



National Institute for Occupational Safety and Health  
 National Personal Protective Technology Laboratory  
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Procedure No. RCT-ASR-STP-0133	Revision: 1.1	Date: 21 September 2005
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DETERMINATION OF EXHALATION BREATHING RESISTANCE - OPEN-CIRCUIT, PRESSURE-DEMAND, SELF-CONTAINED BREATHING APPARATUS USING TWO SECOND STAGE REGULATORS STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedure for ensuring that the level of protection provided by the exhalation breathing resistance requirements on Open-Circuit, Pressure-Demand, Self-Contained Breathing Apparatus (SCBA) using Two Second Stage Regulators submitted for Approval, Extension of Approval, or examined during Approval Product audits meet the minimum certification standards set forth in 42 CFR, Part 84, Subpart G, Section 84.63(a)(c)(d) and Subpart H, Section 84.91(a)(c)(d) Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the Determination of Exhalation Breathing Resistance - Open-Circuit, Pressure-Demand, Self-Contained Breathing Apparatus Using Two Second Stage Regulators 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/MATERIAL

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

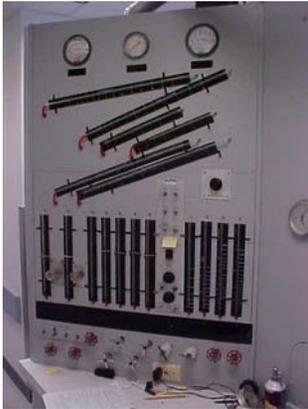


3.1.1. Dwyer Slant Manometer 0-3", F. W. Dwyer Manufacturing Co., Michigan City, Indiana or equivalent.

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



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



3.1.3. Positive-pressure source calibrated at a flow of 85 lpm located on the silica dust chamber. (See Figure 1.)



3.1.4. Ground Glass Joint



3.1.5. Pinch Clamp

#### 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 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. Assemble unit as per manufacturer's instructions - except only hook up primary regulator.
- 5.2. Mount facepiece on an anthropometric head fitted with a breathing tube, pressure tap, and ground glass joint connector.
- 5.3. Turn on unit cylinder.
- 5.4. To measure static pressure attach anthropometric head to slant manometer with pressure tap and block off ground glass connector. Allow at least one minute and read directly of manometer.
- 5.5. To measure exhalation resistance, block off pressure tap and connect anthropometric head to positive blower adjusted to 85 liters per minute and read directly off manometer which is connected to positive blower. (See Figure 1.)
- 5.6. Hookup secondary regulator, unhook primary regulator and repeat 5.2 through 5.5.

Note: This test should be done on a minimum of two respirators, or 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), Subpart H, Section 84.91(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.

84.91 Breathing resistance test; exhalation.

(a) Resistance to exhalation airflow will be measured in the facepiece or mouthpiece of open-circuit apparatus with air flowing at a continuous rate of 85 liters per minute.

(c) The exhalation resistance of pressure-demand apparatus shall not exceed the static pressure in the facepiece by more than 51 mm. (2 inches) water-column height.

(d) The static pressure (at zero flow) in the facepiece shall not exceed 38 mm. (1.5 inches) water-column height.

6.3. Modified Requirement

In section 84.91, 42 CFR, Part 84 Breathing resistance test; exhalation resistance, a maximum static pressure of 1.5 inches of water-column height and an additional maximum pressure of 2 inches exhalation resistance is permitted for pressure-demand units. If the total exhalation resistance does not exceed 3.0 inches of water, then the static pressure may be increased by 0.5 inch or to a maximum of 2.0 inches of water-column height.

Note: This modified requirement applies only to the primary regulator while the backup or secondary regulator must meet the static pressure requirement per 84.91(d), Part 84. In

modifying this static pressure requirement by allowing an additional 0.5 inches of static pressure (increase of approximately 30%) the exhalation resistance level requirement was lowered by 1.0 inches of pressure (decrease of approximately 100%) thereby, reducing the scheduled maximum total respiratory workload by 15%.

## 7. RECORDS/TEST SHEETS

- 7.1. All test data will be recorded on the BREATHING RESISTANCE - EXHALATION, OPEN-CIRCUIT, PRESSURE-DEMAND, SELF-CONTAINED BREATHING APPARATUS WITH TWO SECOND STAGE REGULATORS 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.

**BREATHING RESISTANCE - EXHALATION, OPEN-CIRCUIT, PRESSURE-DEMAND,  
 SELF-CONTAINED BREATHING APPARATUS  
 WITH TWO SECOND STAGE REGULATORS**

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

Company : \_\_\_\_\_

Respirator Type: \_\_\_\_\_

Reference: 42 CFR, Part 84, Subpart H, Section 84.91(a)(c)(d).

Requirements: 84.91(a) Resistance to exhalation airflow will be measured in the facepiece or mouthpiece of open-circuit apparatus with air flowing at a continuous rate of 85 liters per minute.

84.91(c) The exhalation resistance of pressure-demand apparatus shall not exceed the static pressure in the facepiece by more than 51 mm. (2 inches) water-column height.

84.91(d) The static pressure (at zero flow) in the facepiece shall not exceed 38 mm. (1.5 inches) water-column height.

Modified Requirement:

In section 84.91, 42 CFR, Part 84 Breathing resistance test; exhalation resistance, a maximum static pressure of 1.5 inches of water-column height and an additional maximum pressure of 2 inches exhalation resistance is permitted for pressure-demand units. If the total exhalation resistance does not exceed 3.0 inches of water, then the static pressure may be increased by 0.5 inch or to a maximum of 2.0 inches of water-column height.

Note: This modified requirement applies only to the primary regulator while the backup or secondary regulator must meet the static pressure requirement per 84.91(d).

