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| PROTECTIVE EQUIPMENT                    | SAFETY AND WELFARE<br>ENGINEERING STANDARD |              |
|-----------------------------------------|--------------------------------------------|--------------|
| <b>RESPIRATORY PROTECTIVE EQUIPMENT</b> | ISSUED<br><b>JAN 1964</b>                  | <b>S 2 H</b> |
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**1. SCOPE**

1.1 This standard provides information for the selection, use, and care of respiratory protective equipment (respirators). The term "respirator" in this standard is used inclusively and applies to atmosphere-supplying and air-purifying devices that provide breathable air to the wearer within the limits of the equipment, whatever the source of air. This standard does not apply for exposure to airborne radioactive contamination for which special consideration may be necessary.

**2. GENERAL**

2.1 Respiratory protective equipment should not be used as a substitute for adequate exhaust ventilation or other engineering control methods.

2.2 Respiratory protective equipment shall be worn at all times where the atmosphere may be harmful to employees due to unusual conditions, and where work is necessary in contaminated or oxygen-deficient, confined areas.

2.2.1 When the oxygen content of the air is less than 16 percent by volume, the symptoms range from increased volume of breathing and acceleration of pulse rate to unconsciousness and death, depending upon oxygen content and the degree of a person's activity. *Self-contained breathing apparatus or a hose mask with blower shall be worn in oxygen-deficient atmospheres.*

2.2.2 An oxygen deficiency may indicate a hazard in addition to inert gas: eg, flammability (see paragraph 4.4), skin toxicity, or absorption through the skin, particularly HCN. Maximum acceptable concentrations (MAC's) of air contaminants are given in Standard S2T. Portable oxygen and toxic-gas detectors are covered in Standard S3T.

2.3 Pure oxygen shall not be used in atmosphere-supplying respirators.

2.4 Only equipment listed and approved by the U. S. Bureau of Mines shall be used, if schedules for a particular type of equipment have been established. (U. S. Department of Agriculture has approved respiratory devices which may be used for protection against certain pesticides.)

2.4.1 Information Circular 7885, "Respiratory Protective Devices Approved by the Bureau of Mines

as of October 16, 1958" together with a list of supplemental approvals since 1958 can be obtained from the Publications Distribution Section, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pennsylvania. At the present time, the Bureau does not have approval schedules for the following equipment (d and e are Du Pont approved):

- e. Filter-type respirators for protection against particulate aerosols, such as beryllium dusts and fumes, dusts impregnated with organic phosphorus insecticides (parathion), and radioactive substances.
- b. Air-supplied suits.
- c. Chemical cartridge respirators for respiratory protection against gases and vapors other than organic vapors.
- d. Escape-type self-contained breathing apparatus.
- e. Combination airline and self-contained breathing apparatus.

2.4.2 A list of "Respiratory Devices for Protection Against Inhalation Hazards of Dusts, Mists, and Low Vapor Concentrations of Certain Pesticides," can be obtained from the U. S. Department of Agriculture, Agricultural Research Service, Washington 25, DC.

**3. MANUFACTURERS**

3.1 Names and addresses of companies to which approvals on currently available respiratory protective devices have been granted by the U. S. Bureau of Mines are given in Table 1. Companies to which approvals have been given by the U. S. Department of Agriculture for insecticide respiratory protective devices also are indicated in Table 1. The listing of a manufacturer in this standard does not mean necessarily that all of his products are approved.

**4. TYPES, USE, AND LIMITATIONS**

4.1 A list of the several types of respiratory protective equipment, method of operation, use,

Vendors and merchandise designations are given to describe materials and may not include all acceptable products. Substitutions are to be made only on approval of the authority initiating the use of this standard.

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limitations, and remarks is given in Table 2. For additional information in this regard, reference should be made to:

American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1, American Standards Association, 70 East Forty-fifth Street, New York 17, NY

Respiratory Protective Equipment, Data Sheet D-444, National Safety Council, 425 North Michigan Avenue, Chicago, Illinois

Respiratory Protective Devices Manual published by American Industrial Hygiene Association and American Conference of Governmental Industrial Hygienists (copies are available from Braun and Brumfield Inc, Box 1203, Ann Arbor, Mich.

