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Respirator Studies Related to the AEC Directorate of Regulatory Standards

January 1 through December 31, 1973

by

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**RESPIRATOR STUDIES RELATED TO THE
AEC DIRECTORATE OF REGULATORY STANDARDS
January 1 through December 31, 1973**

by

**Bruce J. Held, Project Manager
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**Edwin C. Hyatt, Consultant
(Project Manager, January 1 through June 30, 1973)**

ABSTRACT

During calendar year 1973, the LASL Respirator Research and Development Section, Industrial Hygiene Group, performed laboratory studies and consulting services for the AEC Directorate of Regulatory Standards (DRS). Major efforts included writing a draft of a manual for respiratory protection against airborne radioactive materials, organizing and hosting a respirator symposium (sponsored jointly by DRS, LASL, and the AEC's Division of Operational Safety), providing respirator training for AEC Regional Office personnel, testing special respiratory protective devices, working on development of a rapid method for fitting individuals with respirators on the basis of facial dimensions, and providing consulting services for the DRS.

I. INTRODUCTION

The LASL Respirator Research and Development Section, Industrial Hygiene Group, 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) and the AEC Division of Operational Safety (DOS) began funding the section in 1971 and 1973, respectively. All three organizations are presently supporting various projects related to respiratory protection. Some projects are jointly sponsored, allowing a more concentrated and efficient

effort to be directed toward these projects. Progress reports are prepared for each sponsor concerning projects for which they provide funds. Each sponsor also receives copies of the other two sponsors' progress reports.

During calendar year 1973, top priority DRS projects were to complete the first draft of a manual on respiratory protection against airborne radioactive material, provide training in respiratory protection to AEC Regional Office personnel, and organize and host a respiratory symposium. A project

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of slightly lower priority was the development of a rapid method for fitting individuals with respirators on the basis of facial dimensions. Long term DRS projects include:

1. Continue evaluation of all types of respirators.
2. Provide consultation on respiratory protection problems as requested by the Director of Regulations.
3. Continue to provide the Regulatory staff with training, including video tapes on 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. DRS RESPIRATOR MANUAL

In 1963, the American Industrial Hygiene Association (AIHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) published a Respiratory Protective Devices Manual¹ as a guide for health physicists, industrial hygienists, and other health and safety specialists. This manual was prepared jointly by representatives of the U.S. Bureau of Mines, AEC contractors, respirator manufacturers, and other industry and university specialists. In May 1963, the AEC's Division of Licensing and Regulation sponsored a Respiratory Protective Equipment Conference at the Harvard School of Public Health to examine and evaluate practices and other information on the use of respirators for protection against airborne radioactive hazards. This meeting used the 1963 Respirator manual as a primary reference. Following this AEC sponsored conference it was decided to prepare an AEC guide covering the aspects of respiratory protection peculiar to the needs of its licensees. A draft was prepared with the assistance of the Harvard University Graduate School of Public Health, and a review conference, sponsored by the AEC's Division of Safety Standards, was held in April of 1965 at AEC Headquarters.

The results of these conferences, together with information from the AEC's Division of Operational Safety (DOS) regarding the practices of AEC prime contractors, and information from a draft of a United States of America Standards Institute (USASI) code of recommended practice for respiratory protection then being prepared by the ZP3 Sectional Committee, were used extensively in a second draft of this guide, dated October 1967. This draft guide was made available for review and comment in connection with an AEC Notice of Proposed Rulemaking concerning use of respiratory protective equipment (32 FR 15432). Comments received on the proposed rule and draft guide demonstrated a need for development of additional technical information on use of respirators.

Since 1969, the Directorate of Regulatory Standards has supported a respiratory protection studies project in the Respirator Research and Development Section, Industrial Hygiene Group at Los Alamos Scientific Laboratory to develop necessary information for final preparation of this guide.

Early in calendar year 1973, the first draft of a manual on respiratory protection against airborne radioactive material was completed. This first draft was critically reviewed by personnel in the AEC DRS and DOS. Comments from these two organizations were used to prepare a second draft, which was reviewed by AEC DRS and members of the AIHA-ACGIH Joint Respirator Committee. Subsequent comments resulted in a third draft, completed in December of 1973. The table of contents of this third draft, entitled "Respiratory Protection Against Airborne Radioactive Materials," is included as Appendix A.

