



National Institute for Occupational Safety and Health
 National Personal Protective Technology Laboratory
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Procedure No. RCT-ASR-STP-0142	Revision: 1.1	Date: 12 September 2005
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DETERMINATION OF VIBRATION (RO-TAP TEST) FOR MAN TEST NUMBER 1 ON - ESCAPE, CLOSED-CIRCUIT, DEMAND, SELF-CONTAINED BREATHING APPARATUS STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedure for ensuring that the level of protection provided by the vibration requirements on Escape, Closed-Circuit, Demand, Self-Contained Breathing Apparatus (ESCBA) 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 H, Sections 84.97, 84.99, and 84.103; Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the Determination of Vibration (Ro-Tap Test) For Man Test Number 1 on - Escape, Closed-Circuit, 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/MATERIAL

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



3.1.1. Electric timer, calibrated to hundredths of a minute (Precision Scientific Co.) or equivalent.

Approvals:	1 st Level	2 nd Level	3 rd Level
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3.1.2. WS Tyler Rotap Machine - Model RX30 or equivalent.



3.1.3. Bruel and Kjaer Measuring AMP - Model 2525 or equivalent.



3.1.4. Bruel and Kjaer Accelerometer - Model 4384 or equivalent.



3.1.5. WS Tyler Sound Enclosure - Model R-30050 or equivalent.

Note: See test procedure RCT-ASR-STP-0140 (man test) for additional equipment.

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:

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. Glue metal accelerometer mounting block in center of unit with an epoxy glue. Allow to dry in accordance with adhesive manufacturer's recommendations.

5.2. Lubricate the rotap machine as per manufacturer's instructions.

5.3. Set up peak meter for operation.

5.4. Set up electric timer.

5.5. Mount the respirator unit on the rotap in a vertical position with accelerometer mounting plate facing outward from rotap. (All measurements are taken in the same (Z) direction.)

5.6. Adjust the positioning plates with 1-inch foam pads on each plate until respirator is trapped in a secure manner.

5.7. Also, it may be necessary to tape the unit for additional security and is a decision based on the containment surface area and shape of the respirator/case. If it becomes necessary, it should be done after completing step 5.10.

5.8. Mount the accelerometer to the accelerometer mounting plate on respirator center front surface by screwing in securely.

5.9. Start rotap and observe peak acceleration. It should read 15 ± 2 g's. If additional adjustment becomes necessary, repeat step 5.6. by securing trapped respirator with more or less pressure obtained with the adjustment plates.

- 5.10. Turn on rotap and check peak acceleration and repeat step 5.9. until a reading of 15 ± 2 g's are obtained. Turn off rotap.
- 5.11. Set timer to "0," turn on rotap simultaneously with timer and run for 13 hours and 20 minutes. Check peak meter approximately every hour and record peak reading and reset peak meter. If the peak falls outside of acceptable range, then it is necessary to perform steps 5.9 and 5.10. Turn off unit at completion of test time.
- 5.12. Repeat steps 5.6 through 5.11. and change unit orientation to position on side and proceed with step 5.12. It will be necessary to remount accelerometer mounting plate to side center portion of respirator.
- 5.13. Repeat steps 5.6 through 5.11 and change unit orientation to position unit on its back surface.
- 5.14. After test completion (i.e., 13 hours and 20 minutes on each of 3 orientations or 40 hours total), take respirator and examine for defects. If there does not appear to be any mechanical defects then open unit and check for powdering in mouthpiece and breathing tube by inserting finger or probe and scraping. Also, if possible, remove breathing bags using same procedure, check for powdering. If all appears satisfactory, proceed to man test No. 1. If respirator shows any problems with excess powdering or mechanical problems (i.e., screened retainers broken, etc.), then man test no. 1 cannot be run and unit fails test requirement.
- 5.15. Conduct man test No. 1 (see test procedure RCT-ASR-STP-0140) and record required data.
- 5.16. Data Analysis

If unit passes all of man test No. 1 minimum performance requirements, then the respirator passes the test satisfactorily. Samples are taken of oxygen, carbon dioxide, temperature, and breathing resistance. Minimum oxygen level is 19.5% by volume. Maximum carbon dioxide level is 0.5% downstream of the scrubber for facepieces and 1.5% in the inhalation tube with mouthpiece respirators. See Test Requirements for permissible temperature levels.

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 H, Sections 84.97, 84.99, and 84.103; 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.

