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Progress Report

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Progress Report

Respirator Studies for the
AEC Division of Operational Safety

July 1 through December 31, 1973

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

MASTER

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This work supported by the U.S. Atomic Energy Commission's Division of Operational Safety.

MASTER

RESPIRATOR STUDIES FOR THE AEC DIVISION OF OPERATIONAL SAFETY

JULY 1 THROUGH DECEMBER 31, 1973

by

Bruce J. Held, Project Manager
Philip Lowry, Darell Bevis, Thomas Davis, Alan Hack, Louis Geoffrion,
Thomas Moore, John Pritchard, Charles Richards, Lloyd Wheat, and
Edwin C. Hyatt, Consultant

ABSTRACT

This report describes work performed by the LASL Respirator Research and Development Section, Industrial Hygiene Group, for the AEC Division of Operational Safety (DOS) during the first half of FY 1974. Major projects included providing respirator training for AEC contractors and AEC Operations Office personnel, testing various respiratory protective devices, evaluating the relationship between anthropometric characteristics of the working population and respirator performance, revising a draft of DOS Respirator Guide #1, and providing consulting services for the DOS and contractors.

I. INTRODUCTION

The LASL Respirator Research and Development Section was organized in July of 1969 to perform studies for the AEC Directorate of Regulatory Standards (DRS). The National Institute for Occupational Safety and Health (NIOSH) began providing additional support in 1971. Both of these organizations are still funding the Section. The AEC's Division of Operational Safety (DOS) began funding the Section in January 1973. Initially, two full-time technicians and the equivalent of 1/2 time of a staff member were funded by DOS. The DOS now supports two full-time technicians and the equivalent of one and a half staff members. Top priority DOS projects for FY 74 are to complete the first round training of AEC contractors and Operations Office personnel, test devices submitted by contractors, and finalize a respiratory protective device guide. Long term, ongoing studies and services performed for the DOS include:

1. Continued training of AEC contractors and Operations Office personnel.

2. Testing respiratory protective devices.

3. Study of anthropometric factors affecting the performance of respirators.

4. Study of the physiological factors affecting the efficiency, use, and acceptance of respirators.

5. Review breathing air quality standards.

6. Provide newsletters and video tapes on new equipment, test methods, and regulation changes to contractors and Operations Offices.

7. Provide consulting on matters related to respiratory protection.

Supplemental technical support for the above projects is provided by members of LASL Group H-5's Engineering, Bio-analytical and Chemical, and Aerosol Studies Sections.

II. TRAINING PROGRAM

The DOS respirator training program began in April of 1973. During the reporting period, July 1 to December 31, 1973, training

courses sponsored by DOS were attended by 53 people from 20 AEC contractors, 44 people from 5 AEC Operations Offices, 16 NIOSH people, and 41 OSHA people. Contractors and Operations Offices represented at the above mentioned training courses are listed in Appendix A.

The courses are directed toward personnel in charge of respirator programs. The basic training course covers, in three eight-hour sessions:

1. Acceptable respirator program to comply with OSHA, 29CFR Part 1910, "Occupational Safety and Health Standards," and American National Standards Institute (ANSI) Z88.2, "Practices for Respiratory Protection"

2. Methods of training

3. Methods of fitting (including qualitative and quantitative methods)

4. Actual training on selection, use, and fitting and training with;

- a. Air purifying devices

- b. Self-contained breathing devices (SCBA)

- c. Air line equipment

- d. Special Use equipment

5. Problems peculiar to the nuclear industry

The course includes classroom training and discussion with the use of visual aids, actual wearing and fitting of air purifying devices, actual wearing of airline and special use equipment, and a comprehensive classroom training on self-contained breathing apparatus plus a rigorous field exercise with the apparatus.

A major accomplishment during this reporting period was the production of a 30-minute respirator training video tape entitled, "30 Minute, Open Circuit, Compressed Air, Self-contained Breathing Apparatus," which discusses, in five sections:

1. Available types of self-contained breathing apparatus (SCBA) and their uses and limitations

2. SCBA parts and possible malfunctions

3. Operational checkout procedures

4. Donning procedures

5. Storage procedures

154 Respirator Training manuals were prepared and distributed to trainees during the reporting period. Trainees addresses have been coded and incorporated into a computerized mailing list.

