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

Procedure No. RCT-ASR-STP-0146	Revision: 1.1	Date: 12 September 2005

DETERMINATION OF DIAPHRAGM OVER PRESSURIZATION ON OPEN-CIRCUIT, SELF-CONTAINED BREATHING APPARATUS WITH BELT MOUNTED REGULATORS AND BREATHING TUBES STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedures for ensuring that the level of protection provided by the diaphragm over pressurization requirements on Open-Circuit, Self-Contained Breathing Apparatus (SCBA) with a belt mounted second stage regulator and a flexible breathing tube connected to the facepiece, 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), Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the Determination of Diaphragm Over Pressurization on Open-Circuit, 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. Two channel thermal tip recording system (Gould Model No. RS3200) with carrier amplifier (Model No. 13-4615-35) or equivalent.

Approvals:	1st Level	2nd Level	3rd Level

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 or equivalent.

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

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

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

3.1.6. Skinner Electronic Valve No. LC2DA 4l50, l50 PSI, 8 watts, l20/60 volts, New Britain, Conn. or equivalent.

3.1.7. Helicoid Standard Gauge ± l/2% or equivalent.

3.1.8. NaCl Generator and Penetrometer - Frontier Enterprises Model FE560A NaCl aerosol test system or equivalent.

3.1.9. Two stage pressure reducer - Matheson or equivalent.

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

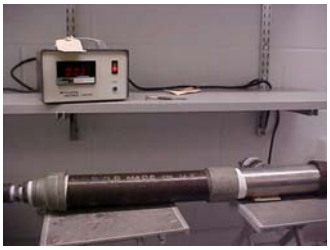
3.1.11. N.P.T. Piping

3.1.12. Hose Clamps

3.1.13. Pneumatic (BOM) - Drawing PR-0011-13 (9/16/69) or equivalent.

3.1.14. Multiple outlet box with 6 receptacles or equivalent.

3.1.15. Corn Oil Generator and Chamber - Dynatech Frontier Enterprises Model 260 - (May be substituted for No. 3.1.8., above) or equivalent.



3.1.16. Teledyne Hastings - Ray Dist Mass Flow Meter - Model NAHL-25 (May be substituted for No. 3.1.13., above) 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 during all testing.

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. REGULATOR DIAPHRAGM INTEGRITY TEST

Abstract - Regulators to be tested are assembled with diaphragm and retainers (where required) and leak tested by the manufacturers' QA test procedure, mounted in the NaCl challenge aerosol test chamber and initial penetration noted. Regulator is then tested for resistance to over pressurization for l00 cycles at moderate and l0 cycles at high air flows, retested for penetration and for leakage. Criteria for rejection of the regulator are:

5.1.1. Damage or permanent deformation in any component; or

5.1.2. Visible damage or breach of the diaphragm, including bubbles, thinning stretching; or

5.1.3. Average NaCl penetration greater than 0.002%; or

5.1.4. Failure of any Subpart H test.

5.2. Test Protocol

Four regulators will be tested as received from the manufacturer. All four regulators must successfully complete the regulator test series (tests l-4 above) before starting Subpart H testing. In addition, all units tested as complete assemblies must successfully complete all required Subpart H tests for approval or extension of approval.

5.3. The general tests will consist of the following sequence:

5.3.1. NaCl penetration test of regulator before over pressurization.

5.3.2. Diaphragm over pressurization test at a low flow simulating an escape with the bypass.

5.3.3. Diaphragm over pressurization test at maximum flow simulating severe misuse

of the bypass without the facepiece attached.

5.3.4. NaCl penetration test of the regulator after over pressurization.

5.3.5. Visual and dimensional inspection.

5.3.6. Approval tests for SCBA, Subpart H.

*NOTE: WHEN USING CORN OIL THIS PROCEDURE REMAINS THE SAME.

5.4. NaCl Penetration Test

5.4.1. Regulator is mounted on a ring stand in the center of a 3 feet in diameter by 3 feet high double walled test hood. The regulator is supplied with breathing air by an externally mounted cylinder and is cycled by the standard breathing machine (l) through a special 6 feet breathing tube assembly attached to a facepiece and mounted on a test dummy attached to the breathing machine.