4.2 The air-purifying respirators, ie, canister gas masks, chemical cartridge respirators, and mechanical filter respirators (Table 2C) shall not be used for rescue work, or for emergency work of any nature. This is because these respirators require at least 16 percent oxygen in the air. Other reasons for this requirement are that (a) gas masks are intended for use with no more than 2 percent of most toxic gases, and (b) chemical cartridge respirators are approved for no more than 1000 ppm by volume of organic vapor in air.

4.3 Use of canister masks that bear the label "All-Service," "All-Purpose," or "Universal" has been prohibited by the Safety and Fire Protection Division.

4.4 Although self-contained breathing apparatus and hose mask with blower have no concentration limit in regard to toxicity, many toxic gases and vapors are flammable and the user could be exposed to a potential fire or explosion. The 2 percent concentration limits approved for toxic gas removal with canister-type masks may be within the flammable range for some gases. Standard F6J provides information and instructions for use of portable flammable vapor and gas detectors.

### 5. SELECTION

5.1 In general, in choosing a respirator, the following factors should be considered: (a) nature of the hazard; (b) severity of the hazard. (Only self-contained breathing apparatus or hose mask with blower, shall be used in oxygen-deficient atmospheres or where the contaminant is, or may be, immediately dangerous to life.); (c) type of contaminant; (d) concentration of the contaminant; (e) period protection is required; (f) location of the

contaminated area with respect to a source of respirable air, (g) expected activity of the wearer; (h) operating characteristics and limitations of the available respirators (see Table 2).

5.2 Table 3 lists the hazards and the respirators that are recommended to afford respiratory protection against them. By reference to this table, and by considering the foregoing factors, the user can determine the type of respirator that should be used.

### 6. PRECAUTIONS

6.1 An extensive list of instruction in use and precautions for each type of respirator is given in the previously referenced ASA Z2.1. Some precautions are given in Table 2 under headings of Limitations and Remarks.

6.2 The manufacturer's instructions should be posted with the respiratory device. Where these are not available, precautions of ASA should be posted at the respiratory storage locations.

6.3 All persons who may have occasion to use respiratory devices, or cause them to be used, should be properly trained in their use before circumstances require that they use them to protect their lives and the property of the Company. Also, in execution of plant disaster plans, proper training in use of respiratory protective equipment will aid in the performance of smooth and safe rescue or repair operations.

### 7. CARE

7.1 General. A centralized maintenance, cleaning, and storage station should be used to care for respiratory protective equipment.

#### 7.2 Procedures Applicable to All Respirators

7.2.1 *Inspection.* All respirators shall be inspected at regular intervals to make sure that they are ready to use. It is good practice to integrate the respiratory and fire-extinguisher inspection and maintenance program.

7.2.2 *Maintenance.* When it is necessary to replace worn or deteriorated parts, only those made specifically for the device should be used; and the repair work should be accomplished by trained personnel. For most plants, it is preferable that parts of this type be replaced as a unit or returned to the manufacturer for repair.

7.2.3 *Cleaning and Disinfecting.* Respiratory protective equipment, except canisters and cartridges, should be cleaned and disinfected after

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each use, unless assigned to individuals. Respiratory equipment can be cleaned with detergent and lukewarm water by hand brushing or agitation in a washing machine, rinsed, and dried. The quaternary ammonium salt disinfectants\* are recommended for sterilizing respiratory devices, since they are not particularly irritating to the skin if they are not completely rinsed from the device after sterilization.

**7.2.4 Storage.** All respiratory protective equipment should be stored in a clean, cool, dry place, out of direct sunlight, under conditions of moderate temperature (see Chemox mask in Table 2B).

**7.3 Special Procedures for Maintaining, Cleaning, Disinfecting, and Storing Respirators**

**7.3.1 Self-Contained Breathing Apparatus.** In demand-type (Table 2B), the cylinder pressure should be checked periodically and brought to rated pressure if necessary. Recharge after each use, following manufacturer's instructions. Follow manufacturer's instructions on tightness tests for self-contained respirators.

**7.3.2 Hose Masks.** Check the blower periodically for proper operation. Check hose for wear and tear after each use and steam clean when necessary. Keep hose capped when not in use to prevent entrance of dust or other contaminants.

**7.3.3 Air-Line Respirators.** The facepiece should be serviced after each use, as for all other respirators. The flow control valves should be inspected after each use and cleaned and repaired, if necessary. Air-line hose should be checked

for wear and tear after each use and be steam cleaned when necessary. See Standard S1H on air-supply system.