III. RESPIRATOR SYMPOSIUM

A respirator symposium, jointly sponsored by the DRS, DOS, and the LASL Respirator R & D Section, Industrial Hygiene Group, was held at LASL on February 6, 7, and 8, 1973. Approximately 75 AEC contractor and

licensee personnel attended. The symposium consisted of 10-minute reports on licensees' and contractors' respirator programs, invited papers, and two panel discussions. (See Appendix B for the symposium agenda and list of companies represented.)

The overall impression gained from the various presentations was that many respirator programs were being upgraded, but all had major weaknesses. Many of the weaknesses were due, in part, to a lack of available information on specific subjects. These included medical limitations of users, proper training methods (including visual aids), and backup data to obtain management support.

IV. RESPIRATOR TRAINING

During calendar year 1973, respirator training courses sponsored by the DRS were presented by the LASL Respirator Research and Development Section to 14 people at the AEC Region I Compliance Office, 9 people at the AEC Region II Compliance Office, and 22 people at the AEC Region III Compliance Office. The basic training course covers, in two or 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) 288.2, "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

- 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, wearing and fitting of air purifying devices, air line and special use equipment, and self-contained breathing apparatus. The

training course outline is presented in Appendix C.

A major accomplishment during this reporting period was the production of a 38-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.

At the respirator symposium held at LASL in February of 1973, it was suggested that a newsletter be published to keep AEC licensees and contractors updated on such things as revisions of laws governing respiratory protection, new developments at AEC contractor and licensee installation and certification of respiratory protective equipment. The LASL Respirator Research and Development Section agreed to publish such a newsletter with funding provided jointly by the DOS and DRS. The first newsletter is now 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 is also included.

V. TESTING OF RESPIRATORY PROTECTIVE DEVICES

As part of a program of respirator evaluation for the DRS, Mound Laboratory's and Snyder Manufacturing Company's atmosphere supplying suits were tested in a chamber containing a polydispersed DOP aerosol (mass median aerodynamic diameter $\approx 0.75 \mu\text{m}$ and geometric standard deviation ≈ 1.8) for aerosol penetration, air temperature in the suit, pressure in the suit, and wearer comfort. Aerosol penetration was determined by sampling from the wearer's breathing area (inside the suit) with a LASL Model 69B

forward light scattering photometer at a flow rate of $0.000133 \text{ m}^3/\text{s}$ (8 liter/min). Suit internal pressure was monitored at chest level with a differential pressure transducer. Only relative pressure was indicated, as the pressure transducer was not calibrated. Air temperature in the suit was monitored at the upper chest, forearm, and mid-calf areas with thermistor thermometer probes.

Air at 296°K (23°C) and 5% relative humidity was supplied to both suits at flow rates ranging from $4.72 \times 10^{-4} \text{ m}^3/\text{s}$ (1 CFM) to $47.2 \times 10^{-4} \text{ m}^3/\text{s}$ (10 CFM). Flow rates were incremented in $4.72 \times 10^{-4} \text{ m}^3/\text{s}$ (1 CFM) steps, and a complete test was done at each flow rate.

The waistband of the Mound suit pants had a tendency to work down. Suspenders were fashioned to alleviate this problem, and the suit was tested both with and without suspenders. The Mound suit always maintained a positive internal pressure, even at the lowest flow rates, while the Snyder suit internal pressure was never

measurably positive. Internal air temperature was comparable for both suits, ranging from 299°K (26°C) to 305°K (32°C). Both suits were uncomfortably hot in the leg area, and both air delivery systems irritated the wearer's eyes.

Exercise schedules and indicated aerosol penetration are presented in Tables I, II, and III for the Snyder suit, the Mound suit without suspenders, and the Mound suit with suspenders, respectively. The Mound suit without suspenders showed erratic aerosol penetration (Table II, bending and running exercises), believed to be caused by the pants working down, as erratic penetration did not occur when suspenders were used. As indicated in the tables, the Mound suit with suspenders showed less DOP penetration than either the Mound suit without suspenders or the Snyder suit. A complete report and a recommendation that the Mound suit be used in preference to the Snyder suit was sent to the DRS.