The first newsletter is ready for distribution and will be circulated throughout the AEC family. Contents include articles on half mask respirators, chemical sorbent respirators, and pesticide respirators. A question and answer section and an enrollment form for the training course are also included.

III. TESTING OF RESPIRATORY PROTECTIVE DEVICES

A. Scott/Drager BG 174 and MSA McCaa

Quantitative man tests have been run on the MSA McCaa and the Scott/Drager BG 174. Both devices are self-contained, closed circuit, recirculating, oxygen breathing apparatus typically used in mine rescue operations. Both devices were tested on at least seven different test subjects in a chamber containing a polydispersed DOP aerosol (mass median aerodynamic diameter $\approx 0.6 \mu\text{m}$ and geometric standard deviation ≈ 1.5). Facepiece leakage of the test aerosol was determined by sampling from the facepiece with a LASL model 69B forward light scattering photometer at a flow rate of $0.000133 \text{ m}^3/\text{s}$ (8 liter/min). Pressure inside the facepiece was monitored with a calibrated pressure transducer. Exercise schedules and test results are presented in Tables I and II. For all exercises on both devices, the average peak pressure inside of the respirator facepiece was negative with respect to atmospheric pressure. It is therefore recommended that both devices be assigned a protection factor of not more than 100, consistent with protection factors assigned to other demand SCBA devices which allow facepiece pressure to drop below ambient on inhalation.

TABLE I
MAN TEST RESULTS FOR SCOTT/DRAGER BG 174

<u>Exercise</u>	<u>Average Peak Pressure Inside Facepiece on Inhalation</u>		<u>Average Indicated DOP Penetration (Complete Breathing Cycle)</u>	<u>Indicated DOP Penetration Range (Complete breathing Cycle) for 7 Test Subjects</u>
	<u>Inches Water (gauge)</u>	<u>Pascals (gauge)</u>	<u>%</u>	<u>%</u>
Normal Breathing	-0.85	-212.5	0.31	0.0 to 1.5
Deep Breathing	-1.55	-387.5	0.11	0.01 to 0.5
Side to Side	-1.0	-250.0	0.18	0.01 to 1.0
Up and Down	-1.1	-275.0	0.13	0.01 to .75
Talking	-1.5	-375.0	0.07	0.01 to 0.40
Normal Breathing	-1.2	-300.0	0.11	0.01 to 0.65
Two mph Treadmill	-1.2	-300.0	0.08	0.01 to 0.45
Three mph Treadmill	-1.3	-325.0	0.08	0.01 to 0.45
Four mph Treadmill	-1.5	-387.5	0.07	0.01 to 0.40
Resting	-1.2	-300.0	0.05	0.01 to 0.30
Normal Breathing	-1.3	-325.0	0.07	0.01 to 0.35
Average	-	-	0.11	-

TABLE II
MAN TEST RESULTS FOR MSA McCaa

<u>Exercise</u>	<u>Average Peak Pressure Inside Facepiece on Inhalation</u>		<u>Average Indicated DOP Penetration (Complete Breathing Cycle)</u>	<u>Indicated DOP Penetration Range (Complete breathing Cycle) for 7 Test Subjects</u>
	Inches Water (gauge)	Pascals (gauge)	%	%
Normal Breathing	-0.45	-112.5	0.15	0.03 to 0.70
Deep Breathing	-1.80	-450.0	0.15	0.02 to 0.85
Side to Side	-0.50	-125.0	0.11	0.01 to 0.60
Up and Down	-0.50	-125.0	0.04	0.01 to 0.24
Talking	-1.80	-450.0	0.08	0.01 to 0.35
Normal Breathing	-0.42	-105.0	0.09	0.01 to 0.40
Two mph Treadmill	-0.60	-150.0	0.05	0.01 to 0.30
Three mph Treadmill	-0.85	-212.5	0.03	0.01 to 0.20
Four mph Treadmill	-1.1	-275.0	0.07	0.01 to 0.50
Resting	-1.1	-275.0	0.05	0.01 to 0.35
Normal Breathing	-0.55	-137.5	0.05	0.01 to 0.20
Average	-	-	0.08	-

B. Automatic Data Processing

At the end of FY 1973, a project was begun to computer code all respirator man test results on file at LASL. This project is 95% completed.