84.97 Test for carbon dioxide in inspired gas; open- and closed-circuit apparatus; maximum allowable limits.

(a) Open-circuit apparatus:

(1) The concentration of carbon dioxide in inspired gas in open-circuit apparatus will be measured at the mouth while the apparatus mounted on a dummy head is operated by a breathing machine. An acceptable method for measuring the concentration of carbon dioxide is described in Bureau of Mines Report of Investigations 6865, A Machine-Test Method for Measuring Carbon Dioxide in the Inspired Air of Self-Contained Breathing Apparatus, 1966. Copies of Report of Investigations 6865 may be inspected or obtained from the NIOSH, Respirator Branch, 1095 Willowdale Road, Morgantown, W.V. 26505-2888.

(2) The breathing rate will be 14.5 respirations per minute with a minute-volume of 10.5 liters.

(3) A sedentary breathing machine can will be used.

(4) The apparatus will be tested at a temperature of $27 \pm 2^\circ \text{C}$. ($80 \pm 5^\circ \text{F}$).

(5) A concentration of 5 percent carbon dioxide in air will be exhaled into the facepiece.

(b) Closed-circuit apparatus. The concentration of carbon dioxide in inspired gas in closed-circuit apparatus will be measured at the mouth while the parts of the apparatus contributing to dead-air space are mounted on a dummy head and operated by the breathing machine as in paragraphs (a)(1) through (5) of this section.

(c) During the testing required by paragraphs (a) and (b) of this section, the concentration of carbon dioxide in inspired gas at the mouth will be continuously recorded, and the maximum average concentration during the inhalation portion of the breathing cycle shall not exceed the following limits:

Where the service time is	Maximum allowable average concentration of carbon dioxide in inspired air percent by volume
Not more than 30 minutes.....	2.5
1 hour.....	2.0
2 hours.....	1.5
3 hours.....	1.0
4 hours.....	1.0

(d) In addition to the test requirements for closed-circuit apparatus set forth in paragraph (b) of this section, gas samples will be taken during the course of the man tests described in Tables 1, 2, 3, and 4 of this subpart. These gas samples will be taken from the closed-circuit apparatus at a point downstream of the carbon dioxide sorbent, and they shall not contain more than 0.5 percent carbon dioxide at any time, except on apparatus for escape only, using a mouthpiece only, the sample shall not contain more than 1.5 percent carbon dioxide at any time.

84.99 Man tests; testing conditions; general requirements.

(a) The man tests described in Tables 1, 2, 3, and 4 of this subpart represent the workload performed in the mining, mineral, or allied industries by a person wearing the apparatus tested.

(b) The apparatus tested will be worn by Institute personnel trained in the use of self-contained breathing apparatus, and the wearer will, before participating in these tests, pass a physical examination conducted by a qualified physician.

(c) All man tests will be conducted by the Institute.

(d) The apparatus will be examined before each man test to ensure that it is in proper working order.

(e) Breathing resistance will be measured within the facepiece or mouthpiece and the wearer's pulse and respiration rate will be recorded during each 2 minute sample period prescribed in tests 1, 2, 3, and 4.

(f) Man tests 1, 2, 3, 4, 5, and 6 will be conducted in duplicate.

(g) If man tests are not completed through no fault of the apparatus, the test will be repeated.

84.103 Man tests; performance requirements.

- (a) The apparatus shall satisfy the respiratory requirements of the wearer for the classified service time.
- (b) Fogging of the eyepiece shall not obscure the wearer's vision, and the wearer shall not experience undue discomfort because of fit or other characteristics of the apparatus.
- (c) When the ambient temperature during testing is 24 ± 6 °C. (75 ± 10 °F.), the maximum temperature of inspired air recorded during man tests shall not exceed the following, after correction for deviation from 24 °C. (75 °F.):

Where service life of apparatus is--	Where percent relative humidity of inspired air is--	Maximum permissible temperature of inspired air shall not exceed--	
1/4 hour or less	0-100	135	57
1/2 hour to 3/4 hour	0-50 50-100	125 ¹ 110	52 ¹ 43
1 to 2 hours	0-50 50-100	115 ¹ 105	46 ¹ 41
3 hours	0-50 50-100	110 ¹ 100	43 ¹ 38
4 hours	0-50 50-100	105 ¹ 95	41 ¹ 35

¹Where percent relative humidity is 50-100 and apparatus is designed for escape only, these maximum permissible temperatures will be increased by 5°C (10°F).

6.3. If unit passes all of man test No. 1 minimum performance requirements, then the respirator passes the test satisfactorily. Samples are taken of oxygen, carbon dioxide, temperature, and breathing resistance. Minimum oxygen level is 19.5% by volume. Maximum carbon dioxide level is 0.5% downstream of the scrubber for facepieces and 1.5% in the inhalation tube with mouthpiece respirators. See Test Requirements for permissible temperature levels.

