



National Institute for Occupational Safety and Health  
National Personal Protective Technology Laboratory  
P.O. Box 18070  
Pittsburgh, PA 15236

Procedure No. RCT-ASR-STP-0108	Revision: 1.1	Date: 21 September 2005
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DETERMINATION OF INHALATION AIRFLOW RESISTANCE, DEMAND,  
TYPE C AND CE, SUPPLIED-AIR RESPIRATORS  
STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedures for ensuring that the level of protection provided by the airflow resistance requirements on Type C and CE, Demand, Supplied-Air 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), and Subpart J, Section 84.156(a); Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the Determination of Inhalation Airflow Resistance, Demand, Type C and CE, Supplied-Air 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 product passes the test.

3. EQUIPMENT/MATERIALS

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

3.1.1. A 300 cubic foot gas cylinder of compressed air or equivalent.

3.1.2. A Helicoid calibrated pressure gauge and connecting fittings or equivalent.

3.1.3. Air regulator, Model 8, from Matheson Gas Products or equivalent.

3.1.4. Two channel thermal tip recording system (Gould Model No. RS3200) with carrier amplifier (Model No. 13-4615-35) or equivalent.

3.1.5. ISI Anthropometric Test heads with tube for measuring breathing resistance and air flows - Model SR-085 or equivalent.

3.1.6. Temperature compensated pressure transducer (Validyne Engineering Model No. DP45) or equivalent.

Approvals:	<u>1st</u> Level	<u>2nd</u> Level	<u>3rd</u> Level
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- 3.1.7. Mechanical breather with 622 kg. m/min. cam as per U.S. B. of M. drawings C-1748 (3/17/69) breathing machine and B-1198 (3/6/69) breathing cam or equivalent.
- 3.1.8. Dwyer Slant Manometer 0-3", F. W. Dwyer Manufacturing Co., Michigan City, Indiana or equivalent.
- 3.1.9. Digital stopwatch, calibrated to hundredths of a minute (Cronus Precision Products, Inc.) or equivalent.

#### 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. The compressed gas cylinder must meet all applicable Department of Transportation requirements for cylinder approval as well as for retesting/requalification.
- 4.3. Normal laboratory safety practices must be observed. This includes all safety precautions described in the current ALOSH Facility Laboratory Safety Manual.
  - 4.3.1. Safety glasses, lab coats, and hard-toe shoes must be worn at all times.
  - 4.3.2. Work benches must be maintained free of clutter and non-essential test equipment.
  - 4.3.3. 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. Turn on recorder and allow at least 30-minute warmup.

##### PRE-TEST BALANCING OF TRANSDUCER AND RECORDER

- 5.1.1. Connect the transducer to be used during testing in parallel with a manometer. Attach the manometer and transducer to a pressure regulated air source. A pinch clamp, used for slight pressure changes, is placed inline with two equal lengths of tubing for the manometer and transducer connections.
- 5.1.2. Connect the transducer cable to the carrier amplifier in the chart recorder.

Calibrate the recorder and carrier amplifier per instruction manual. Press the 5 mm/sec chart speed button. With no load applied to the transducer/manometer system, adjust the "POSITION" potentiometer on the chart recorder until the pen is at the mid-scale position. Press the STOP button on the chart recorder.

- 5.1.3. Apply a pressure of 0.5 inches of water to the transducer/manometer system. Press the 5 mm/sec chart speed button. Adjust the "CAL" potentiometer on the carrier amplifier until the pen on the chart recorder is at the next bold line left of mid-scale position. This represents 0.5 inches of water. Press the STOP button on the chart recorder.
- 5.1.4. Reduce the pressure to 0.0 inches of water to the transducer/manometer system. Press the 5 mm/sec chart speed button and check the chart recorder pen is at zero mid-scale position. Make any necessary adjustments. Press the STOP button on the chart recorder.
- 5.1.5. Repeat steps 5.1.3 and 5.1.4 with a pressures of 1.0, 1.5, and 2.0 inches of water until no adjustments are necessary at the "CAL" potentiometer on the carrier amplifier.
- 5.1.6. After the calibration sequence is complete remove the pressure source from the system.
- 5.2. Assemble the apparatus as shown in Figure 1. Mount the pressure transducer where shock and vibration are minimal.
- 5.3. Mount facepiece on anthropometric head, taking care not to block resistance port below and left of nose, particularly if a nose cup is used. Make sure that the face seal is leak tight by blocking off inhalation port of facepiece and inhaling through the breathing tube port exiting back of head. After building up several inches of negative pressure hold breathing several seconds, which will enable you to determine if a leak is present. If there is a leak, readjust headstraps and facepiece position and repeat leak test until a seal is obtained.
- 5.4. Connect regulator or breathing tube to facepiece. Do not connect head to breathing machine. Turn on breathing machine and use a timer to determine that the cam is operating at 24 rpm. (This will give a 40 lpm volume). When calibrated, turn breathing machine off.
- 5.5. Turn on the recorder and zero the base-line to mid-point of chart paper. Then turn off recorder.
- 5.6. Assemble respirator using maximum hose length. Connect the anthropometric head with the facepiece to the breathing machine.
- 5.7. Turn on the air supply to the respirator and set it to the minimum specified pressure.

