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EXHALATION VALVE LEAKAGE TEST

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February 1976

Respirator Test Procedure

ABSTRACT

A procedure is described to enable the reader to perform exhalation valve leakage tests on respirators as required by Title 30 CFR, Part 11. The steady state leakage rate of the exhalation valve is measured in milliliters per unit time and on the positive pressure side of the exhalation valve.

PREFACE

The author wishes to thank Mrs. Greta Fawcett for her help in preparing the procedure and thanks to Ms. Sandy McClead for her effort in preparing the manuscript.

This is not an endorsement of the equipment described in this procedure. Equipment of comparable accuracy could be used in place of that listed in this procedure.

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LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS

approx. -- approximately

Fig. -- figure

gal. -- gallon

I.D. -- internal diameter

in. -- inch

min. -- minute

ml -- milliliter

mm -- millimeter

NIOSH -- National Institute for Occupational Safety and Health

INTRODUCTION

This procedure was established for measuring exhalation valve leakage since 30 CFR Part 11 (March 25, 1972) gives NIOSH the authority to test and certify respirators.

This procedure describes the equipment and method by which dry exhalation valves and valve seats are subjected to a suction of 25 mm (one inch) of water. Leakage is measured with a bubblemeter and must not exceed 30 ml per minute.

§ 11.102–2 Exhalation valve leakage test.

(a) Dry exhalation valves and valve seats will be subjected to a suction of 25 mm. water-column height while in a normal operating position.

(b) Leakage between the valve and valve seat shall not exceed 30 milliliters per minute.

EQUIPMENT REQUIRED

The following items are shown assembled in Fig. 1.

1. Vacuum Source -- A vacuum source is needed to supply a steady suction of 25 mm per minute.

2. Manometer -- A water manometer is used to measure the vacuum.

   Dwyer Manometer: F. W. Dwyer Mfg. Co.
   Michigan City, Indiana

3. Bubblemeter -- A bubblemeter is used to measure valve leakage.

   Kimax 100 ml pinchcock buret: Kimble Products
   Toledo, Ohio

4. Cylinder Valve Holder -- The valve holder keeps the valve and valve seat in the proper position while suction is applied.

   The cylinder was designed by the Testing and Certification Branch's Respirator Section.

5. Gasket Cutter -- A cutter is used to make the gasket to hold the valve during testing.

   Spearhead No. 750: Zimmerman Packing
   Cincinnati, Ohio

6. Timer -- A timer is used to time the leakage rate.

   Precision "Time It": Precision Scientific Co.
   Subsidary of GCA Corp.

7. Miscellaneous Equipment -- 400 ml Beaker
   Tripod
   Vacuum Bottle
   Hose Clamps
   1/2 in. ID Hose
   3-Way "T" Hose Connectors

