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 RATED SERVICE TIME - OPEN-CIRCUIT, DEMAND AND PRESSURE-DEMAND, SELF-CONTAINED BREATHING APPARATUS STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This document establishes the procedure for determining rated service time requirements for an Open-Circuit, Demand and Pressure-Demand, Self-Contained Breathing Apparatus (SCBA) per performance requirements in 42 CFR, Part 84, Subpart H, Section 84.95.

2. GENERAL

This STP describes the test used for Determination of Rated Service Time - Open-Circuit, Demand and 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 sample 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

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

4. TESTING REQUIREMENTS AND CONDITIONS

4.1. 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. 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 source. 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 LabVIEW readout if necessary.

5.1.4. Repeat steps 5.1.3 with the pressure 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.

5.1.5. Verify that the pressures are correct, by applying pressure at 1.5, 0.5, and 0.0 inches of water in descending order ensuring each pressure point reads correctly on the waveform. If adjustments are necessary, then repeat the calibration process for all pressures.

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.

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 determine that the cam is operating at 24 rpm (24 rpms yields a 40 lpm volume). The breathing machine contains a cycle counter for obtaining exact and total cycle counts and is used to make precise corrections at end of test. 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 and 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 timer and hit the Start button on the PC simultaneously.

5.9. When alarm activation is heard, record time and the exact number of cycles indicated by the counter on the breathing machine. Continue recording until inhalation portion of the breathing curve falls below baseline and record this time. The elapsed time may also be determined by viewing the time that appears in the upper part of the display just before hitting the 'Complete' button when the inhalation pressure goes negative. The time is displayed in count down mode from the rated service time, and when the rated time is exceeded, the time reads in count–up mode starting from 0, with a negative sign. Add the absolute value shown to the rated time for the total elapsed time.

5.9.1. The gauge readings should be from the remote gauge, where provided, but may be taken from the cylinder gauge if a remote gauge is not provided. Including the data point required to be recorded in the preceding step, record the time observed at each of the major gauge pressure increments (minimum of three data points). The time interval of the alarm should be included.

5.10. 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. Disconnect transducer from head, and record counter

setting on data sheet.

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

5.12. Data Analysis

5.12.1. The PC- based system produces a trace showing the inhalation (negative) and exhalation (positive) breathing resistance. 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.

5.12.2. A calibrated electric timer can be used to determine the length of time between starting the breathing machine and the point at which the inhalation portion of the breathing curve falls below minimum requirements, or the service time is determined as stated in section 5.10.

5.12.3. The corrected end of service time is calculated following the equation below:

$$\text{Corrected Time} = \frac{\text{Final Cycles - (Final Time X 24)}}{24} + \text{Final Time}$$

5.12.4. The corrected alarm time is calculated following the equation below:

$$\text{Corrected Alarm Time} = \frac{\text{\# of Cycles Alarm Activation - (Alarm Time X 24)}}{24} + \text{Alarm Time}$$

6. PASS\FAIL CRITERIA

6.1. The limits of acceptability for conducting this test are set forth in 42 CFR, Part 84, Subpart H, Section 84.95 (a)(b)(c).

Reference:

(a) Service time will be measured with a breathing machine as described in 84.88.

(b) The open-circuit apparatus will be classified according to the length of time it supplies air or oxygen to the breathing machine.

(c) The service time obtained on this test will be used to classify the open-circuit apparatus in accordance with 84.53.

7. RECORDS\TEST SHEETS

7.1. Record 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

8.1. Sample Data Sheet

RATED SERVICE TIME, OPEN-CIRCUIT,
SELF-CONTAINED BREATHING APPARATUS

Project No: _____ Date: _____

Company: _____

Respirator Type: _____

Reference: 42 CFR, Part 84, Subpart H, Section 84.95.

Requirement: (a) Service time will be measured with a breathing machine as described in 84.88.

(b) The open-circuit apparatus will be classified according to the length of time it supplies air or oxygen to the breathing machine.

(c) The service time obtained on this test will be used to classify the open-circuit apparatus in accordance with 84.53.

Use 622 kg-m/min. cam and rate unit according to flow duration and classify as in 84.53.

Results:

TIME-MIN	PSIG	CYCLES
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Corrected End of Service-life: _____

Corrected alarm time: _____

Comments: _____

_____

_____

_____

Test Engineer: _____ Pass _____ Fail_____

Revision History

Revision	Date	Reason for Revision
1.0	23 May 2001	Historic document
1.1	20 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.
1.3	10 March 2020	Updated Section 5, with changes related to the calibration sequence and checking for leaks around the face seal.