5.4.2. The regulator is challenged with a NaCl aerosol of approximately 0.6 micrometers MMAD at a concentration of approximately l5 milligram per cubic meter generated by a Frontier Enterprises model FE 560A NaCl aerosol test system.

5.4.3 As the regulator in (5.4.3.1.) is cycled, air is sampled at approximately 0.3 liters per minute from the facepiece and passed through the Frontier flame photometer and the pulse height is recorded on a strip chart. The average of peak pulse heights for a 5 minute period is reported as average penetration.

5.4.3.1. A breathing machine cam with a work rate of 622 kg-m/min. and 24 respirations/min. with an approximate minute volume of 40 liters.

5.4.4. Maximum allowable average penetration will be 0.002% which is the value reported for an undamaged regulator diaphragm. All four regulators must pass the penetration test.

5.4.5. A similar test using DOP is available and has been used by some manufacturers for penetration studies. Test results seem comparable at low levels with NaCl but NIOSH tests will be performed with NaCl.

5.5. Regulator Over Pressurization Test - See Figure l for test setup.

5.5.1. The regulator, high-pressure hose assembly and variable pressure source of high-pressure breathing air are connected to a pressure gage or pressure transducer/recorder, an electrically operated valve, and transducer/recorder, by the regulator outlet.

5.5.2. The regulator by-pass valve is used to control the flow through the regulator, as measured by the transducer/recorder, out the electrically operated valve which is

used to interrupt the flow to over pressurize the regulator. The regulator over pressure is then recorded.

5.5.3. Initial flow rate is 200 liters per minute with a source pressure of 20-25% of the maximum rated service pressure.

5.5.4. Final flow rate is maximum deliverable by regulator at the maximum rated cylinder pressure.

5.5.5. 100 cycles consisting of 1-2 second actuations of the valves with 1-2 second pause are performed at the lower flow rate.

5.5.6. 10 similar cycles will be performed at the higher flow rate

5.5.7. Damage or permanent deformation in any component or visible damage or breach to the diaphragm will be considered a failure and will be cause for rejection of the application. No adjustment or repair of the regulator is allowed before the penetration test.

5.6. NaCl Penetration Test

Repeat this test.

Failure of the regulator to pass the leak test before over pressurization will be cause for rejection of that regulator for rework and retesting. Failure of a second test will be cause for rejection of that regulator and substitution of another unit.

5.7. Visual Inspection

All tested diaphragms and regulators will be visibly inspected at the completion of the penetration tests. No permanent damage or deformation to the components or visible damage or breach of the diaphragm, including bubbles or thinning or stretching, will be allowed.

5.8. Subpart H Tests

Tests of complete SCBA's will be carried out in accordance with Subpart H on at least two units.

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), 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.

6.3. Regulators to be tested are assembled with diaphragm and retainers (where required) and leak tested by the manufacturers' QA test procedure, mounted in the NaCl challenge aerosol test chamber and initial penetration noted. Regulator is then tested for resistance to over pressurization for l00 cycles at moderate and l0 cycles at high air flows, retested for penetration and for leakage. Criteria for rejection of the regulator are:

6.3.1. Damage or permanent deformation in any component; or

6.3.2. Visible damage or breach of the diaphragm, including bubbles, thinning or stretching; or

6.3.3. Average NaCl penetration greater than 0.002%; or

6.3.4. Failure of any Subpart H test.

7. RECORDS\TEST SHEETS

7.1. All test data will be recorded on the SPECIAL TEST - DIAPHRAGM OVER PRESSURIZATION, OPEN-CIRCUIT, SELF-CONTAINED BREATHING APPARATUS WITH BELT MOUNTED REGULATORS AND BREATHING TUBES 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.