Computer programs have been developed to search the coded data and retrieve all coded tests satisfying certain criteria specified by the programmer. Criteria by which tests are retrieved are:

1. Type of respirator (half mask, full facepiece)
2. Respirator manufacturer
3. Filter type (dust, fume, high-efficiency)
4. Test aerosol (monodispersed DOP, polydispersed DOP, NaCl)
5. Generator pressure if aerosol is NaCl
6. Exercise schedule

Any or all of the above may be specified. For example, the programmer can retrieve all coded tests on half masks using high efficiency filters when the test aerosol was monodispersed, 0.3 μ m, DOP. The programs also calculate penetration averages for each test, calculate penetration averages for all tests, and calculate frequency distributions of aerosol facepiece leakage in terms of the percent of test subjects having facepiece leakage less than each of several stated values. Other programs inspect the coded test and correct simple coding mistakes. A permanent file of program results is maintained.

C. Use of Paid Volunteers for Quantitative Respirator Man Test

The use of two test aerosols, sodium chloride and DOP (dioctyl phthalate), on paid volunteers is being reviewed by the LASL Human Use Committee for compliance with regulations of the University of California and the Department of Health Education and Welfare. Permission to conduct experiments is expected early in 1974, at which time subjects will be selected and measured.

IV. ANTHROPOMETRIC STUDIES

This project was initiated to develop respirator testing methods to predict a respirator's performance on a working population composed of a large variety of facial shapes. A scheme was developed for selecting respirator test subjects with facial dimensions representative of the American working population. In the scheme, facial dimensions obtained from USAF anthropometric surveys are used to establish limits and subgroups for test panels. The test panel to be used for testing full facepiece respirators is presented in Figure I. Twenty-five subjects are divided into ten groups on the basis of face length (distance from chin to nasal root depression) and face width (distance across the widest part of the cheek). Face length correlates strongly with the distance from the chin to the eyebrows, the minimum length a full facepiece can be and not have the sealing surface across the eyebrows. Face length is used here because the measuring points, chin and nasal root depression, are clearly defined. Face width is used because all full facepiece respirators currently available seal on the points across which this measurement is made.

The test panel for testing half mask respirators is shown in Figure II. Twenty-five subjects are divided into ten groups, as with the panel for full facepiece respirators. In this case, lip length (width of the lips, mouth closed) and face length are the criteria for subgrouping test subjects. Lip length is used because a half mask will not seal if it is not wider than the lips. Face length is used because the measuring points are clearly defined and because there is good correlation between face length and the distance from the chin to the nasal bridge, the optimum length for half mask respirators. (Masks much longer will interfere with eyeglasses, while shorter masks could interfere with breathing through the nose).

Approximately 95% of the American working population, both male and female, have facial dimensions within the limits of each of the test panels. For a more complete discussion of respirator test panels, refer to Los Alamos Scientific Laboratory Report LA-5488, "Selection of Respirator Test Panels Representative of U.S. Adult Facial Dimensions."

V. RESPIRATOR GUIDE #1

A draft of Respirator Guide #1 is being revised to include protection against non-radioactive airborne materials. When completed, this draft will be circulated within the AEC for comments.

VI. CONSULTING SERVICES FOR DOS AND CONTRACTORS

A. Army M9/M9A1

The U.S. Army M9/M9A1 respirators were evaluated for the AEC, DOS Ad Hoc Respirator Committee. The M9/M9A1 was evaluated for performance characteristics and economy of production. A report of this evaluation was sent to the DOS.

* Males and females having the same facial dimensions are considered equivalent. The designations here indicate most probable sex of subject.

