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RESPIRATORY PROTECTIVE DEVICES MANUAL





PUBLISHED BY

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

1963

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American Conference of Industrial Hygienists

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PREFACE

Respiratory protective devices are perhaps the oldest method of controlling occupational diseases; however, health and safety personnel are generally less informed about the applications and limitations of these devices than about any other particular control device. Many books and technical reports have been written on engineering control measures, but it should be noted that no text exists covering comprehensively the field of respiratory protective devices.

Because of the limited published technical data in this field, the committee has drawn heavily upon the experience of respirator manufacturers, representatives from the U.S. Bureau of Mines, and information made available by the American Standards Association. Throughout the preparation of the manual, close cooperation of all these agencies was achieved.

The manual primarily involves commercial devices; hence, there are specific technical details that cannot be discussed. Obviously, the respirator manufacturers are reluctant to jeopardize their development investment and possible patent rights by disclosing information until such rights are protected. Research and development laboratories are reluctant to give interim progress reports, preferring to make the completed research available in the form of a technical report or of a product. Government classification may also make it necessary to withhold some of the developments.

This book has been prepared primarily to provide the industrial hygienist and other health and safety specialists with technical information pertaining to the principles of operation of the various types of respiratory protective devices and their selection, use, and maintenance. Safety and supervisory personnel will find many of the chapters especially useful.

This committee will gratefully receive comments and suggestions for future consideration. The manual will be revised as needed to present new practices and developments.

Edwin C. Hyatt, Chairman
Joint AIHA-ACGIH Respiratory
Protective Devices Committee

Chapter 12

MAINTENANCE, CARE, AND STORAGE

Maintenance is an important phase of any control procedure, and this is as true for respirators as it is for ventilation equipment. No matter how well a respirator is designed or how good its performance, it cannot give satisfactory protection unless it is maintained in good condition. This, one of the most important factors in the use of these devices, is yet the most frequently neglected, particularly with nonemergency respirators in which the results of such neglect are not so readily evident. In addition to providing adequate protection, proper attention to maintenance of respirators in use has a definite economic value. Well-maintained equipment lasts longer and requires less frequent replacement.

The operations of a maintenance program—frequent and periodic inspections, cleaning, replacing or repairing worn or deteriorated parts, and storage—should be centralized wherever possible. They should also be supervised carefully by a responsible and capable person, because proper care and maintenance require a thorough knowledge of the device.

I. INSPECTION

All routinely used respirators should be inspected frequently.

Emergency respirators should be inspected at least every 30 days because, though they may stand unused for a considerable time, they must be available in first-class condition at a moment's notice. The tightness of connections should be checked, as well as the condition of the facepiece, headbands, exhalation and inhalation valves, connecting tube, and canister. The rubber parts of emergency equipment should receive particular attention to assure that they show no signs of deterioration. Unused rubber parts should be kept pliable and flexible, and prevented from taking a set during periods of disuse by working, stretching, and manipulating with a massaging action during the inspection. If the sides of the exhalation valve gap even slightly, a new valve should replace the old.

Emergency devices should be cleaned after each use. After the device is dry, an antifogging compound should be placed on the inside of the lens. Damaged lenses in some masks can be replaced by maintenance personnel, whereas others must be replaced by the manufacturer. The carrying cases for emergency devices are designed to protect facepieces but the device must be properly placed to prevent crimping or pinching. The storage place should be cool and dry, because high temperatures shorten the useful life of rubber parts.

Self-contained breathing apparatus, either demand- or recirculating-type, must be inspected monthly. The air or oxygen cylinder must be fully charged to 1,950 pounds per square inch (1,800 psi plus 10 per cent at 70°F, as allowed by the Interstate Commerce Commission), and the regulator must function properly. No attempt should be made to repair or adjust either the reducing or admission valve mechanism or the safety valve of the regulator. If the regulator is not operating properly, it should be returned to the manufacturer for adjustment or repair. It is extremely dangerous for anyone other than a highly trained mechanic, who thoroughly understands the construction, operation, and adjustment of a regulator to attempt to repair or adjust the regulator.

II. CLEANING

Routinely used respirators also should be cleaned after each use, and they should be collected at a central point at the end of each shift for cleaning and inspection. Each person's respirator should bear some sort of identification, such as his initials or employment number. When a worker receives a respirator, he should be briefed on the cleaning procedure and assured that he will always get the same device. If the respirators are serviced between shifts, only one respirator per workman is needed. If the cleaning is done during a work shift, each worker requires two respirators. When not in use (for example, during the lunch period), the respirators should be stored in clean cabinets at convenient locations in the work area.

It is generally accepted that washing with a good detergent in warm water, by hand brushing or agitation in a washing machine, is a sound basic cleaning procedure. According to Drinker and Hatch,[1] "there is no reason to require special sterilizing . . . . Scrubbing with warm water and soap, rinsing, and air drying in a clean place is entirely adequate."