7. RECORDS/TEST SHEETS

7.1. All test data collected will be recorded on the SPECIAL TEST - VIBRATION, CLOSED-CIRCUIT, SELF-CONTAINED BREATHING APPARATUS and MAN TEST #1 - 1 HOUR, CLOSED-CIRCUIT, SELF-CONTAINED BREATHING APPARATUS test data sheets.

Note: Man test number 1 test data sheet for one hour is recorded as an example. The test data sheet used for testing will always be for the service time required by the man test.

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 - VIBRATION

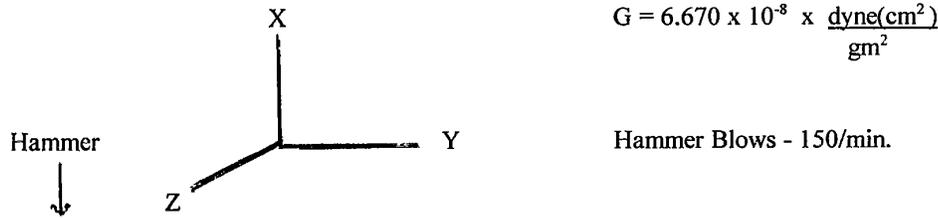
Project No : _____ Date: _____

Company : _____

Respirator Type: _____

Reference: 42 CFR, Part 84, Subpart G, Section 84.63(a)(c)(d) and Subpart H, Sections 84.97, 84.99, and 84.103 Volume 60, Number 110, June 8, 1995.

Results:

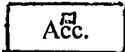


Z Directions

_____ Maximum Positive Peak _____ G _____ Minutes
 _____ Maximum Positive Peak _____ G _____ Minutes



_____ Maximum Positive Peak _____ G _____ Minutes
 _____ Maximum Positive Peak _____ G _____ Minutes



_____ Maximum Positive Peak _____ G _____ Minutes
 _____ Maximum Positive Peak _____ G _____ Minutes

Note: X-Ray before and after each test. If available. (40-Hours of Vibration simulates 18 months of wearing time.)

Comments : _____

Test Engineer: _____ PASS _____ FAIL _____

**MAN TEST #1 - 1 HOUR, CLOSED-CIRCUIT,
SELF-CONTAINED BREATHING APPARATUS**

PROJECT NO: _____ DATE: _____

Subject: _____ Age: _____

Subject weight: Initial - _____ Final - _____

RESPIRATOR TYPE: 1 hr positive pressure

Unit weight: Initial - _____ Final - _____

Observers: _____

Sampling Schedule

Time/Min. _____	Gas Percent		Pulse bpm	Resp. rpm	Resistance		Temperature		Press. gauge
	CO ₂	O ₂			inh.	exh.	unit	amb.	
0-2 _____									
20-22 _____									
40-42 _____									
58-60 _____									

Comments :

Test Engineer: _____ PASS _____ FAIL _____

WORK Schedule

<u>Time/Min.</u>	<u>Exercise</u>
2-20	walk - 3mph
22-40	walk - 3mph
42-58	walk - 3mph

