

**PLAINTIFF'S
EXHIBIT**

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CHAPTER VI
PERSONAL PROTECTIVE DEVICES

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Aluminum Company of America

INDUSTRIAL HYGIENE HANDBOOK

Chapter VI

Personal Protective Devices

Scope

The contents of this chapter are confined only to those protective devices which are used to prevent industrial hygiene problems. Those items such as glasses, shoes, helmets, suits, etc. fall more appropriately in the field of safety and will not be discussed here.

Protectors as Precautionary Devices

The function of personal protective devices is to give protection to the worker when all other methods of control have proved impractical. They are not intended, nor should they be used, as substitutes for good engineering control methods. The wearing of a personal protective device should not acknowledge that a hazard is definitely and continually present (frequently protectors are worn for reasons of comfort rather than protection). At most, their use admits that there is a possibility of a hazard. This approach is recognized and accepted with the use of safety glasses, for example. It is not expected that molten metal, metal chips, or grinding wheel fragments will strike the employee's eyes. However, these happenings are possible and therefore safety glasses are worn. On the other hand if a worker is observed to be wearing ear or respiratory protection it is generally assumed that he is working in a continuously hazardous environment. The implications of wearing protective equipment should not be dependent upon the type of protector. Whether they be safety glasses, safety shoes, respirators or ear plugs, the use of all personal protective devices is simply precautionary.

Respirators

Respiratory protective devices can be classified in three major groups: Self Contained Breathing Apparatus, Supplied Air Equipment and Air Purifying Equipment. When selecting such devices it is always desirable to obtain equipment which has the approval of the U. S. Bureau of Mines. This approval is clearly marked on the product. There are, however, some types of respiratory protective equipment which have not come under any of the schedules set up by the Bureau and have not been tested by them. Therefore the absence of their stamp of approval does not necessarily mean that the respirator is an inferior product.

Supplied Air Equipment

Self contained breathing apparatus and supplied air equipment have very little use for industrial hygiene purposes. Their use in Alcoa plants is primarily for emergency situations. Common exceptions are the uses of supplied air devices when sand blasting, cleaning large solvent tanks and welding in enclosed areas.

Air Purifying Equipment

Types of air purifying equipment may be further broken down into three subdivisions: mechanical filter respirators, chemical cartridge respirators and canister-type gas masks. Like the self contained breathing apparatus and supplied air equipment, canister-type gas masks have few industrial hygiene applications. They are generally used for emergency situations in areas of high gas contamination, up to 2% by volume, and for relatively long periods of time. For industrial hygiene purposes the main interest in air purifying equipment lies with mechanical filter and chem-

ical cartridge respirators. These small respirators are designed for relatively short exposures. The chemical cartridge respirator is also limited to concentrations of gaseous contaminants below 0.1% (1000 ppm) by volume. If the worker's environment is other than this, a different type of protective device must be used. Again, it should be stressed that a respirator should never be used as a substitute for good hygienic practices.

Chemical Cartridge Respirator

The chemical cartridge respirators afford protection against a variety of toxic gases and vapors. They are not all alike, each type being intended to protect against certain kinds of gaseous contaminants. To provide complete protection chemical cartridges may be used with mechanical filters in areas having both gaseous and particulate contamination. All cartridges have a limitation on their useful life and must be replaced as the reactive chemicals approach depletion.

Mechanical Filter Respirator

The mechanical filter type respirators are used to protect the wearer against dusts, fumes and mists. The particle size and toxicity of these contaminants must be considered when selecting a suitable filter for the respirator. Whereas an inefficient type (e.g. cheese cloth) may be perfectly suitable for protection against inert nuisance dust of large particle size (e.g. alumina), it cannot be used for highly toxic material, regardless of its particle size. Materials of extremely high toxicity and small particle size, such as beryllium or radioactive fumes, require the most efficient type of filter available. For the greatest ease of breathing, respirators containing these high efficiency filters should be of the twin cartridge type. Filters like the chemical cartridges also have a limited life. With constant usage they become clogged and must be replaced.

Selection of a Respirator

Selection of a respirator should be based on its ability to do the job and to fit properly and comfortably. Because there are so many different types of filters and cartridges available it is important that care be taken to select the correct type so that it will protect the wearer from the contaminants to which he may be exposed. The respirator should fit the contours of the face well with no leaks and with the maximum of comfort. For maximum ease of breathing the two-cartridge unit is best because of its large filtering area. Also, this type of respirator has a longer useful life than the single cartridge type.