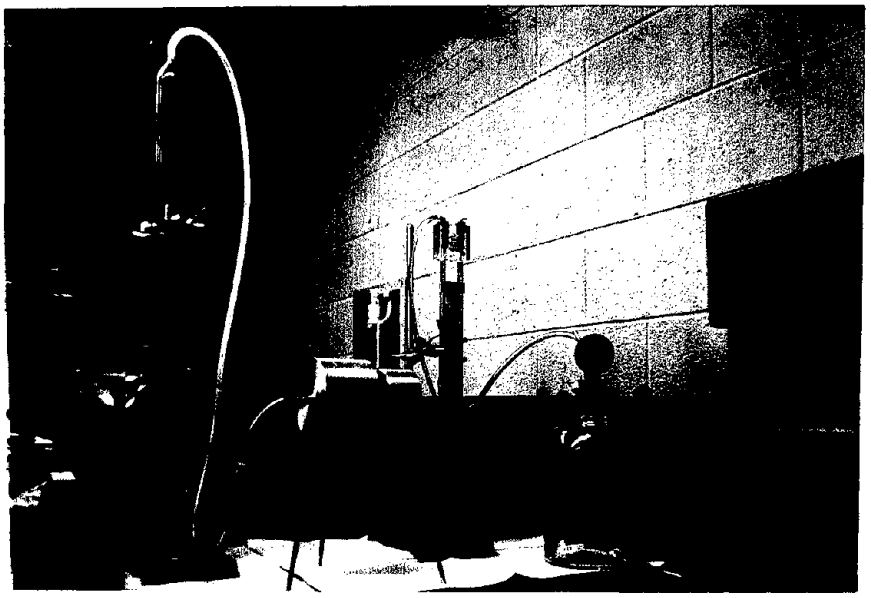


Fig. 1. Exhalation Valve System - Assembly for Testing

CALIBRATION PROCEDURES

Timer

Apparatus -- Communication Receiver.

Method -- The timer is calibrated by comparing it to a standard time signal over a range of time. Our timers are calibrated using the WWV time signal which is accurate to $\pm$ 1 part in 10^{11}.

Bubblemeter -- The bubblemeter is precalibrated by the company and the tolerance on accuracy is twice that specified by NBS.

Manometer

Apparatus -- (1) Calibrated gage blocks (accurate to .000005 in.) for 0.5 inch and 1 inch; (2) distilled water; and (3) level.

Method -- With the gage blocks, check the scale over the entire 10 in. range of the manometer. If the scale is inaccurate, make 0.5 and 1 inch markings. Mount the manometer in a vertical position and use the level to assure that the manometer is perpendicular. Fill the manometer to the zero mark with distilled water.

OPERATING PROCEDURES

1. Cut a round gasket four inches in diameter from soft plastic such as .03 inch thick polyethylene sheet from United States Plastic Corporation.

2. Measure the valve to be tested and cut an appropriate mounting hole in the middle of the gasket. (Examine the gasket. A clean smooth gasket is necessary to prevent leakage.)

3. Insert the valve into the gasket. Be careful to keep the valve seat clean and dry.

4. Apply caulking material, such as Rope Caulk from DAP, Inc., around the valve body to seal it to the gasket.

5. Place the gasket on the cylinder lip. Be careful so that no particle or dirt lodges between the cylinder lip and the gasket. (See Fig. 2.)