TABLE I
INDICATED DOP
PERCENT PENETRATION vs EXERCISE
AT VARIOUS FLOW RATES: SNYDER SUIT

FLOW RATE ($\text{m}^3/\text{s} \times 10^{-4}$)	4.7	9.44	14.2	18.9	23.6	28.3	33.0	37.8	42.5	47.2
FLOW RATE (CFM)	1	2	3	4	5	6	7	8	9	10
EXERCISE										
Standing	T*	0.01	0.003	0.001	0.02	0.01	0.001	0.001	0.001	0.001
Bending		2.0	1.5	3.5	1.0	1.1	0.28	0.50	1.0	1.3
Running	T	T	1.5	1.6	4.8	1.0	1.5	0.2	0.55	0.012
Lifting arms	T	T	1.0	1.2	0.9	2.4	0.45	0.4	1.3	0.32
Twisting	T	T	0.5	6.0	0.22	1.9	0.12	0.3	0.17	0.028
Standing	T	T	0.008	0.001	0.02	0.013	0.001	0.002	0.001	0.001
Purge time from maximum leakage Seconds	T	>120	90	90	60	60	60	90	60	30

* T indicates test was terminated due to excessive DOP penetration.

TABLE II
INDICATED DOP
PERCENT PENETRATION vs EXERCISE
AT VARIOUS FLOW RATES: MOUND SUIT - WITHOUT SUSPENDERS

FLOW RATE (m ³ /s x 10 ⁺⁴)	4.7	9.44	14.2	18.9	23.6	28.3	33.0	37.8	42.5	47.2
FLOW RATE (CFM)	1	2	3	4	5	6	7	8	9	10
EXERCISE										
Standing	0.001	0.001	0.002	0.004	0.001	0.003	0.001	0.004	0.001	0.001
Bending	1.8	0.014	0.04	0.35	0.005	0.024	0.022	0.004	0.020	0.001
Running	1.6	0.017	0.011	8.0	0.004	0.84	-	0.014	0.001	0.001
Lifting arms	T*	0.004	0.005	-**	0.001	-	-	0.004	0.053	0.001
Twisting	T	0.002	0.004	-	0.002	-	-	0.005	0.001	0.001
Standing	T	0.002	0.003	0.005	0.001	0.003		0.004	0.001	0.001

Purge time from
maximum leakage
Seconds 210 90 180 270 - - - 60 120 <30

* T indicates test was terminated due to excessive DOP penetration.

** (-) indicates readings were indeterminable.

TABLE III
INDICATED DOP
PERCENT PENETRATION vs EXERCISE
AT VARIOUS FLOW RATES: MOUND SUIT - WITH SUSPENDERS

FLOW RATE (m ³ /s x 10 ⁺⁴)	4.7	9.44	14.2	18.9	23.6	28.3	33.0	37.8	42.5	47.2
FLOW RATE (CFM)	1	2	3	4	5	6	7	8	9	10
EXERCISE										
Standing	T*	0.002	<0.001	0.001	0.002	0.002	0.001	0.001	0.002	<0.001
Bending	T	0.004	0.19	0.003	0.032	0.004	0.002	0.011	0.003	<0.001
Running	T	0.26	0.16	0.015	0.013	0.006	0.003	0.002	0.002	<0.001
Lifting arms				0.005	0.004	0.004				
Twisting				0.005	0.004	0.003				
Standing				0.002	0.002	0.003				

Purge time from
maximum leakage
Seconds <30 <30 <30 60 60 30 <30 <30 <30 <30

* T indicates test was terminated due to excessive DOP penetration.

VI. RAPID METHOD OF RESPIRATOR SELECTION

As part of an agreement for fiscal year 1974, the LASL Respirator Research and Development Section agreed to develop, for DRS, a rapid field method of selecting respirators according to individual facial dimensions. Such a method would, hopefully, assure an individual of optimum respiratory protection even though no quantitative leak test was performed. This project resulted as an outgrowth of anthropometric studies performed by the LASL Respirator Research and Development Section for the NIOSH and DOS. While a suitable field method for selecting respirators was not developed in the first half of FY 1974 (last half of calendar year 1973), a scheme for selecting respirator test panels on the basis of facial dimensions was developed for the NIOSH and DOS.² The use of two test aerosols, sodium chloride and DOP (dioctyl phthalate), on paid test subjects is being reviewed by the LASL Human Use Committee for compliance with regulations of the University of California and the U.S. Department of Health Education and Welfare. Permission to conduct experiments is expected early in calendar year 1974. The volunteers will be divided into groups (test panels) on the basis of facial dimensions, and used as test subjects for quantitative man tests. Data from these tests should aid in developing rapid methods of respirator selection.

