National Institute for Occupational Safety and Health National Personal Protective Technology Laboratory 626 Cochrans Mill Road Pittsburgh, PA 15236		
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DETERMINATION OF POSITIVE PRESSURE - OPEN-CIRCUIT, PRESSURE-DEMAND, SELF-CONTAINED BREATHING APPARATUS STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedures for ensuring that the level of protection provided by the breathing resistance requirements on Open-Circuit, Self-Contained Breathing Apparatus (SCBA) 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 H, Section 84.70(b)(2)(ii), and 84.90(a)(b); Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the test used for Determination of Positive Pressure - Open-Circuit, Pressure Demand, Self-Contained Breathing Apparatus 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. National Instruments NI USB-9215A Portable USB-Based DAQ with Simultaneous Sampling; LabVIEW 2013; Dell Optiplex 755 Personal Computer, SCBA test software

3.1.2. Mechanical Breather with 622 Kg.m/min. Cam as per U.S. BOM Drawings C-1748 (3/17/69) Breathing Machine and B-1198 (3/6/69) Breathing Cam

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

3.1.4. Validyne Engineering model DP45-20 transducer used with Validyne Engineering model CD-19A carrier demodulator mounted in the Validyne MC1-333 module case. Pressure range up to 3.5 inches of water - accuracy: ± 0.5% F.S.

3.1.5. 3-Liter lung in bottle with plastic tubing, Hans Rudolph Co. part number CM 1435 or equivalent

Approvals: First Level	Second Level	Third Level	Fourth Level

3.1.6. Electric Timer, calibrated to hundredths of a minute (Precision Scientific Company) or equivalent

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

3.1.8. Setra Datum 2000 Model 239 digital manometer – accuracy: ± 0.01%R ± 1 digit, or equivalent

3.1.9. Gilian model GilAir-3 personal sampling pump or equivalent

3.1.10. Connection line with valve for pressure decay test

3.1.11. Dwyer model A-396A calibration pump 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 testing laboratory's calibration procedure and schedule. All measuring equipment utilized for this testing must have been calibrated using a method traceable to the National Institute of Standards and Technology (NIST) when available.

5. PROCEDURE

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

5.1. Perform pre-test balancing of transducer and recording system.

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 supply. A pinch clamp, used for slight pressure changes, is placed in-line with two equal lengths of tubing for the manometer and transducer connections. An alternate method to generate low pressures for calibration is to use the Dwyer model A-396A calibration pump or equivalent.

5.1.2. Connect the transducer cable to the CD-19A demodulator, and then connect the demodulator to the National Instruments DAQ. The DAQ is then connected to the PC via USB port. Turn the system on and press the Calibration button. After the calibration screen appears, with no load applied to the transducer, press the Zero button to set the zero pressure point.

5.1.3. Apply a pressure of 0.5 inches of water to the transducer/manometer system. Check that the demodulator reads 0.5 inches, and adjust if necessary. Then check that the waveform displayed is at 0.5 inches, and adjust the LabVIEW readout if

necessary.

5.1.4. Reduce the pressure to 0.0 inches of water to the transducer/manometer system. Check that the waveform returns to zero.

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 each pressure point reads correctly on the waveform. No adjustments should be necessary at this point.

5.1.6. After the calibration sequence is complete remove the pressure source from the system.

5.2. Take precautions to mount the pressure transducer in a manner that isolates it from shock and vibration, in particular that which is induced by the breathing machine and the operation of the SCBA.

5.3. Fill SCBA cylinder with air to pressure as noted in the instruction manual. Make sure the pressure remains within the DOT-certified pressure range. A "+" indicates that the DOT pressure may be exceeded by 10%.

5.4. Assemble respirator. Mount facepiece on anthropometric head, taking care not to block resistance port below and left of nose, particularly if a nosecup 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 the head. After building up several inches of negative pressure, hold breath for several seconds, this 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. An alternate method to check the facepiece to headform seal is to attach the pressure probe to a digital or inclined manometer, and to use a small vacuum pump attached to the ¾" copper tube from the back of the headform, with a shut-off valve in line, to create a negative pressure in the facepiece. Close off the shut-off valve when a pressure of minus 2-3 inches of water is achieved in the facepiece, and start timing the loss of vacuum from -1 inch to -0.8 inches of water. If the vacuum decay rate from 1 – 0.8 inches of water is more than 5 seconds, the seal is acceptable.

5.5. Connect regulator or breathing tube to facepiece. Do not connect head to breathing machine. Turn on breathing machine and use a timer or the built-in tachometer to verify that the cam is operating at 24 rpm (24 rpms yields a 40 lpm volume). Stop the breathing machine when the pistons are at the end of the upstroke and reset counter to zero.