There are a number of procedures currently in use for cleaning respirators. When a respirator is used by only one individual, a practical

... as follows:

... the filter or cartridge and discard.

2. Wash in good detergent or soap in warm water (120°F).

3. Rinse completely in clean, warm water.

4. Air dry the device in a clean area.

5. Inspect the valves, headstraps, and other parts; replace with new parts if defective.

6. Insert new filters or cartridges; make sure the seal is tight.

7. Place in a plastic bag for storage.

For complete decontamination against phosphate pesticides on respirators, following washing with alkaline soap, it should be rinsed with 50% alcohol (ethyl or iso propyl).

Several respirator manufacturers currently sell a cleaner sanitizer that effectively cleans the respirator and contains a bactericidal agent. This bactericidal agent is generally a quaternary ammonia compound. One manufacturer marketing a combination detergent and quaternary ammonia salt recommends immersing the respirator in the solution, rinsing in clean, warm (120°F) water, and air drying.

When the same respirators are used by different individuals, a good public health policy is to disinfect them before they are re-issued. The literature[2-5] lists a variety of chemicals and methods for disinfecting respirators. A number of the procedures are unsatisfactory. For example, formaldehyde not only is a poor disinfectant, but it is absorbed on the rubber and may cause dermatitis. Soaking a respirator in a 70 per cent solution of ethyl alcohol for 1 hr may be partially effective. Live steam or very hot water (170°F), organic solvents, and ultraviolet light should not be used because of their injurious effects, particularly on the rubber parts.

The compounds generally considered to be the most reliable for disinfecting respirators are: (1) a hypochlorite solution (50 parts per million (ppm) of chlorine; immersion time, 2 min), or (2) an alcoholic solution of iodine (50 ppm iodine; 2 min immersion). A concentration of 200 ppm of quaternary ammonia compounds in water with less than 500 ppm total hardness is generally an effective disinfecting solution. The disadvantages of the quaternary ammonia compounds are: (1) different concentrations of salts are required to achieve a disinfecting solution with waters of varying composition, and (2) the possibility of dermatitis if the quaternary ammonia salts are not completely rinsed from the respirator.

If cleaning and inspection reveal parts which should be replaced or repaired, this should be done only by experienced personnel with parts specifically designed for the particular device. Filters or chemical cartridges also can be replaced at this time. Whether such replacements are made after each use or after some definite period of time will depend upon the conditions under which the device is used and upon past experience. In general, if the conditions are not relatively constant and well-known, replacement after each use is recommended, particularly for cartridges and canisters using sorbents.

III. STORAGE

After cleaning, inspection, and necessary repair, the equipment should be stored properly, in essentially dustproof containers, away from sunlight, heat (not near radiators or steam pipes), extreme cold, and excessive moisture. Most devices come in cartons or cases which are suitable for storage; however, if devices are placed at stations and work areas for emergency use, special compartments may be necessary to protect the devices even in their original containers. Routinely used devices, such as dust respirators, may be placed in plastic bags. The devices should never be stored in such places as clothes lockers or tool boxes unless they are in their carrying cases or cartons.

Respirators should be packed or stored so that the rubber facepiece and exhalation valve will rest in a normal position and function will not be impaired by the rubber setting in a bent or twisted position.

Instructions for the proper storage of emergency devices, such as universal gas masks and self-contained breathing apparatus, are on the "instructions for use and care" bulletin mounted on the inside of their carrying case lid.

REFERENCES

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2. Industrial Safety Equipment Association, Inc.: Care and Maintenance of Safety Equipment, Safety Maintenance, 115:14-16, 30, Apr. 1958.
3. National Safety Council: Respiratory Protective Equipment, Data Sheet D-444, National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill., 1957.
4. American Standards Association: American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1-1959, American Standards Assoc., 10 East 40 St., New York 16, N.Y.
5. Michigan Department of Health: Respirators—Selection, Use and Care, Occup. Health Bull., 4:1-6, Winter 1958.

I. INTRODUCTION

A very important, but often neglected, phase of respiratory protection is adequate training of those who are expected to use such protection. It is a common misconception that training is needed only for the self-contained breathing apparatus. Training is necessary for supervisors, such as foremen who are to supervise the use of any type of respiratory protective device, as well as for those who are to wear it, if a device is to be used intelligently, confidently, and safely. Obviously, the more complicated the apparatus or the more hazardous the atmosphere in which it is to be used, the more extensive and intensive the training must be. Such training should be given by a qualified person, such as an industrial hygienist, a safety engineer, or respirator manufacturer's representative.

Training in the use of any respirator should cover the following:

1. Discussion of the airborne contaminants against which the wearer is to be protected, including information on their physical properties, possible concentrations or changes thereof, mode of physiological action, toxicity, and means of detection.