6. Assembly the cylinder. Position the cylinder so that the exhalation valve is in its normal operating position.

7. Attach hose numbers 7 and 9 to the cylinder using hose clamps. (See Fig. 3.)

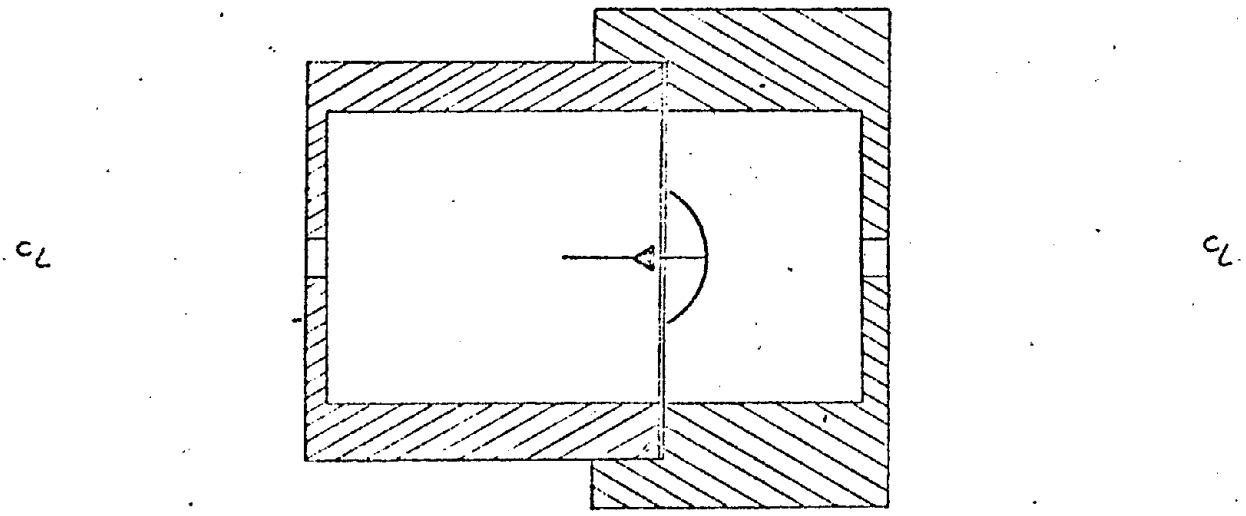


Fig. 2. Valve Holder - Assembled Unit with Valve in Place

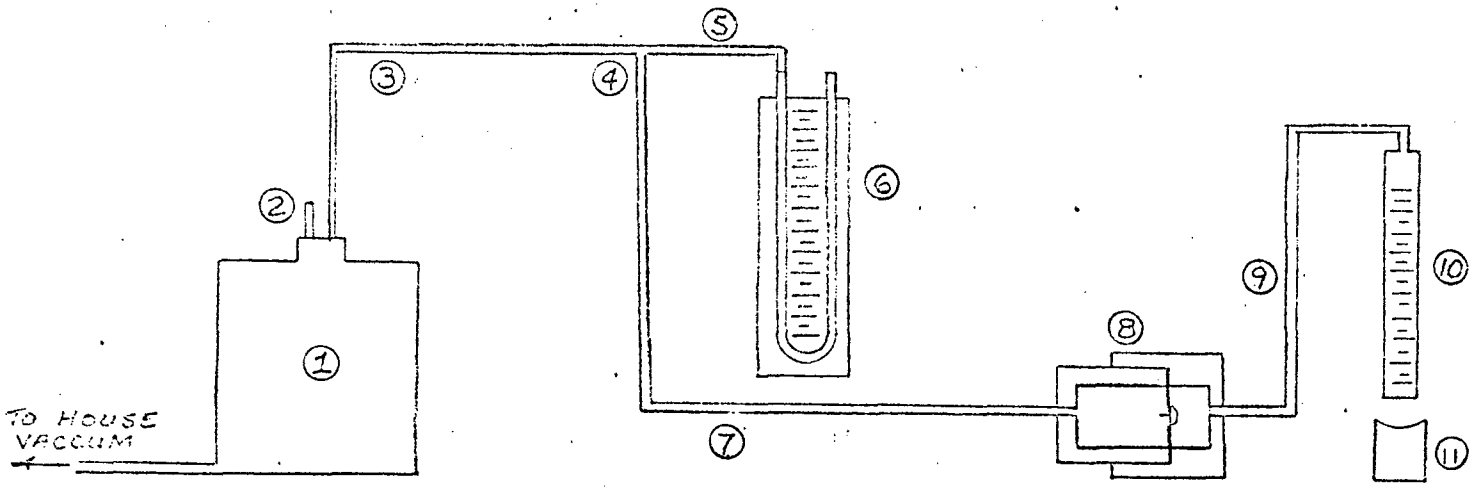


Fig. 3. Schematic Diagram of the System

1. Vacuum bottle (approx. 1 gal.) with three tube connections for house vacuum source, air inlet valve, and tubing to rest of system. This vacuum bottle apparatus allows an accurate control of small negative pressures to the system.
2. Short hose with pinch clamp for control of flow.
3. 1/2 in. I.D. hose approximately 2 1/2 feet in length.
4. 3-Way "T" hose connector.
5. 1/2 in. I.D. hose approximately 2 feet in length.
6. Open end water manometer.
7. 1/2 in. I.D. hose 3 to 4 inches in length.
8. Aluminum exhalation valve cylinder holder.
9. 1/2 in. I.D. hose approximately 2 1/2 feet in length.
10. Bubble flow meter apparatus.
11. Soap solution.

8. Test the system for leaks. (See Fig. 3.)

   (a) Clamp off hose number 9 completely. Apply a six inch vacuum to the system using the house vacuum valve. If the house vacuum is insufficient to maintain six inches, restrict the flow through the system using a pinch clamp at 2.