VII. CONSULTING SERVICES FOR DRS

Numerous written and phone consulting occurred during this reporting period, both for licensees and Regional Offices. A few examples of information requests received during calendar year 1973 are listed below to illustrate the nature of consulting services provided.

1. AEC Region I requested information on NIOSH and Bureau of Mines approved respiratory protective devices.

2. General Electric Illinois Fuel Reprocessing Plant requested information on protection factors of supplied air suits.

3. AEC DRS requested information on supplied air suits which would provide protection for up to six hours in reactor control rooms following high level chlorine releases.

4. Arkansas Nuclear I requested basic information on establishing an acceptable respirator program.

REFERENCES

1. Respiratory Protective Devices Manual, (American Industrial Hygiene Association and American Conference of Governmental Hygienists, Ann Arbor, 1963).
2. Alan Hack, E.C. Hyatt, B.J. Held, T.O. Moore, C.P. Richards and J.T. McConville, "Selection of Respirator Test Panels Representative of U. S. Adult Facial Sizes," Los Alamos Scientific Laboratory Report LA-5488 (March 1974).

APPENDIX A

RESPIRATORY PROTECTION AGAINST AIRBORNE RADIOACTIVE MATERIALS

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REFERENCES

APPENDIX B

RESPIRATOR SYMPOSIUM FOR AEC CONTRACTOR AND LICENSEE HEALTH AND SAFETY PERSONNEL

February 6, 7, and 8, 1973

Tuesday, February 6

Chairman - Dr. Don Ross, DOS

- 8:15 - 8:30 a.m. - Registration (Note: Buses will leave motels for Auditorium promptly at 8:00 a.m.)
- 8:30 - 8:45 a.m. - Welcome - Harold M. Agnew, Director, LASL; George L. Voelz, M.D., Health Division Leader, LASL; Harry F. Schulte, Industrial Hygiene Group Leader, LASL Announcements
- 8:45 - 9:00 a.m. - Minimum Acceptable Respirator Program Specified in ANSI Z88.2 - Dr. Don Ross, DOS
- 9:00 - 10:00 a.m. - Contractor and Licensee Reports
- 10:00 - 10:30 a.m. - Coffee Break
- 10:30 - 11:30 a.m. - Contractor and Licensee Reports
- 11:30 - 12:30 - Lunch
- Chairman - Bruce Reinert, ALOO
- 12:30 - 3:00 p.m. - Contractor and Licensee Reports
- 3:00 - 3:30 p.m. - Coffee Break

Tuesday, February 6 (contd)

- 3:30 - 3:50 p.m. - Freon Man Test Systems - Maureen Hamilton; Environmental Health Sciences, Hanford Environmental Health Foundation
3:50 - 4:10 p.m. - DOP Man Test Systems - G. Sauders, REECO, NTS
4:10 - 4:30 p.m. - Respirator QC Program at Rocky Flats - C. Skaats, Dow Chemical Company
4:30 - 4:50 p.m. - The Development of the Mound Laboratory Supplied Air Bubble Suit - G. Phillabaum, Mound Laboratory

Wednesday, February 7

Chairman - Ed Hyatt, LASL

Announcements

- 8:30 - 9:30 a.m. - Contractor and Licensee Reports
9:30 - 9:50 a.m. - Respirator Cartridge Efficiency Studies at LLL - G. Nelson, LLL
9:50 - 10:20 a.m. - Coffee Break
10:20 - 10:40 a.m. - Methyl Iodide Adsorption Efficiencies of Impregnated Carbons - Dr. D. T. Pence, Allied Chemical Corporation, Idaho Falls
10:40 - 11:00 a.m. - LASL Anthropometric Survey and Selection of a Representative Test Panel - A. Hack, LASL
11:00 - 11:20 a.m. - DOS and DREP Sponsored Respirator R & D at LASL - J. Caplin, DREP, and J. Maher, DOS
11:20 - 12:20 - Lunch