5.6. Check that the waveform reads zero, then hit the Data Entry button and enter the task number, date, make and model of the unit being tested. (While this is being done the transducer should be connected to the recorder but the transducer should not have any pressure load on it).

5.7. Connect the anthropometric head with the facepiece mounted to the lung-in-bottle assembly, using the tubing side that is connected to the breathing bag inside the bottle, and then connect the other tube from the lung in bottle to the breathing machine.

Connect transducer of the PC-based recording system to resistance port of the headform with a short length of tubing. Fully open SCBA cylinder valve and, for belt mounted regulator type units, fully open main line valve. Make sure any incorporated by-pass valve is closed.

5.8. Turn on the breathing machine and hit the Start button on the PC simultaneously. Take at least three separate tracings of the breathing cycles. (1-cycle includes the inhalation and exhalation breathing phases of the pressure wave form.)

5.9. When tracings are complete - Turn off breathing machine and cylinder valve on SCBA and then bleed down high-pressure air trapped in breathing hose by opening the by-pass valve, then shut the by-pass off. If also running STP-0121, see RCT-ASR-STP-0121 for procedure on when and how to end the test.

5.10. Retrieve the tracings for data analysis from the PC –based system which uses a custom LabView operating code to display the results.

5.11. Data Analysis

5.11.1 The PC-based system produces a trace showing the inhalation (negative) and exhalation (positive) breathing resistance. For this test the inhalation phase is the component for analysis. The PC-based system can be adjusted for sizing, i.e. how many peaks will appear on the screen. The spread of the waveform on the PC display will not affect the results.

5.11.2. For a pressure-demand unit the peak values of the inhalation tracings shall remain positive with respect to the base-line (zero) established at the time the system is calibrated. The PC-based system will automatically log and display any negative peaks with sufficient area to qualify as a failure. A single confirmed negative peak will result in a failure in this test.

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 H, Section 84.70(a)(2)(ii), and 84.90(a); Volume 60, Number 110, June 8, 1995.

6.2. This test establishes the standard procedure for assessing the following requirements:

84.70 Self-contained breathing apparatus; description.

(a) Self-contained breathing apparatus, including all completely assembled, portable, self-contained devices designed for use as respiratory protection during entry into and escape from or escape only from hazardous atmospheres, are described as follows:

(2) Open-circuit apparatus. An apparatus of the following types from which exhalation is

vented to the atmosphere and not rebreathed:

(ii) Pressure-demand-type apparatus. An apparatus in which the pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.

84.90 Breathing resistance test; inhalation.

(a) Resistance to inhalation airflow will be measured in the facepiece or mouthpiece while the apparatus is operated by a breathing machine as described in 84.88.

6.3. Pressure-demand type apparatus.

This test establishes the standard procedure for ensuring that an apparatus in which the pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation and is done at full cylinder pressure to the point at which the inhalation portion drops below the baseline during the rated service time test.

7. RECORDS\TEST SHEETS

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

8. ATTACHMENTS

8.1 Sample Data Sheet

POSITIVE PRESSURE TEST, OPEN-CIRCUIT,
SELF-CONTAINED BREATHING APPARATUS

Project No. : _____ Date: _____

Company : _____
_____

Respirator Type: _____

Reference: 42 CFR Part 84, Subpart H, Section 84.70(a)(2)(ii), and 84.90(a)

Requirements: 84.70(a)(2)(ii) Pressure-Demand Type Breathing Apparatus - An apparatus in which the pressure inside the face piece in relation to the immediate environment is positive during both inhalation and exhalation.

84.90(a) Resistance to inhalation airflow will be measured in the facepiece or mouthpiece while the apparatus is operated by a breathing machine as described in 84.88.

Procedure: A breathing machine with a 622 kg. -m./min. Cam operating at 24 rpm with a 40 lpm volume (115 lpm peak flow) is connected to an anthropometric head for cycling. A pressure tap in the head is connected to a transducer which in turn is connected to a strip chart recorder for determining the pressure in the face piece.

Results:

Facepiece pressure

Unit #1 > or = ambient _____ ; < ambient _____ ;

Unit #2 > or = ambient _____ ; < ambient _____ ;

Comments:

_____

_____

_____

_____

Test Engineer: _____ PASS_____ FAIL_____

Revision History

Revision	Date	Reason for Revision
1.0	23 May 2001	Historic document
1.1	12 September 2005	Update header and format to reflect lab move from Morgantown, WV - No changes to method
1.2	5 June 2018	Updated test procedure to reflect new PC based recording system using LabVIEW, plus minor editorial changes. Updated header with current address, and current NIOSH logo.