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- 5.8. Turn on breathing machine and the recorder at 20 mm/sec for three complete cycles to obtain inhalation resistance. (See data Analysis) Then turn off breathing machine and recorder but leaving the air pressure turned on.
- 5.9. With the air supply pressure still turned on connect transducer port from head form to a slant manometer to obtain static pressure in facepiece.
- 5.10. Repeat steps 5.6 thru 5.9 with minimum hose length and maximum pressure. This must be done for each hose length and pressure range specified for respirator.
- 5.11. When tracings are complete, stop on the recorder, shut off breathing machine and air supply pressure, and disconnect transducer from head.
- 5.12. Retrieve the tracings on chart paper for data analysis.
- 5.13. Data Analysis
  - 5.13.1. Take the peak values of the inhalation tracings and read resistance in inches of water column height (See Figure 2.).
  - 5.13.2. All values read in paragraph 5.8 may not exceed 50 mm (2 inches) of water column height in order to meet Part 84 performance requirements for demand class.

Note: This test should be done on a minimum of two respirators, or more if additional testing is required (42 CFR, Part 84, Sections 84.12, 84.30, and 84.60).

## 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), and Subpart J, Section 84.156(a); 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.

84.156 Airflow resistance test; Type C supplied-air respirator, demand class; minimum requirements.

(a) Inhalation resistance shall not exceed 50 millimeters (2 inches) of water at an air flow of 115 liters (4 cubic feet) per minute.

## 7. RECORDS\TEST SHEETS

- 7.1. All test data will be recorded on the AIRFLOW INHALATION RESISTANCE, DEMAND CLASS, TYPE C AND CE, SUPPLIED-AIR RESPIRATORS 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.

**AIRFLOW INHALATION RESISTANCE, DEMAND CLASS, TYPE C AND CE,  
SUPPLIED-AIR RESPIRATORS**

Project No : \_\_\_\_\_ Date:

Company :

Respirator Type:

Reference: 42 CFR, Part 84, Subpart J, Section 84.156(a).

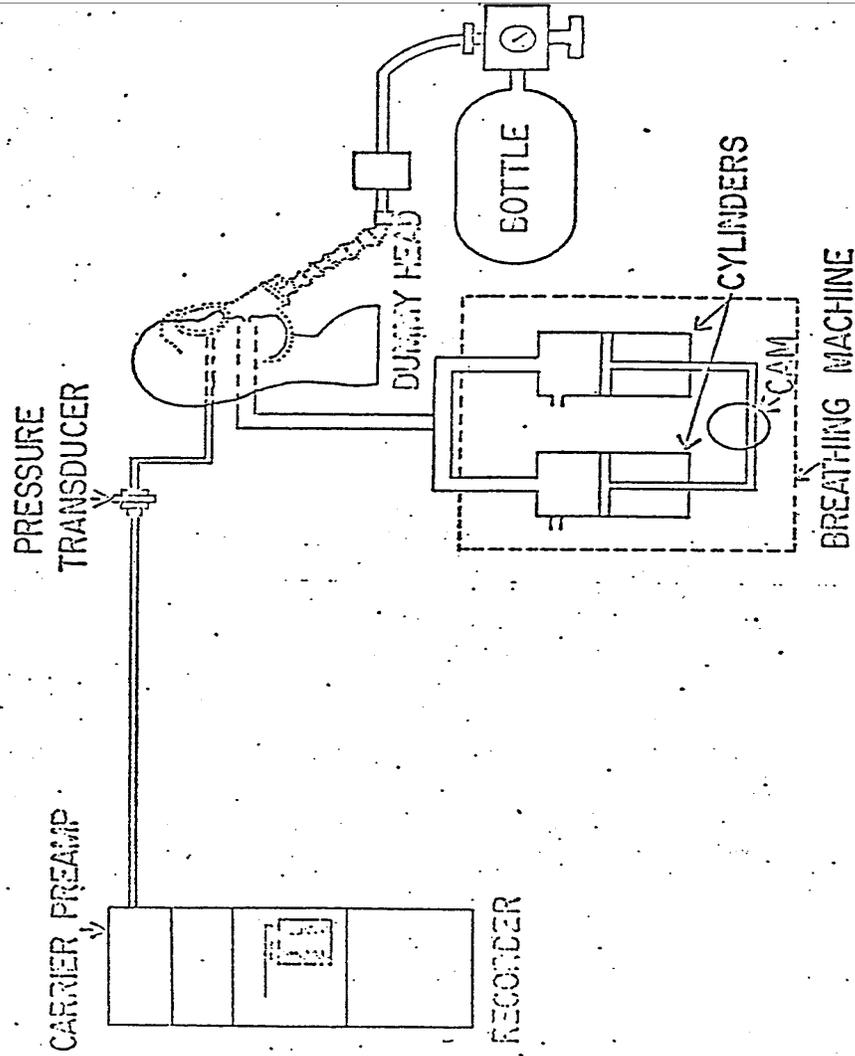
Requirement: (a) Inhalation resistance shall not exceed 50 mm (2 inches) of H<sub>2</sub>O col. Ht. At an air flow of 115 lpm. (4 cfm).