Chairman - Jerrold Caplin, DREP

- 12:20 - 12:40 p.m. - LASL Respirator R & D Projects and Their Relationships to Amendments of 30 CFR Part 11 and OSHA Standards - Ed Hyatt, LASL
12:40 - 1:00 p.m. - Interim Protection Factors for High-Efficiency Filter Respirators and SCBA - John Pritchard, LASL
1:00 - 1:20 p.m. - Interim Protection Factors for Disposable and Dust Respirators - Charles Richards, LASL
1:20 - 1:40 p.m. - SCBA Training Program at LLL - S. Walker, LLL
1:40 - 2:00 p.m. - LASL Respirator Training and AEC Program being Developed for Contractors - Bruce J. Held, LASL
2:00 - 3:00 p.m. - Review and Presentation of Various Visual Aids on Respiratory Protective Devices Training - Darell Bevis, LASL
3:00 - 3:30 p.m. - Coffee Break
3:30 - 3:50 p.m. - Visual Aids Continued
3:50 - 4:50 p.m. - Panel Discussion on Film, Videotape, and Slide/Tape Production Costs and Benefits: Panel - Moderator, J. Maher, DOS; N. Bolton, ORNL; J. Caplin, DREP; R. Colgan, Sandia; B. Held, LASL; J. Lipera, LLL; R. Wellnitz, LASL
5:15 - 6:30 p.m. - Social Hour at the Red Room (Beside Science Museum) Hosted by Harold M. Agnew, Director, LASL
7:30 p.m. - Dinner at Community Hall - M.C., Ed Hyatt; Speaker, Edwin J. Kloos, U.S. Bureau of Mines, Pittsburgh, Pa.

Thursday, February 8

Moderator - Dr. Don Ross, DOS

Announcements

- 8:30 - 12:00 noon - Panel Discussion on Problems and Recommendations Not Covered. Open to all attendees for questions and comments. Panel - J. Maher, DOS; J. Caplin, DREP; E. Hyatt, LASL; E. Kloos, B of M; J. Lipera, LLL
12:00 - 1:00 p.m. - Lunch
1:00 - 3:00 p.m. - Tour and Demonstration of LASL Man Test Systems

Respirator Symposium Attendees

Please list below any topics, questions, or problems you have on respirators which you would like the panel to discuss on Thursday morning. Turn in to Don Ross or any of the panel members before Thursday.

CONTRACTORS AND LICENSEES REPRESENTED

Aerojet Nuclear Co. Idaho Falls, Idaho	(C)	Mason & Hanger-Silas Mason Co. Burlington, Iowa	(C)
Allied Chemical Corp. Idaho Falls, Idaho	(C)	Monsanto Research Corp. Dayton, Ohio	(C)
Allied Gulf Nuclear Services Barnwell, South Carolina	(L)	National Lead Company of Ohio Cincinnati, Ohio	(C)
Argonne National Laboratory Argonne, Illinois	(C)	Nine Mile Point Nuclear Station Lycoming, New York	(L)
Argonne National Laboratory Idaho Falls, Idaho	(C)	Nuclear Fuel Services West Valley, New York	(L)
Battelle Columbus Labs Columbus, Ohio	(C)	Reynolds Electrical & Engineering Nevada Test Site	(C)
Battelle Pacific Northwest Lab Richland, Washington	(C)	Rochester Gas & Electric Co. Rochester, New York	(L)
Bendix Corporation Kansas City, Missouri	(C)	Sandia Laboratories Albuquerque, New Mexico	(C)
Boston Edison Co. Plymouth, Massachusetts	(L)	United Power Association Elk, River, Minnesota	(C-L)
Dairyland Power Cooperative Genoa, Wisconsin	(C-L)	University of California - LASL Los Alamos, New Mexico	(C)
Dow Chemical Company Rocky Flats, Colorado	(C)	University of California - LBL Berkeley, California	(C)
E. I. DuPont deNemours & Co. Aiken, South Carolina	(C)	University of California - LLL Livermore, California	(C)
Exxon Nuclear Richland, Washington	(C)	Union Carbide Corp. - ORNL Oak Ridge, Tennessee	(C)
Florida Power & Light Co. Miami, Florida	(L)	Union Carbide Corp. - K-25 Oak Ridge, Tennessee	(C)
Goodyear Atomic Corp. Piketon, Ohio	(C)	Union Carbide Corp. - Y-12 Oak Ridge, Tennessee	(C)
Hanford Environmental Health Foundation Richland, Washington	(C)	Union Carbide Corp. Paducah, Kentucky	(C)
Kerr-McGee Grants, New Mexico	(L)	Union Carbide Corp. Grand Junction, Colorado	(L)
Lovelace Foundation for Med. Ed. Albuquerque, New Mexico	(C)	(C) Contractor	
Mason & Hanger-Silas Mason Co. Amarillo, Texas	(C)	(L) Licensee	