   (b) Clamp hose number 5 off completely. If the manometer starts to fall, there is a leak at the manometer connection and must be corrected before proceeding to (c).

   (c) Remove the clamp from hose 5. Clamp off hoses 7 and 3 in that order. If the manometer falls, there is a leak around the "T" connector and must be corrected before proceeding to (d).

   (d) Remove the pinch clamps from hoses 3 and 7. Replace the clamp on hose 3. If the manometer falls, there is a leak around the cylinder and must be corrected before proceeding to step 9.

9. Remove all pinch clamps from the interconnecting hoses.

10. Turn off the vacuum.

11. Completely open pinch clamp number 2. (See Fig. 3.)

12. Dip the bubblemeter in the soap solution to form a bubble.

13. Turn the vacuum supply on very slightly. Usually a vacuum of 0.10 inch will not seal the valve and the bubble will rise to the calibrated section of the bubblemeter.

14. Slowly increase the vacuum to 25 mm (1 in.) of water. If 25 mm is exceeded, return to zero vacuum and again slowly bring the vacuum to 25 mm.

15. Measure the leakage rate of the valve.

   (a) Start the stop watch as the bubble passes a graduation mark of the bubblemeter. Record this height.

   (b) At the end of one minute, record the new height of the bubble.

   (c) Repeat steps (a) and (b) three times to assure consistent results.

16. A minimum of three valves are tested in this manner.

ANALYSIS OF DATA

The maximum allowable valve leakage is 30 ml/min. The valve passes or fails on this basis.

Leakage = $H_f - H_i$

H_i = the initial height of the bubble.

H_f = the height of the bubble after one minute.

MAINTENANCE INSTRUCTIONS

1. Check the water level in the manometer. If the water level is not at zero, remove the top from the unconnected end (See Fig. 3.) and slowly add drops of distilled water until it reaches zero.

2. If the bubblemeter becomes dirty or clouded, wash and rinse it thoroughly.

APPENDIX A -- DATA SHEET

EXHALATION VALVE LEAKAGE TEST

(SAMPLE DATA SHEET)

Test Sheet No. _____ *Date:* _____

Project No.: _____

Company: _____

Respirator Type: _____

30 CFR Part 11 Reference: Subpart H 11-85-7 Exhalation Valve Leak Test

Requirement: Shall not exceed 30mm/min. at a suction of 25mm of water.

Valve #1:

Event No.	*Leakage-mm.*	*Time/Min.*	*Leakage-mm/Min.*
1.			
2.			
3.			

Average: *mm/Min.*

Valve #2:

Event No.	*Leakage-mm.*	*Time/Min.*	*Leakage-mm/Min.*
1.			
2.			
3.			

Average: *mm/Min.*

Valve #3:

Event No.	*Leakage-mm.*	*Time/Min.*	*Leakage-mm/Min.*
1.			
2.			
3.			