SPECIAL TEST - DIAPHRAGM OVER PRESSURIZATION, OPEN-CIRCUIT, SELF-CONTAINED BREATHING APPARATUS WITH BELT MOUNTED REGULATORS AND BREATHING TUBES

Project No : _____ Date: _____

Company : _____

Respirator Type: _____

Reference: 42 CFR, Part 84, Subpart G, Section 84.63(a)(c)(d)

Regulator	Regulator No.	Diaphragm No.	Torque	NaCl% Initial	Flow Rate LPM	Cycles	NaCl% Final	Visual Inspection	Pass	Fail
1.	_____	_____	_____	_____	200	100	_____	_____	____	____
					Max.	10				
2.	_____	_____	_____	_____	200	100	_____	_____	____	____
					Max.	10				
3.	_____	_____	_____	_____	200	100	_____	_____	____	____
					Max.	10				
4.	_____	_____	_____	_____	200	100	_____	_____	____	____
					Max.	10				

VISUAL INSPECTION NOTES

Comments :

_____

_____

_____

_____

_____

_____

_____

_____

_____

Data Analysis

Regulator No.	1. Initial NaC1 Penet. Pass/Fail	2. Final NaC1 Penet. Pass/Fail	3. Unacceptable Regulator or Component Deformation	4. Visible Breach in Diaphragm
I.	_____	_____	_____	_____
II.	_____	_____	_____	_____
III.	_____	_____	_____	_____
IV.	_____	_____	_____	_____
Totals:	_____	_____	_____	_____

Comments :

_____

_____

_____

_____

_____

_____

_____

_____

_____

Test Engineer: _____ Pass: _____ Fail: _____

Figure 1
Diaphragm Over Pressurization Test Setup

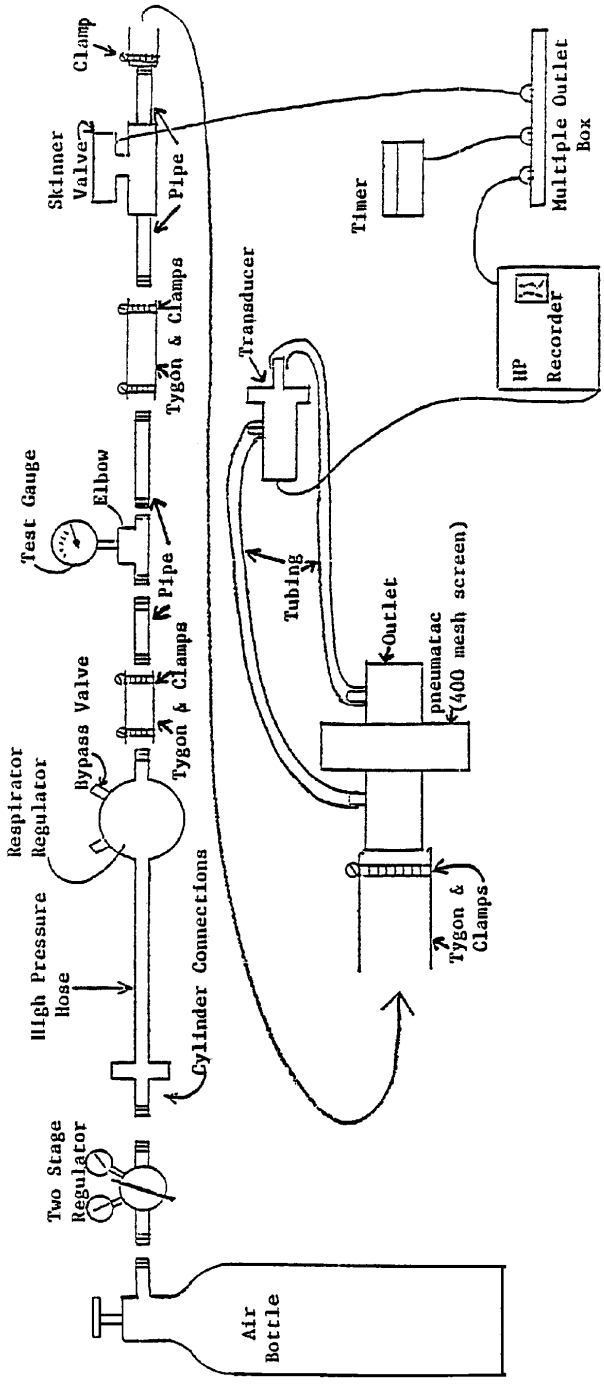


Figure 1 - Overpressurization Test Setup

Revision History

Revision	Date	Reason for Revision
1.0	6 February 2001	Historic document
1.1	12 September 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method