APPENDIX C

AEC REGIONAL COMPLIANCE OFFICE TRAINING OUTLINE

1.0 Introduction

Minimal Acceptable Respirator Program! What is it? On December 29, 1970, Congress approved the Occupational Safety and Health Act (OSHA) which became law 120 days later on April 28, 1971. Section 1910.134 of OSHA, Respiratory Protection, outlines the minimal acceptable program. Prior to enactment of OSHA, a guide to respirator use could be found in ANSI Z88.2 "Practices for Respiratory Protection," approved as an American National Standard on August 11, 1969. Prior to Z88.2, there were no guidelines for a minimal program. Z88.2 is the core for section 1910.134 of OSHA and it is implied that compliance with OSHA is compliance with Z88.2 in its entirety. Since enactment of OSHA, all respirator users have scrambled to bring their programs into compliance but find that some requirements and nomenclatures need further definition.

Title 10 - Code of Federal Regulations - Part 20, Standards for Protection Against Radiation, adds additional regulations for use of respiratory protective equipment for protection against radioactive contaminants. As with OSHA and Z88.2, further explanation and definition is needed.

Our aim is to provide information that will help clarify the intentions and meaning of these requirements.

1.1 Purpose

- 1.1.1 Provide information and definition relevant to OSHA and Z88.2
- 1.1.2 Provide information and definition of 10 CFR 20

1.1.3 Training of compliance officers to enable them to competently inspect and make recommendations on an entire respirator program

1.1.4 Provide updated information relevant to changes in all aspects of respiratory protective equipment and respirator programs

1.1.5 Provide information on respiratory protection for the unique problems of the nuclear industry

1.2 Scope

1.2.1 Provide training and information on:

- a. accepted methods of fitting and training
- b. accepted laundering and maintenance program
- c. accepted quality assurance methods
- d. program administration including SOP's
- e. problems unique to the nuclear industry

1.2.2 Demonstration of faulty equipment

2.0 Permissible Practice

2.1 Prevent atmospheric contamination

2.1.1 Enclosure or confinement of operation

2.1.2 General or local exhaust ventilation

2.1.3 Less toxic materials

2.2 Respirator use

2.2.1 When engineering controls not feasible or are being instituted or in event of an emergency

- 2.2.2 Provide respirators that are applicable and suitable
- 2.2.3 Establish a fitting, training and maintenance program
- 2.2.4 Approved or accepted devices
 - 2.2.4.1 Bureau of Mines/NIOSH
 - 2.2.4.2 LASL testing (accepted)
- 3.0 Program Administration
 - 3.1 Responsibility of program shall be vested in one qualified individual
 - 3.1.1 Upper-level superintendent
 - 3.1.2 Foreman
 - 3.1.3 Other qualified individual
 - 3.1.3.1 Administrator shall have sufficient knowledge of subject
- 4.0 Minimal Acceptable Program (ANSI Z88.2)
 - 4.1 Written SOP's on all sub-categories of 4.0
 - 4.2 User training and education
 - 4.2.1 What is hazard and why wear respirator
 - 4.2.2 Why is hazard present - control
 - 4.2.3 Respirator capabilities and limitations
 - 4.2.4 Respirator inspection prior to use (selection)
 - 4.2.5 Instruction and training in actual use of respirator
 - 4.2.5.1 Donning of device and wearing for reasonable period in normal air
 - 4.2.5.2 Testing facepiece to face seal in test atmosphere
 - 4.2.5.3 Field training to recognize and cope with emergency situations
 - 4.2.5.4 Other special training as needed for special problems
- 4.3 Fitting - Testing facepiece to face seal
 - 4.3.1 Qualitative testing
 - 4.3.1.1 Amyl-acetate
 - 4.3.1.1.1 Chamber or special room
 - 4.3.1.1.2 Stencil Brush (Field)
 - 4.3.1.1.3 Plastic shroud
 - 4.3.1.2 Irritant smoke (smoke tube or smoke house)
 - 4.3.2 Quantitative testing
 - 4.3.2.1 DOP
 - 4.3.2.1.1 Thermally generated
 - 4.3.2.1.2 Air jet generated
 - 4.3.2.2 Sodium chloride
 - 4.3.2.3 Freon 12
 - 4.3.3 Field test by user (after proper fitting)
 - 4.3.3.1 Negative pressure test
 - 4.3.3.2 Positive pressure test
- 4.4 Respirator Selection
 - 4.4.1 Competent person making selection
 - 4.4.2 Selection guide
 - 4.4.2.1 Based on quantitative testing for application to qualitative testing
 - 4.4.3 Respirator selection based on hazard
 - 4.4.3.1 Oxygen deficiency
 - 4.4.3.2 Immediately dangerous to life or health
 - 4.4.3.3 Not immediately dangerous to life or health