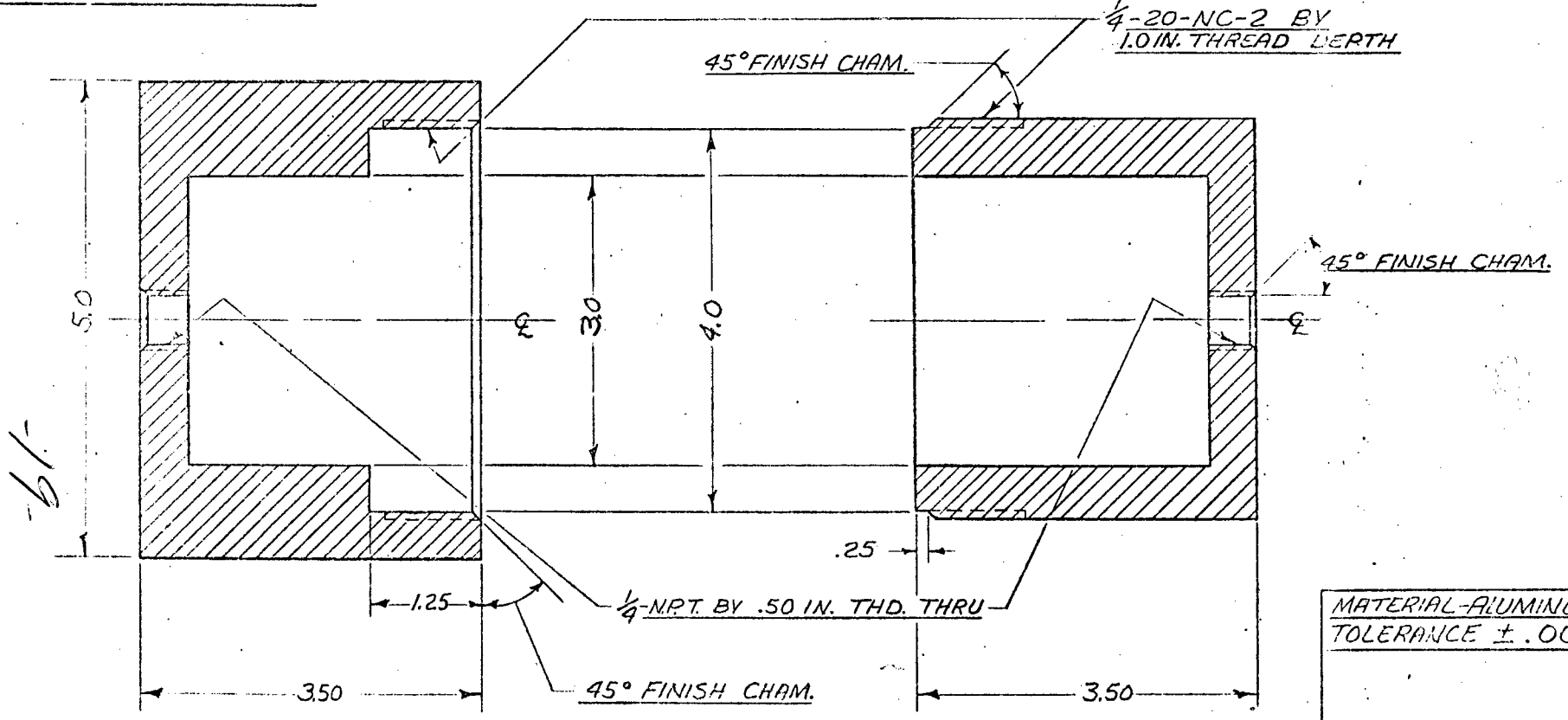
Average: *mm/Min.*

Comments: _____

Operator: _____

APPENDIX B -- VALVE HOLDER SCHEMATIC

NOTE - USE FOSTER BARBED INSERTS - M-7 1/4 NPT X 1/4 HOSE ID
OR SCOVILL HOSE CONNECTER - 400-0404 1/4 HOSE ID X 1/4 NPT
FOR END FITTINGS



MATERIAL-ALUMINUM
TOLERANCE ± .005

EXHALTION VALVE SYSTEM

SCALE 3/4

DWG. BY-
GRETA FAWCETT

VALVE HOLDER

APPENDIX C -- BIBLIOGRAPHY

1. Analytical Experimental Physics, Illinois, University of Chicago Press, 1937, pg. 131.

2. Interior, United States Department of, Federal Register, Part 11, Vol. 37, No. 59, March 25, 1972.

APPENDIX D -- GLOSSARY

1. Approval -- A certificate or formal document issued by the Bureau and the Institute stating that an individual respirator or combination of respirators has met the minimum requirements of Part 11, and that the applicant is authorized to use and attach an approval label to any respirator, respirator container, or instruction card for any respirator manufacturered or assembled in conformance with the plans and specifications upon which the approval was based, as evidence of such approval (Part 11, pg. 6247).

2. Leakage -- Amount of air escaping through the exhalation valve (measured on the positive pressure side) when a vacuum pressure of 25 mm of water is applied to the valve.

3. Respirator -- Any device to provide the wearer with respiratory protection against inhalation of a hazardous atmosphere (Part 11, pg. 6247).