2. Discussion of the reasons for using the respirator.

3. Description of its construction, operating principles, and limitations.

4. Instruction in procedures for assuring that it is in proper working condition.

5. Instruction in fitting the respirator properly and checking for the adequacy of fit.

6. Instruction in the proper use and maintenance of the respirator.

7. Discussion of the importance of careful reading of labels on the respirator and on its container and of the manufacturer's instructions for its use and care.

An important by-product of training is the sense of confidence that the trainee should develop in his ability to use the respirator properly. If something suspicious should happen to the respirator, or to the atmospheric conditions, he would act rationally rather than panic.

To conserve space and avoid repetition, only those items of the foregoing list that require special emphasis will be included in the discussion of specific training for the various types of respirators. However, all of the items should be covered adequately in the training program.

II. SPECIFIC TRAINING FOR VARIOUS TYPES OF RESPIRATORS

Supervisory personnel should be trained to select the proper type of respirator for the job. A choice from several makes of the proper type and design of respirator might be left up to those who are to wear them. Such a procedure tends to lessen the workers' apparent inborn resistance to wearing a respirator.

Since the maintenance of respirators is discussed in Chapter 12, no specific instructions on this matter will be given here. However, instruction in proper maintenance of respirators is a very important part of any training program.

A. Particulate-removing Respirators

The particulate-removing (mechanical filter) respirator is the simplest type, yet there have been many instances of misuse because of inadequate training. These misuses have included such practices as wearing the respirator upside down, wearing it without filters or without exhalation valve, and discarding the entire respirator because the filter "plugged up." Trained persons would not have committed these blunders.

Since the main field of use of particulate-removing respirators is for respiratory protection against contaminants that have no immediate unpleasant effects, the worker usually must be convinced that it is necessary for him to wear the respirator. This can be accomplished in a factual manner without undue "scare" tactics.

Instruct the trainee how to check the respirator to be sure that it is in good wearing condition. Then allow him to actually check a respirator as follows:

1. Check the exhalation and inhalation valves to see that they are in place and not misshapen, and that no dirt or lint is on the valve or valve seating surfaces.

2. Check the body of the facepiece to see that the face-contacting periphery is clean and has not been unduly softened by body oils, distorted, or hardened.

3. Check for the presence and condition of gaskets and special spacers, if any.

[illegible] surface [illegible] for [illegible] is properly as- [illegible] respirator.

[illegible] Replace missing parts, and repair or replace damaged or defective parts.

Instruct the trainee how to wear the respirator properly. Since the most important part of this phase of training is to fit the respirator to his face, show him how to test for proper face fit, then remove the respirator from his face, and have him go through the procedure several times by himself until he is confident that he can do it properly. Stress the importance of maintaining a proper face fit. A convenient means for testing the face fit is to close off the exhalation valve and exhale gently into the facepiece. The face fit is satisfactory if a slight positive pressure can be built up in the facepiece without any evidence of outward leakage of air at the periphery.

Instruct in the need to change the filter and the procedure for changing it. Train in the proper maintenance of the respirator, particularly if a centralized system for respirator maintenance is not used.

B. Gas- and Vapor-removing Respirators

1. Chemical Cartridge Respirator

Discuss the following limitations of the chemical cartridge respirator: It is for use only against the type of contaminant listed on the cartridge label, in concentrations not exceeding the maximum given on the cartridge label. It will not afford respiratory protection against particulates unless a particulate-removing filter is indicated and present.

Instruction and training in checking and fitting the respirator should be the same as described for particulate respirators except that the trainee should check the cartridge (and particulate-removing filter, if used) to see that it is of the proper type, is in good physical condition, and is seated securely against its gasket. It is desirable that the trainee check the fit of the facepiece by actually wearing the respirator, equipped with organic vapor cartridges, in an atmosphere containing approximately 100 parts per million (ppm) of isoamyl acetate vapor (banana oil). Before this test is made, an organic vapor cartridge should be affixed to the respirator in lieu of any other type of cartridge.

A special test chamber is not needed for this training since such a concentration can be built up in any room, without damage to its contents, by evaporating 17.3 milliliters (ml) of isoamyl acetate for each 1,000 cubic feet (ft^3) of room volume. Isoamyl acetate can be detected by odor in very low vapor concentrations. If the person wearing the respirator can enter and remain in the test atmosphere for a minute or two without detecting the odor of isoamyl acetate, the respirator is properly fitted. If he detects the odor of isoamyl acetate, he should retreat to fresh air, readjust the facepiece, and then repeat the test. If leakage is still noted, he should retreat to fresh air and recheck the respirator, as previously. If the respirator is to be worn in air containing contaminants other than organic vapors, replace the organic vapor cartridges with cartridges of the appropriate type, after a satisfactory face fit test.