Figure I

Panel for Testing Full Facepiece Respirators
25 Test Subjects, Male (m) and Female (f)*

B. Review of Contractor Respirator Programs

The Oak Ridge (Y-12) respirator program and the Aerojet Nuclear Corporation respirator program were reviewed. The written procedures for Goodyear Atomic's respirator program was also reviewed. A report of the Aerojet Nuclear Corporation review was submitted to AEC, IDO.

C. Respirator Quality Assurance Questionnaire

To determine what quality control procedures are needed by contractors using respirators, a questionnaire was prepared and will be mailed to contractors by the DOS, Washington. A copy of this questionnaire is included as Appendix B.

D. Miscellaneous Consulting

Numerous written and phone consulting occurred during this reporting period, both for contractors and Operations Offices.

* Males and females having the same facial dimensions are considered equivalent. The designations here indicate most probable sex of subject.

Figure II

Panel for Testing Half Mask Respirators
25 Test Subjects, Male (m) and Female (f)*

APPENDIX A

AEC CONTRACTORS AND OPERATIONS OFFICES REPRESENTED AT RESPIRATOR TRAINING COURSES HELD DURING THE PERIOD JULY 1 TO DECEMBER 31, 1973

Contractors - 53 People:

1. University of California - LASL	11. Union Carbide Corporation, Oak Ridge
2. Oak Ridge National Laboratory	12. Argonne National Laboratory
3. Goodyear Atomic	13. Holmes and Narver, Honolulu
4. Dow Chemical	14. E G & G, San Ramon and Las Vegas
5. National Lead Company of Ohio	15. Knolls Atomic Power
6. Lovelace Foundation	16. Battelle Memorial Institute
7. Mason and Hanger - Silas Mason	17. Aerojet Nuclear
8. Sandia Livermore	18. Allied Chemical Corporation
9. Princeton University	19. Bendix Corporation
10. University of California, Livermore
Berkeley Laboratory	20. Reynolds Electric and Engineering Co.

Operations Offices - 44 People

1. Idaho Falls	4. Albuquerque
2. Oak Ridge	5. Richland
3. Chicago	

APPENDIX B

QUALITY ASSURANCE QUESTIONNAIRE

The Respirator Research and Development Section at Los Alamos is compiling information on respirator quality assurance programs being carried out by AEC contractors. Results will be studied and tabulated in an attempt to learn what each contractor is doing and what improvements or changes can be suggested.

The purpose of a quality assurance program is to assure that respiratory protective equipment, both new and used, will function properly when it is needed. Such assurance can only be given after physical inspection, for new devices as received from the manufacturer, and for used devices after laundering and maintenance have been performed. The following questions are asked in the spirit of information-seeking only, and will not be used to rate the respondents. Please give as much information as you can in answering these questions.

- 1) Contractor _____
No. of employees _____
No. of employees who use respirators often (several times per month) _____
- 2) For air purifying devices:
No. kept in stock _____
No. turned over per month (cleaned and reissued, or discarded and replaced) _____
No. of filters discarded or checked and reissued per month _____
- 3) For self-contained breathing apparatus:
No. of devices in stock _____ No. of uses per month _____
- 4) Who controls the ordering, issuing, and maintenance of respiratory equipment;
Industrial Hygiene _____, Safety _____, Health Physics _____, or other group _____.
- 5) Do you have a quality assurance program with written procedures? _____

APPENDIX B (Continued)

- 6) Do you have any special equipment for testing and maintaining respirators, such as aerosol generating and detecting equipment, filter test jigs, test heads, equipment for adjusting regulators, etc? _____
- 7) Describe any checks or inspections on facepieces, such as examination of valves, straps, breathing tubes, etc. _____
What type of leak tests, if any, are done, such as positive or negative pressure, use of aerosols or test atmospheres, etc?
Other tests _____
How much time is spent on each mask? _____
- 8) What tests are performed on filter cartridges? _____
If tests are done, what percentage of new filters fail, used filters fail?
List by brand. _____

- How many times may filters be reused? _____
- 9) If sorbent cartridges are used, what tests are performed _____
- 10) What tests are performed on assembled respirators? _____

Please return questionnaire and any additional information to:

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