Commercially Available Respirators

Table 6.1 lists a representative group of commercially available respirators and the contaminants against which they will give protection. Most of these devices have been approved by the Bureau of Mines. Their approximate price range is between \$4.00 and \$6.50. There are many other good respirators available and the absence from this table of any particular type or make does not necessarily mean that it is an unacceptable or inferior product.

Storage, Maintenance and Cleaning

In areas where respirators are used it is necessary that facilities be available for their storage, maintenance, cleaning and supervision of usage. The best method of cleaning the respirator is with warm water and soap. If several people use the same respirator it is wise that the mask be sanitized after each usage. Solutions of quaternary ammonium salts, such as "Roccal", or alcohol make satisfactory sanitizing agents. It is important that the agent neither damages the respirator nor causes facial dermatitis on the next user. Brandt (1) and Patty (2) have more detailed information in their chapters on respiratory protection.

Table 6.1

SIMPLE RESPIRATORY PROTECTIVE DEVICES

RESPIRATOR MASK		CATALOG NUMBERS OF FILTERS USED FOR PROTECTION AGAINST:					CATALOG NUMBERS OF CHEMICAL CARTRIDGES USED FOR PROTECTION AGAINST:				
Model, Name and Number	No. of Cartridges	Nuisance & Pneumoconiosis Producing Dusts	Toxic Dusts and Mists	Fumes	Highly Toxic Dusts and Fumes	Organic Vapors, Fumes and Mists	Acid Gases, Fumes and Mists	Acid and Organic Gases	Ammonia		
R-1000	one	A, AD	T, AD			CC1, CC3	CC2, CC3	CC3	CC4		
R-2000	one	R15, R17	R16, R17			R31, R33	R32, R33	R33	R34		
R-2900	one	R29									
R-5000	two	R50	R50	R56		R51, R53	R52, R53	R53	R54		
R 9100	*	R9100									
R 9100T	*		R9100T								
Dustfoe 66 76869	one	CM73053 CM73056	CM73053 CM73056								
Gasfoe CM-76853, 76882, 76973	one					Type GMA CM76883	Type GMC GM76884	Type GMC CM76884	Type GMD CM76885		
Comfo Filter Respirator CR-76870, 71, 72	two	Type F CR48152	Type S CR76875	Type S CR76875	Type H CR76876						
Comfo Chemical Cartridge Respirator CR-44158, CR-45323	two					Type GMA CR44135	Type GMC CR10340	Type GMC CR10340	Type GMD CR42876		
441	one					#41					
442	one						#42				
443	one					#43	#43	#43			
750DA	two	R407	R407								
841	two					#41					
842	two						#42				
843	two					#43	#43	#43			
844	two								#44		
860	two	R415	R415								
880A	two			R361							
890	two				R436						

* Respirator and filter are an integral unit. Entire unit must be replaced when expended.

Supplier

American Optical

Appliances

3

Mine Safety

Willson Products

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Ear Protection

Ear protectors find an application in those noisy areas where it is impractical to reduce the employee's exposure by other means. Fortunately the aluminum industry, in contrast to others such as the jet aircraft industry, is a relatively quiet one. There are, however, certain isolated operations in aluminum plants which do create major noise problems that are presently without solutions. In areas around these operations the use of good ear protective devices will insure that the employees do not receive damaging exposures. While they give protection to the employees, ear protectors do not limit their ability to hear speech or warning signals. As a matter of fact the ability to hear them is enhanced by wearing ear protection.

Ear Plugs

Ear protective devices may be classified as either inserts (plugs) or muffs. The plug has almost universal application in Alcoa plants. These made of soft, plastic, rubber-like materials are probably best from the point of view of attenuation, comfort, and durability. Wax impregnated cotton is comfortable and has good initial attenuation but it tends to lose its shape, and by doing this loses some of its effectiveness. Wax plugs, although cheaper than the plastic types can be used only once and then must be discarded for sanitary reasons. Cotton is ineffective as a noise protector. So called "speech filters" such as the Lee Sonic Ear Valve and Selectone K are expensive and give less protection than the solid, less complicated, cheaper and more comfortable soft plastic ear plugs.