There are many occasions when it is necessary to conduct fitting tests in the field. A field check is illustrated in Fig. 13.1. The reliability of the face fit is checked by pouring a few drops of isoamyl acetate onto a piece of cotton and waving it gently near the periphery of the facepiece while the wearer breathes normally. The concentration is likely to be above 100 ppm, but it does serve to check the face fit and is commonly used in the field.

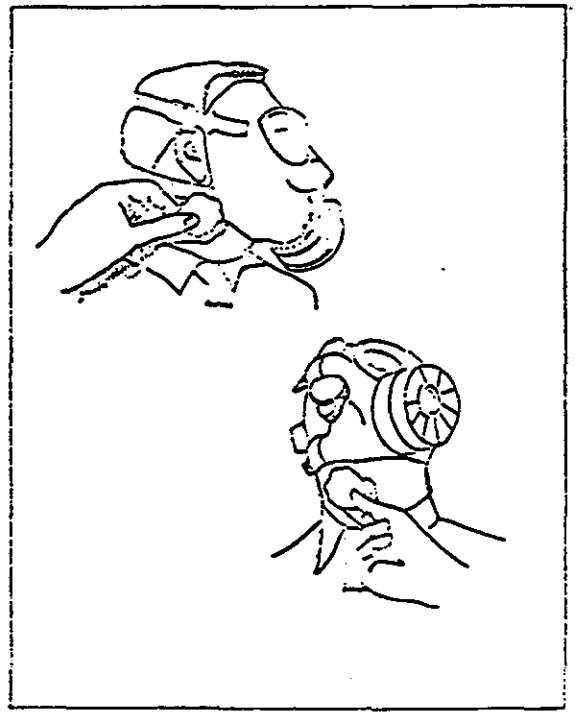

Fig. 13.1. Field test of face fit of respirators using isoamyl acetate.

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[illegible]

3. Test for proper operation of valves, head straps, and other parts; replace with new parts if defective.

4. Insert new filters or cartridges, check seal to face.

5. Place in a plastic bag for storage.

For complete decontamination without possible restrictions on respirators, following cleaning with alkaline soap, it should be rinsed with 50% alcohol (ethyl or iso propyl).

Several respirator manufacturers currently sell a cleaner sanitizer unit effectively cleans the respirator and contains a bactericidal agent. This bactericidal agent is generally a quaternary ammonia compound. One manufacturer marketing a combination detergent and quaternary ammonia salt recommends immersing the respirator in the solution, rinsing in clean, warm (120°F) water, and air drying.

When the same respirators are used by different individuals, a good public health policy is to disinfect them before they are re-issued. The literature[2-5] lists a variety of chemicals and methods for disinfecting respirators. A number of the procedures are unsatisfactory. For example, formaldehyde not only is a poor disinfectant, but it is absorbed on the rubber and may cause dermatitis. Soaking a respirator in a 70 per cent solution of ethyl alcohol for 1 hr may be partially effective. Live steam or very hot water (170°F), organic solvents, and ultraviolet light should not be used because of their injurious effects, particularly on the rubber parts.

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6. Instruction in the proper use and maintenance of the respirator.

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An important by-product of training is the sense of confidence that the trainee should develop in his ability to use the respirator properly. If something suspicious should happen to the respirator, or to the atmospheric conditions, he would not automatically panic rather than panic.

To conserve space and avoid repetition, only those items of the foregoing list that require special emphasis will be included in the discussion of specific training for the various types of respirators. In fact, all of the items should be covered adequately in the training program.

II. SPECIFIC TRAINING FOR VARIOUS TYPES OF RESPIRATORS

Supervisory personnel should be trained to select the proper type of respirator for the job. A choice from several makes of the proper type and design of respirator might be left up to those who are to wear them. Such a procedure tends to lessen the workers' apparent inborn resistance to wearing a respirator.

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A. Particulate-removing Respirators

The particulate-removing (mechanical filter) respirator is the simplest type, yet there have been many instances of misuse because of inadequate training. These misuses have included such practices as wearing the respirator upside down, wearing it without filters or without exhalation valve, and discarding the entire respirator because the filter "plugged up." Trained persons would not have committed these blunders.

Since the main field of use of particulate-removing respirators is for respiratory protection against contaminants that have no immediate unpleasant effects, the worker usually must be convinced that it is necessary for him to wear the respirator. This can be accomplished in a factual manner without undue "scare" tactics.

Instruct the trainee how to check the respirator to be sure that it is in good wearing condition. Then allow him to actually check a respirator as follows:

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2. Check the body of the facepiece to see that the face-contacting periphery is clean and has not been unduly softened by body oils, distorted, or misshapen.

3. Check for the presence and condition of gaskets and special spacers, if any.

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