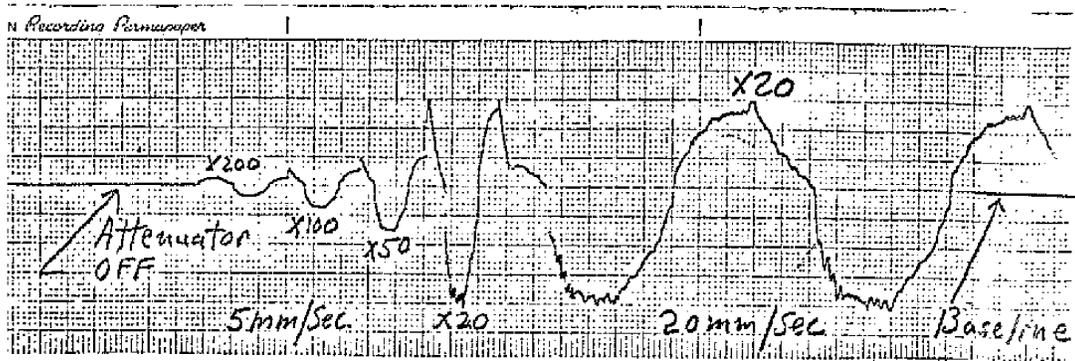
Test Data:           a.     Air Flow 115 lpm (4 cfm.)  
                                  Inhalation Resistance:

Comments :

Test Engineer: \_\_\_\_\_ PASS \_\_\_\_\_ FAIL

Figure 1. Test set-up for measuring inhalation breathing resistance





APPENDIX C

Figure 2.  
Breathing Resistance Trace

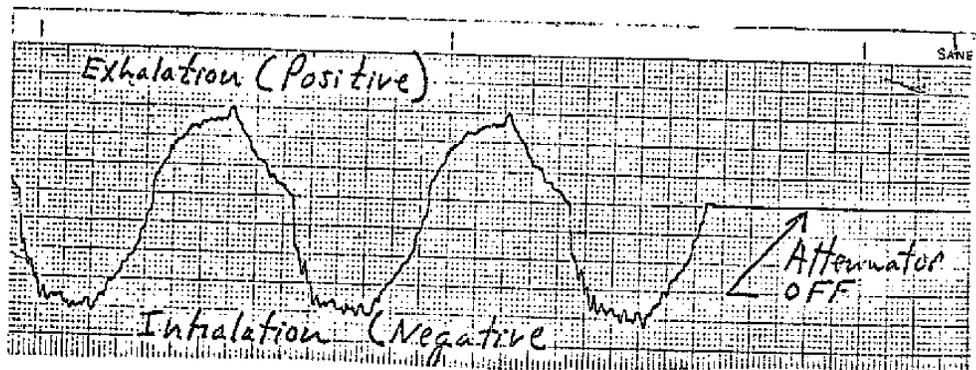


Figure 2  
Breathing Resistance Trace (Demand)

### Revision History

<b>Revision</b>	<b>Date</b>	<b>Reason for Revision</b>
1.0	27 June 2001	Historic document
1.1	21 September 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method