Subpart I, Section 84.122; Subpart K, Section 84.172; Subpart L, Section 84.203; 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 standard testing procedure (STP) describes the determination of exhalation resistance for APRs 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 product passes the test.

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 fixture with no leaks.

3.1.3. Compressed air source capable of delivering a minimum of 85 liters per minute (lpm).

3.1.4. Setra Datum 2000 Model 239 digital manometer, or equivalent, with an accuracy of ± 0.01%R ± 1 digit. Connect manometer to a pressure tap on the line between the flow controller and headform or test fixture with mounted respirator.

3.1.5. Brooks Instrument Co. model 5853S Mass Flow Controller with Brooks Control and Read-out Unit model 0154, or equivalent, with an accuracy +/- 0.70%R +/- 0.20% f.s.

3.1.6. Rope caulk, glue gun with hot-melt glue and beeswax as needed

3.1.7. 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. Malfunctioning equipment must be repaired or replaced and properly set up and calibrated before starting all tests.

5.2. Turn on the airflow and set flow controller 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. Filtering facepiece respirators are sealed using hot melt glue and beeswax on a flat plate with a joint for connection to the resistance apparatus. For CBRN air purifying escape respirators, 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-facepiece 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 fits the standard headform best 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 requirement for passing this test is set forth in 42 CFR, Part 84, Subpart I, Section 84.122, Subpart K, Section 84.172, Subpart L, Section 84.203; 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 Exhalation Resistance
[Millimeter water column]

Type of gas mask	Initial	Final[1]
Front-mounted or back-mounted (without particulate filter)	20	20
Front-mounted or back-mounted (with approved particulate filter)	20	20
Chin-style (without particulate filter)	20	20
Chin-style (with approved particulate filter)	20	20
Escape (without particulate filter)	20	20
Escape (with approved particulate filter)	20	20

[1]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 exhalation shall not exceed 25 mm water column height pressure.

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

Maximum Exhalation Resistance
[Millimeter water column]

Type of chemical-cartridge respirator	Initial	Final [1]
Other than single-use vinyl chloride respirators:		
For gases, vapors, or gases and vapors	20	20
For gases, vapors, or gases and vapors, and particulates	20	20
Single-use respirator with valves:		
For vinyl chloride	20	20
For vinyl chloride and particulates	20	20
Single-use respirator without valves:		
For vinyl chloride	15	20
For vinyl chloride and particulates	25	40

[1] 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 Exhalation Resistance
[Millimeter water column]

Type of tight-fitting PAPR	Initial	Final [1]
With HE particulate filter(s) only	20	20
With chemical cartridge(s) and HE particulate filter(s)	20	20
With chin-style canister and HE particulate filter	20	20
With front or back mounted canister and HE particulate filter	20	20

[1] Measured at end of silica dust test specified in section 84.179

6.6. The maximum allowable resistance requirements for CBRN full facepiece APRs are as follows.

Maximum Exhalation Resistance
[Millimeter water column]

CBRN full facepiece air-purifying respirators	Initial	Final [1]
Chin style	20	20
Non-facepiece mounted	20	20

[1] Measured at end of service life

6.7. For CBRN air-purifying escape respirators (APER), the exhalation resistance prior to environmental conditioning shall not exceed 20 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 example data sheet.

8. ATTACHMENTS

8.1. Attachment A: Sample Exhalation Resistance Test Data Sheet

Attachment A: Sample Exhalation Resistance Test Data Sheet

National Institute for Occupational Safety and Health
Test Data Sheet

Task Number: **STP No.:** 3
Test:
Manufacturer:
Filter Type:
Item Tested:

Sample	Maximum Allowable Resistance (mmH_2O)	Actual Resistance (mmH_2O)	Result
	Exhalation	Exhalation	
1 2 3	25 25 25		

Overall Result:

Comments:

Was all equipment verified to be in calibration throughout all testing? ○ Yes ○ No

Signature: **Date:**

Revision History

Revision	Date	Reason for Revision
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	Significant rewrite of RCT-APR-STP-0003. Document name changed to TEB-APR-STP-0003. Changes affect form and provide clarification of technical content. -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	27 September 2011	Update description of mass flow controller called out in 3A1.5. Formatting check for web accessibility
2.2	19 September 2012	Review and editing for accuracy, no technical changes
2.3	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.
2.4	15 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 2.3 as the standard procedure. Also, eliminated requirement for, and use of dry test meter. -Section 6, Reformatted and normalized tables used to communicate the pass/fail values for the various classes of respirators.
2.5	27 January 2023	Removed references to Subpart KK. Other sections were updated with minor editorial formatting, including the sample test data sheet.