- 4.5 Issue of masks
 - 4.5.1 Issued by qualified individual
 - 4.5.1.1 Non-personal issue
 - 4.5.1.2 Personal issue
 - 4.5.1.2.1 Labeling
 - 4.5.1.2.2 Storage space
- 4.6 Cleaning and maintenance
 - 4.6.1 Work done only by experienced people
 - 4.6.2 Masks cleaned and disinfected
 - 4.6.2.1 After each use for non-personal issue
 - 4.6.2.2 Personal issue masks on regular schedule or as needed
 - 4.6.2.3 Decontamination
 - 4.6.3 Replace worn or damaged parts
 - 4.6.4 Inspect for defects
 - 4.6.4.1 Leak check
- 4.7 Inspection and storage
 - 4.7.1 Inspection
 - 4.7.1.1 Inspected when cleaned
 - 4.7.1.2 Monthly if not routinely used or if device is an emergency unit
 - 4.7.1.3 Checklist for inspection
 - 4.7.2 Storage
 - 4.7.2.1 Clean area
 - 4.7.2.1.1 Contamination, dry, sunlight, etc.
 - 4.7.2.2 Readily accessible
 - 4.7.2.3 Storage bins
 - 4.7.2.4 Clearly marked
- 4.8 Surveillance
 - 4.8.1 Work area conditions
 - 4.8.2 User exposure or stress
 - 4.8.3 Proper use of devices
- 4.9 Inspection and evaluation of program
 - 4.9.1 Fitting and training
 - 4.9.1.1 Worker acceptance
 - 4.9.1.2 Respirators are selected and used properly
 - 4.9.2 Maintenance and care
 - 4.9.2.1 Equipment clean and in good condition (new)
 - 4.9.2.2 Respirators stored properly
 - 4.9.3 Quality assurance
 - 4.9.3.1 Respirators in good repair
 - 4.9.4 Program effectiveness
 - 4.9.4.1 Overall view of selection, use, training, maintenance and acceptance
- 5.0 10 CFR 20, Standards for Protection Against Radiation
 - 5.1 Exposure of Individuals (para. 20.103)
 - 5.1.1 No allowance is made for use of protective equipment except as authorized by the commission. The commission may authorize a licensee to expose an individual to concentrations in excess of listing upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and will not inhale, ingest or absorb quantities of radioactive materials in excess of those which might otherwise be permitted for employees during a 40-hour work week.
 - 5.2 Variance application must include:
 - 5.2.1 Description of equipment to be used