Ear Muffs

Ear muffs are good attenuators and, while there are many instances where their use is preferred, their applications are more limited than the insert type protector. They are best used in areas of short time, intermittent exposures. Muffs are uncomfortable in hot areas or when worn for long periods, especially those protectors with the highest noise attenuation. Generally speaking, the more effective muffs apply a greater pressure to the head and ears. For the ultimate in protection muffs can be used in combination with plugs. However, at the present time there are no noises generated in Alcoa plants of sufficient intensity to warrant the use of such an extreme measure.

Performance Characteristics

Information on the characteristics and performance of some of the more popular types of ear protective devices are listed in Tables 6.2 and 6.3. These data are intended to assist in the selection of suitable devices for any particular requirement. Further information about ear protectors and their performances can be found in the "Industrial Noise Manual" (3) and the Handbook of Noise Control. (4)

Gloves

The use of gloves for protection against harmful materials is nothing new to Alcoas and the selection and use of these protectors are generally obvious. From an industrial hygiene standpoint, gloves can be used to prevent dermatitis caused by irritant and sensitizing materials; mechanical trauma caused by glass wool, wood and similar materials; and intoxication caused by absorption of toxic materials through the skin. Closely woven cotton gloves are good for protection against trauma. Leather gloves which are also good for this application should be made of a soft, pliable, washable leather such as chamois. Gloves for the protection of hands against irritant and sensitizing chemicals should be made of impervious materials. Plastic or plastic-dipped cotton are recommended for this purpose. Suitable applications for them are shown in Table 6.4. They should reach well up the forearms and should be worn under impervious sleeves, fastening at the wrists to prevent chemicals from entering the gloves. The wearing of gloves should not encourage sloppiness. If careless practice permits the contaminant to get inside the gloves it creates a condition which is worse than wearing no gloves at all.

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TABLE 6.2
REPRESENTATIVE GROUP OF INSERT-TYPE PROTECTIVES

Name	Manufacturer	General Type	Attenuation	Comfort	Reusable	Remarks
Com-Fit	(a)	Soft plastic	Good	Good	Yes	
Hear-Guard, Ear Insert	(b)	Soft plastic	Good	Good	Yes	V5LR type
MSA Ear Defenders	(c)	Soft plastic	Good	Good	Yes	V5LR type
Saf-Ear-Insert	(d)	Soft plastic	Good	Good	Yes	V5LR type
SMR	(e)	Soft plastic	Good	Good	Yes	
Sound Silencer	(f)	Soft plastic	Good	Good	Yes	Won't fit everyone
Sound Sentry	(g)	Soft plastic on head strap	?	Poor	Yes	Not recommended
Frontier Anti Noise Plugs	(h)	Wax impregnated cotton	Good	Good	No	
Flents Anti-Noise Ear Stopples	(i)	Wax impregnated cotton	Good	Good	No	Use 1/2 for each ear
Quiet-Down	(i)	Glass fibers	Varies	Good	No	Not recommended, Attenuation depends on manner of insertion
Lee Sonic Ear-Valv	(a)	Speech filter	Poor	Fair	Yes	Not recommended
S-O-S Noise Controllers	(j)	Hard plastic	Fair	Poor	Yes	Not recommended
Cotton	-	Cotton	Poor	Good	No	Not recommended

- (a) Sigma Engineering Co., 1491 N. Vine Street, Los Angeles, Calif.
 (b) American Optical Company, Southbridge, Mass.
 (c) Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh, Pa.
 (d) U.S. Safety Service Co., 1535 Walnut St., Kansas City, Mo.
 (e) Surgico-Mechanical Research Corp., 1905 Beverly Blvd., Los Angeles, Calif.
 (f) Willson Products Div., E.S.B. Inc., Reading, Pa.
 (g) H. E. Douglass Engineering Sales Co., Burbank, Calif.
 (h) Frontier Industrial Products, 3521 Sunset Blvd., Los Angeles, Calif.
 (i) Flents Products Co., Inc., 103 Park Avenue, New York, N. Y.
 (j) M-M-A, Inc., Lancaster, Pa.