SETTINGS FOR RO-TAP VIBRATION TEST

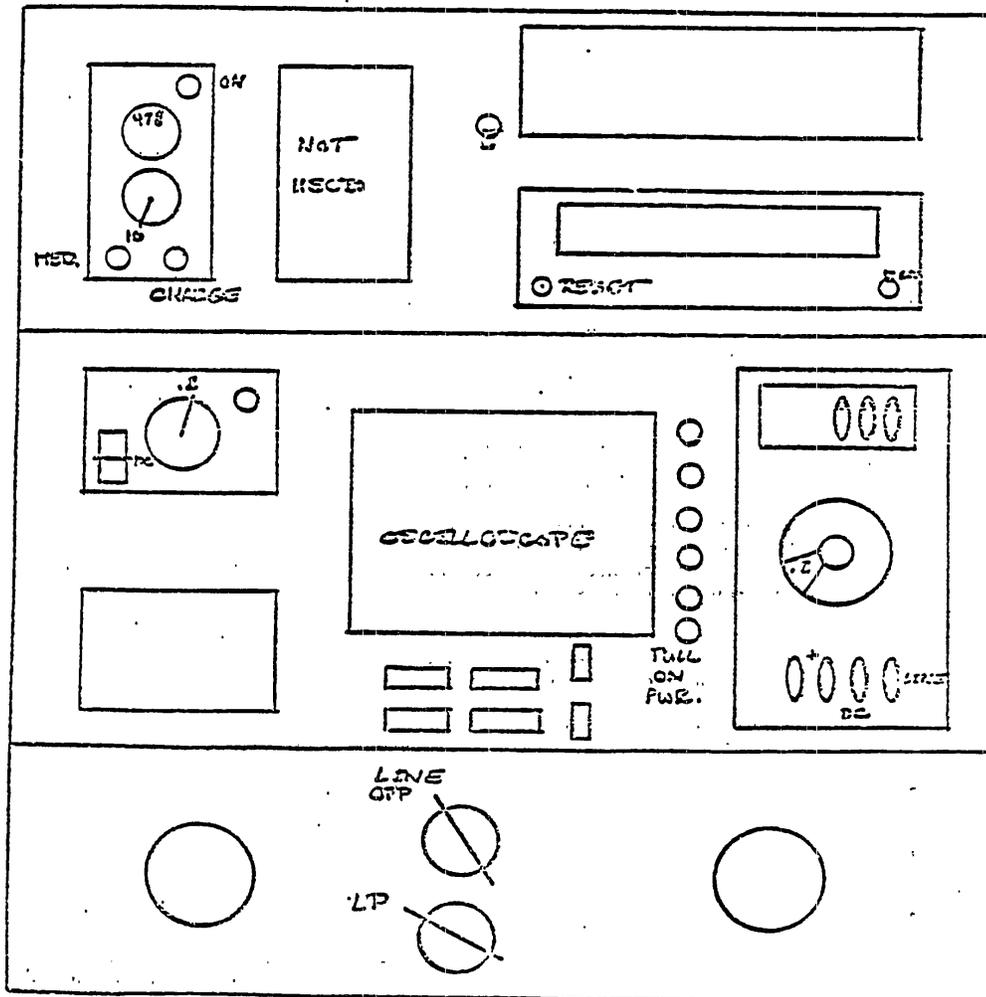
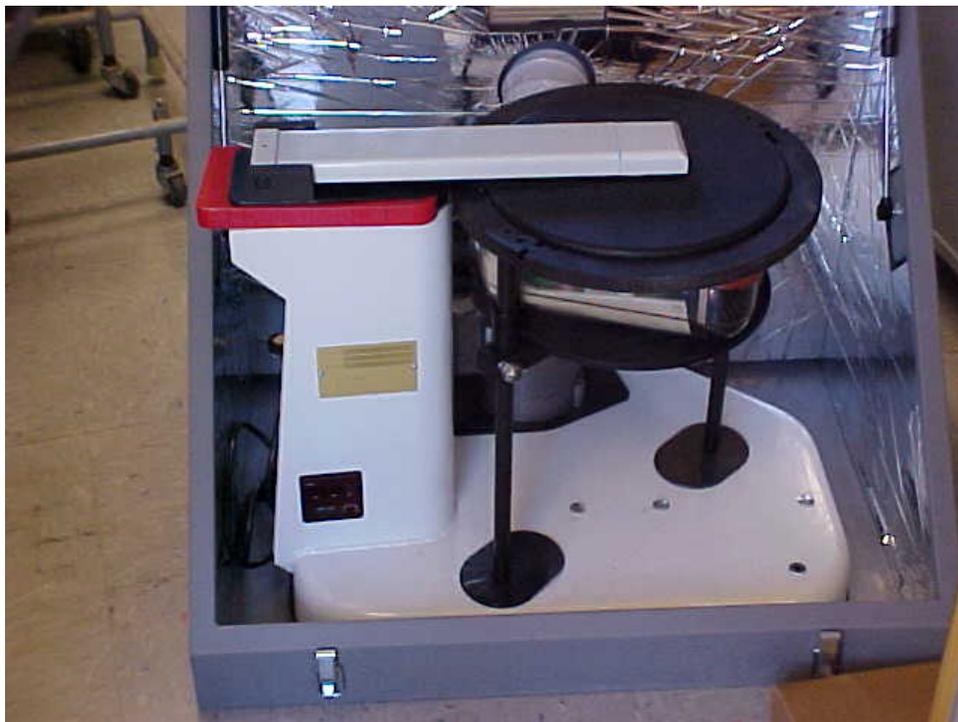
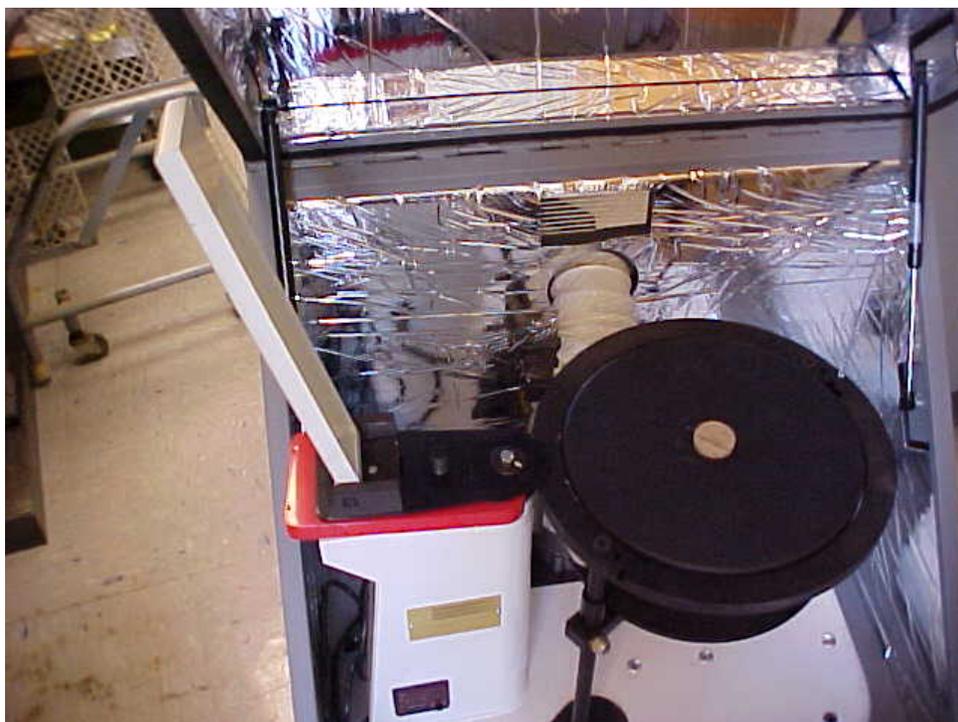
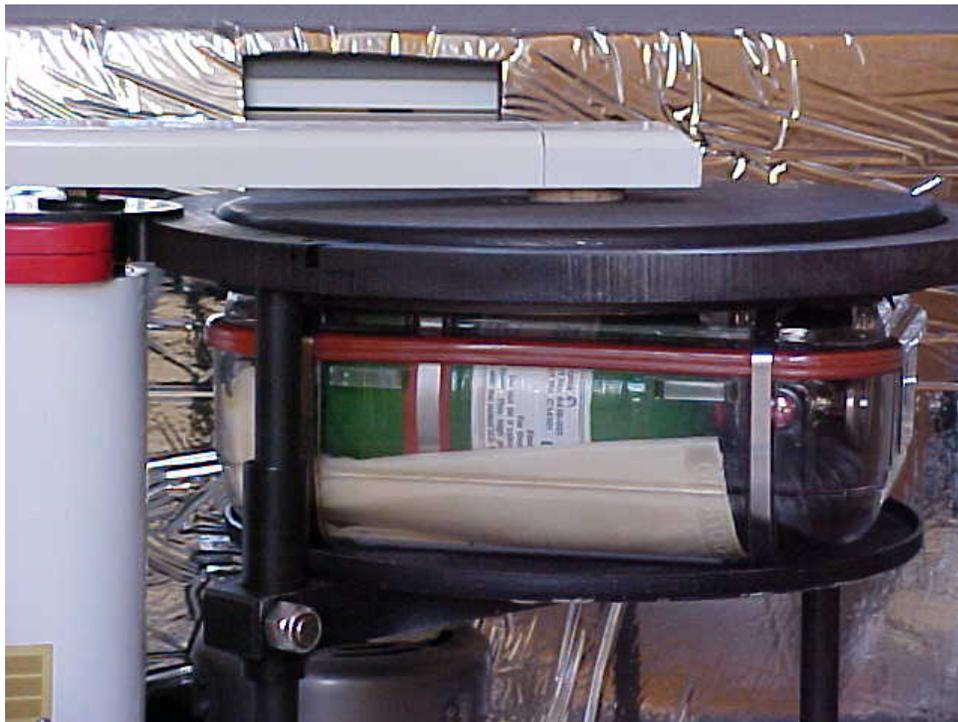


FIGURE 1





Revision History

Revision	Date	Reason for Revision
1.0	18 December 2000	Historic document
1.1	12 September 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method