Results:

	Primary	Secondary	Primary	Secondary
	<u>Unit 1 "H<sub>2</sub>O</u>	<u>Unit 1 "H<sub>2</sub>O</u>	<u>Unit 2 "H<sub>2</sub>O</u>	<u>Unit 2 "H<sub>2</sub>O</u>

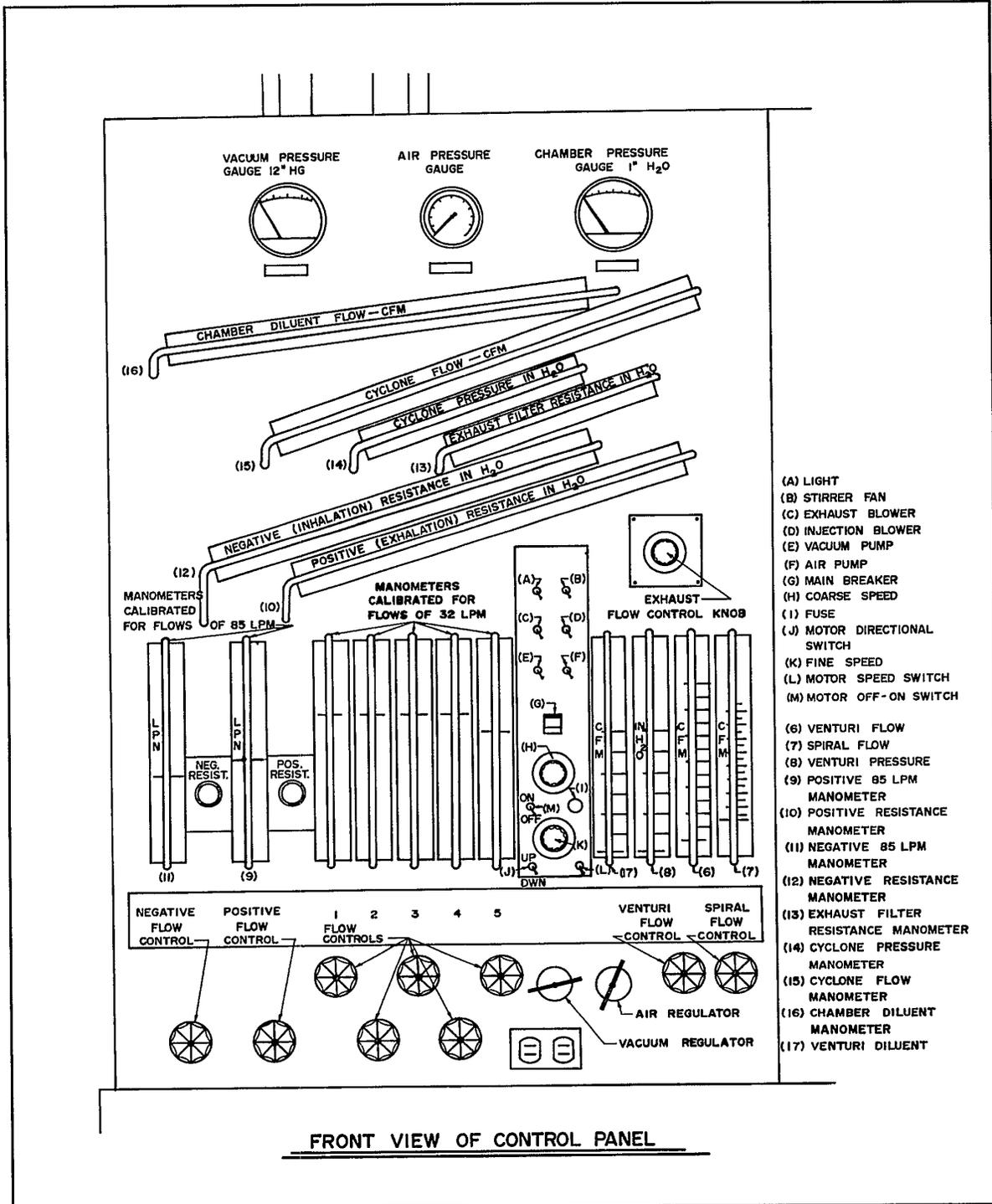
Exhalation: \_\_\_\_\_

Static: \_\_\_\_\_

Comments: \_\_\_\_\_  
 \_\_\_\_\_

Test Engineer: \_\_\_\_\_ Pass \_\_\_\_\_ Fail \_\_\_\_\_

Figure 1.



- (A) LIGHT
- (B) STIRRER FAN
- (C) EXHAUST BLOWER
- (D) INJECTION BLOWER
- (E) VACUUM PUMP
- (F) AIR PUMP
- (G) MAIN BREAKER
- (H) COARSE SPEED
- (I) FUSE
- (J) MOTOR DIRECTIONAL SWITCH
- (K) FINE SPEED
- (L) MOTOR SPEED SWITCH
- (M) MOTOR OFF-ON SWITCH
- (6) VENTURI FLOW
- (7) SPIRAL FLOW
- (8) VENTURI PRESSURE
- (9) POSITIVE 85 LPM MANOMETER
- (10) POSITIVE RESISTANCE MANOMETER
- (11) NEGATIVE 85 LPM MANOMETER
- (12) NEGATIVE RESISTANCE MANOMETER
- (13) EXHAUST FILTER RESISTANCE MANOMETER
- (14) CYCLONE PRESSURE MANOMETER
- (15) CYCLONE FLOW MANOMETER
- (16) CHAMBER DILUENT MANOMETER
- (17) VENTURI DILUENT

### Revision History

<b>Revision</b>	<b>Date</b>	<b>Reason for Revision</b>
1.0	13 November 2000	Historic document
1.1	21 September 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method