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Table 6.3
 REPRESENTATIVE GROUP OF MUFF-TYPE PROTECTORS*

<u>Name</u>	<u>Manu- facturer</u>	<u>Ear Cushion Material</u>	<u>Attenu- ation</u>
Hear-Guard, Hearing Protector	(a)	Foam Plastic	Good
Straightaway Sound Protector	(b)	Foam Plastic	Good
MSA Noisefoe, Mark IV	(c)	Foam Plastic	Good
Willson Sound Barrier	(d)	Liquid Filled	Good
Willson Sound Silencer	(d)	Foam Plastic	Good
Saf-Ear-Shield (same as Straightaway)	(e)	Foam Plastic	Good

*Ear cups of all protectors listed above are constructed of tough plastic with a plastic foam lining.

- (a) Safety Products Div., American Optical Co., Southbridge, Mass.
- (b) David Clark Company, Inc., 360 Park Ave., Worcester, Mass.
- (c) Mine Safety Appliances Co., 201 N. Braddock Avenue, Pittsburgh, Pa.
- (d) Willson Products Div., Ray-O-Vac Co., Reading, Pa.
- (e) United States Safety Service Co., 1535 Walnut St., Kansas City, Mo.

Solvent Protection

When gloves are used for protection against solvents the main thing to remember is that almost all organic solvents will be absorbed by rubber, neoprene or plastics to a greater or lesser extent. Absorption, of course, will be greatest with prolonged usage. This is especially important when handling toxic solvents that can be absorbed through the skin. It is best to check with the glove manufacturer to determine the resistance of his product to any specific material.

Aprons

Aprons are of special value for protection against cutting oils. They should reach well up to the neck and below the knees. It must be emphasized that in order for aprons and other protective clothing to be truly protective, they must be cleaned regularly and frequently. Otherwise they will become primary sources of exposure in themselves. The frequency of cleaning depends on the dirtiness of the job.

Aluminized cloth

A final word can be said on the use of protective clothing made of aluminized cloth. This material is effective as protection against radiant heat and may give relief to workers on operations involving molten metal; for example, permanent mold casting.

Table 6.4

SUITABLE GLOVES FOR SPECIFIC APPLICATIONS

Numbers following names of chemicals represent the types of gloves that give workers the best protection. Recommendations come from information furnished by glove manufacturers. Synthetic rubbers and plastics differ widely in content and purpose; ask your supplier for exact advice on the right types for your purposes.