- 5.2.1.1 Efficiency of equipment for the material involved
 - 5.2.2 Procedures for cleaning, fitting and maintenance of equipment
 - 5.2.3 Procedures governing:
 - a. supervision
 - b. length of time equipment will be used each week
 - 5.2.4 Average concentrations of contaminants
- 6.0 Points of Inspection
 - 6.1 SOP's
 - 6.2 Fitting
 - 6.2.1 Chamber or special room
 - 6.2.1.1 Test atmosphere concentration
 - 6.2.2 Irritant smoke
 - 6.2.2.1 Safety precautions
 - 6.2.2.1.1 Broken end of glass tube covered
 - 6.2.2.1.2 Close eyes when testing half mask
 - 6.2.2.1.3 Sufficient smoke around sealing surface
 - 6.2.3 Instrumentation for quantitative tests
 - 6.2.3.1 Light scattering photometer
 - 6.2.3.2 Flame photometer
 - 6.2.3.3 Freon leak detector
 - 6.2.4 Test medium generator
 - 6.2.4.1 Particle size
 - 6.2.4.2 Output
 - 6.2.5 Instructors familiarity with test equipment
 - 6.3 Cleaning and maintenance
 - 6.3.1 Radiation monitoring devices
 - 6.3.2 Washing
 - 6.3.2.1 Spray jet washer
 - 6.3.2.2 Tumbler washer
 - 6.3.2.3 Water temperature 120-140°
 - 6.3.2.4 Detergents
 - 6.3.2.5 Solvents
 - 6.3.2.6 Sterilize
 - 6.3.3 Drying
 - 6.3.3.1 Air
 - 6.3.3.2 Cabinet
 - 6.3.3.3 Tumbler dryer
 - 6.3.3.4 Temperature
 - 6.3.4 Maintenance and Inspection
 - 6.3.4.1 Replace worn parts
 - 6.3.4.1.1 Valves
 - 6.3.4.1.2 Head bands or harness
 - 6.3.4.1.3 Facepiece
 - 6.3.4.1.4 Cartridge holders and gaskets
 - 6.3.4.2 Filters, cartridges, and canisters
 - 6.3.4.2.1 Reuse
 - a. filters (re-tested)
 - b. chemical cartridges or canisters (No!)
 - 6.3.4.3 Leak test
 - 6.3.5 Experienced personnel
- 6.4 Storage
 - 6.4.1 Sealed bags

- 6.4.2 Storage units
 - 6.4.2.1 Location
 - 6.4.2.2 Enough space
 - 6.4.2.3 Clearly labeled
- 6.5 Devices
 - 6.5.1 Air purifying
 - 6.5.1.1 Facepiece
 - a. deterioration
 - b. distortion
 - 6.5.1.2 Valves
 - a. deterioration
 - b. distortion
 - 6.5.1.3 Valve seats
 - a. scratches
 - b. foreign material
 - 6.5.1.4 Exhalation valve cover
 - 6.5.1.5 Headbands or harness
 - a. elasticity
 - b. adjusters and fasteners
 - 6.5.1.6 Lens
 - a. scratches
 - b. distortion
 - c. foreign material or discolored
 - 6.5.1.7 Filters, cartridges or canister
 - a. damaged
 - b. reused
 - c. window indicator
 - d. expiration date
 - 6.5.2 Self-contained breathing apparatus
 - 6.5.2.1 Cylinder assembly
 - a. Hydrostatic test date (5 years)
 - b. Cylinder valve lock
 - c. Cylinder air pressure
 - 6.5.2.2 Low pressure alarm
 - 6.5.2.3 Facepiece assembly
 - a. stored in sealed bag
 - b. stored such that facepiece rubber and valves will not take "set"
 - c. corrugated breathing tube
 - d. lens
 - e. head harness
 - 6.5.2.3 Regulator assembly
 - a. high pressure hose
 - b. diaphragm
 - c. demand, pressure demand or both
 - 6.5.2.4 Storage case
 - a. location
 - b. check out and operating instructions
 - c. inspection sticker
 - 6.5.2.5 Parts applicable to closed circuit or O₂ generating
 - 6.5.3 Supplied air equipment
 - 6.5.3.1 Air supply hose
 - 6.5.3.2 Regulators
 - 6.5.3.2.1 Demand or pressure demand
 - a. diaphragm
 - 6.5.3.2.2 Continuous flow
 - a. valve
 - 6.5.3.3 Facepieces, hoods or suits
 - a. airflow used
 - b. noise level (80 dba 30 CFR 11)
 - c. condition of equipment
 - d. intervals of inspection
 - 6.5.4 Administration
 - 6.5.4.1 Who in charge
 - a. qualifications
 - 6.5.5 Special problems
 - 6.5.5.1 Corrective lenses
 - 6.5.5.2 Facial hair
 - 6.5.5.3 Communications
 - 6.5.5.4 Cold weather use

- 6.5.6 Records (fitting, Laundry, issue)
- 7.0 Show and discuss defective devices and parts
- 8.0 Show and use fitting equipment when available
- 9.0 Discuss problems unique to the nuclear industry