1—plastic-coated gloves

2—natural rubber-coated gloves

3—synthetic rubber-coated gloves

Naphthalene	1	Ethyl alcohol	1, 2, 3	Naphthalene	1
Nitric acid	1	Ethyl ether	1, 3	Nitric acid	1
Acetone	3	Ethyl formate	1	Nitrobenzene	1
Acetylene gas	1, 2, 3	Ethylaniline	1, 2, 3	Nitroethane	1
Acrylonitrile	1	Ethylene diamine	1, 3	Nitrogen gas	1, 2, 3
Ammonium hydroxide	2, 3	Ethylene dichloride	1	Nitromethane	1
Amyl acetate	1, 3	Ethylene gas	1, 3	Nitropropane	1
Amyl alcohol	1, 2, 3	Ethylene glycol	1, 2, 3	Nitrous oxide	1
Aniline	1, 2, 3	Ethylene trichloride	1	Octyl alcohol	1, 2, 3
Aniline hydrochloride	1, 2, 3	Fatty acids	1, 3	Oleic acid	1, 3
Aniline oil	3	Fluorine	1, 3	Oxalic acid	1, 3
Animal oils	1, 3	Formaldehyde	1, 3	Paint thinners & removers	1
Anthracene	1	Formic acid	2, 3	Palmitic acid	1, 2, 3
Aromatic fuels	1, 3	Freon 11, 12, 21, 22	1	Paradichlorobenzene	1, 3
Banana oil	1, 3	Furfural	1, 2, 3	Pentane	1, 3
Battery acid	1, 3	Gasoline, leaded	1	Perchloric acid	1, 3
Benzaldehyde	1, 3	Gasoline, unleaded	3	Perchloroethylene	1
Benzene	1	Glycerine	1, 2, 3	Perylene	3
Benzol	1	Glycerol	1, 2, 3	Perinachlor	1, 3
Benzyl alcohol	1, 2, 3	Glycol	1, 2, 3	Petroleum spirits	1, 3
Benzyl benzoate	1	Grain alcohol	1, 2, 3	Phenol	1, 3
Benzyl chloride	1	Grease	1, 3	Phenyl hydrazine	1, 2, 3
Bromine	1, 2, 3	Halogens	1, 2, 3	Phil-solv	1, 3
Butane	1, 3	Heptane	1	Phosphoric acid	1, 3
Butyl acetate	1, 3	Hexane	1, 3	Pickling solution	1, 2, 3
Butyl alcohol	1, 2, 3	Hexyl acetate	1, 3	Picric acid	1, 3
Butylaldehyde	1, 2, 3	Hydraulic oils	1, 3	Pine oil	1, 3
Butylene	1, 3	Petroleum base	1, 3	Pitch	1, 3
Butyne	1	Ester base	3	Plating solution	1, 2, 3
Calcium hydroxide	2, 3	Hydrobromic acid	1, 3	Potassium hydroxide	1, 2, 3
Carbolic acid	1, 2, 3	Hydrochloric acid	3	Propane gas	2, 3
Carbon dioxide	1, 2, 3	Hydrofluoric acid	3	Propanol-iso	2, 3
Carbon disulphide	1	Hydrogen gas	1, 2, 3	Propyl acetate	1, 3
Carbon tetrachloride	1	Hydrogen peroxide	1, 3	Propyl alcohol	1, 2, 3
Castor oil	1, 3	Inorganic salts	2, 3	Propyl alcohol iso	1, 2, 3
Chlorine	1, 3	Iodine	1, 3	Propylene gas	3
Chlorobenzene	1	Iso-octane	1	Propyne gas	3
Chloroform	1	Isopropanol	1, 2, 3	Sodium hydroxide	1, 2, 3
Chloronaphthalene	1	Isopropyl alcohol	2, 3	Sodium hypochlorite	1, 3
Chloropicrin	1	Kerosene	1, 3	Solvarsol	3
Chromic acid	1	Ketones	1, 2, 3	Solves-os	1
Citric acid	1, 2, 3	Lacquer thinners	1	Stearic acid	1, 2, 3
Clorox	1	Lactic acid	2, 3	Stoddards solvent	3
Cottonseed oil	1, 3	Lauric acid	1, 3	Styrene	1, 2, 3
Creosote	1	Lineoleic acid	3	Sulfuric acid	1, 2, 3
Cresol	1, 3	Linseed oil	1, 3	Tannic acid	1, 2, 3
Cyclohexane	1	Lubricating oils	1, 3	Tetraethyl lead	1, 3
Cyclohexanol	1	Maleic acid	1, 2, 3	Toluene	1
Cyclohexanone	1, 2, 3	Methane gas	1, 2, 3	Toluol	1
Degreasing fluids	1	Methanol	2, 3	Trichlor	1
Diacetone alcohol	3	Methyl acetate	1, 3	Trichlorethylene	1
Dibenzyl ether	1, 2, 3	Methyl alcohol	1, 2, 3	Tricresyl phosphate	1, 3
Dibutyl phthalate	1	Methylamine	1, 2, 3	Triethanolamine	3
Dichlorethane	1	Methyl bromide	1	Trinitrotoluene	1
Diesel fuel	1	Methyl cellosolve	2, 3	Trinitrotoluol	1, 3
Diethanolamine	1, 3	Methyl chloride	3	Triptane	1, 3
Diethylamine	1, 3	Methyl ethyl ketone	2, 3	Tung oil	1, 3
Diisobutyl ketone	1	Methyl formate	1	Turbine oil	1, 3
Diethyl phthalate	1	Methylene bromide	1, 2, 3	Turpentine	1
Dioxane	1, 3	Methylene chloride	1, 2, 3	Varnoline gas	1, 3
Epoxy resins, dry	1, 3	Mineral oils	1, 3	Varsol	1
Esters	1	Monochlorobenzene	1, 3	Vegetable oils	1, 3
Ethane gas	1, 3	Monoethanolamine	1, 3	Wood alcohol	1, 2, 3
Ethanol	1, 2, 3	Morpholine	1, 2, 3	Wood preservatives	3
Ethers	1, 3	Naphthas, aromatic	1	Xylene	1
Ethyl acetate	3	Naphthas, aliphatic	1, 3	Xylol	1
				Xylidine	3

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Chapter VI

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