**7.3.4 Gas Masks.** The canister should be replaced at least annually whether or not it has been used. At the time of replacement of canister, the face-piece, harness, hose, and headband should be examined carefully for any signs of leak or deterioration, and should be replaced if any are found.

**7.3.5 Self-Rescuers.** Frequent inspection is the most important phase of the maintenance program with this type of equipment because the equipment is seldom used but always must be ready.

**7.3.6 Chemical Cartridge Respirators.** Chemical cartridges should be changed when the wearer detects the odor or irritating effect of the contaminant. In plants with centralized maintenance stations, cartridges sometimes are discarded after a given period of use (based on group experience); but, in most cases, the wearer is responsible for discarding and replacing cartridges in his respirator. Particular care should be exercised in the storage of chemical cartridges because they usually deteriorate if exposed to excess moisture and to gaseous air contaminants. Cartridges should not be stored in the area where it is necessary for the workmen to use chemical cartridge respirators.

**7.3.7 Mechanical Filter Respirators.** Mechanical filters of the "throw-away" type should be discarded when the breathing resistance becomes bothersome to the wearer. Some mechanical filter respirators use recleanable filters, in which case the filters are cleaned when the respirator is being serviced.

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\* Willson Germi-Cloth; American Optical Co, No. 101 and 102 Germicidal Detergent; Pulmeson Sanitizer, MSA Cleaner Sanitizer



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TABLE 1 - APPROVED RESPIRATORY PROTECTIVE DEVICES\*

- \*\* Acme Protection Equipment Co, 1201 Kalamazoo St, South Haven, Michigan  
American-LaFrance Corp, Elmira, NY
- \*\* American Optical Co, Southbridge, Mass.  
Binks Manufacturing Co, 3114 Carroll Ave, Chicago 12, Ill.  
E. D. Bullard Co, 2680 Bridgeway, Sausalito, Calif
- \*\* Chicago Eye Shield Co, 2727 West Roscoe St, Chicago 18, Ill.  
H. S. Cover, Station A, South Bend, Ind  
Davis Emergency Equipment Co, Inc, 45 Hallock St, Newark 4, NJ  
The DeVilbiss Co, Toledo 1, Ohio  
Globe Industries, Inc, 125 Sunrise Place, Dayton 7, Ohio  
B. F. McDonald Co, 5721 West 96th St, Los Angeles 45, Calif  
Metallizing Engineering Co, Inc, 1101 Prospect Ave, Westbury, NY
- \*\* Mine Safety Appliances Co, 201 N Braddock Ave, Pittsburgh 8, Pa.  
Mine Safety Appliances Co, Ltd, Queenslie Industrial Estate, Glasgow E 3, Scotland  
Pangborn Corp, Hagerstown, Md
- \*\* Pulmonar Safety Equip Corp, 644 Pacific St, Brooklyn 17, NY  
Scott Aviation Corp, Lancaster, NY  
U. S. Divers Co, 3323 West Warner Ave, Santa Ana, Calif  
W. W. Sly Manufacturing Co, 4735 Train Ave, Cleveland 2, Ohio  
Welsh Manufacturing Co, 9 Magnolia St, Providence, RI
- \*\* Willson Prod Div, Ray-O-Vac Co, Reading, Pa. (formerly Willson Prod, Inc)

TABLE 2 - TYPES OF RESPIRATORY PROTECTIVE EQUIPMENT

TABLE 2A - AIR-SUPPLIED SUIT

|                     |                                                                                                                                                                                                                                                                                                       |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Method of Operation | Air supply from supplied air or self-contained breathing apparatus.                                                                                                                                                                                                                                   |
| Use                 | Rescue work or repair work where there is exposure to substances that are irritating or corrosive to the skin and mucuous membranes and are also acutely toxic.                                                                                                                                       |
| Limitations         | Air must be supplied to the suit as well as to the mask. The wearing of an impervious suit for any extended period is extremely fatiguing and dangerous unless it is well ventilated. The suit must be impervious to the substance encountered.                                                       |
| Remarks             | No generally accepted specifications. For additional information, see Fleming, A. J., D'Alenzo, C. A., and Zapp, J. A., "Modern Occupational Medicine," Chapter 7, "Protective Clothing for the Chemical Industry," Lea and Febiger, Philadelphia, 1960. See Standard SIH on air distribution system. |

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- \* Approvals on currently available respiratory protective devices which have been granted by U. S. Bureau of Mines
- \*\* Approval given by U. S. Department of Agriculture for certain pesticides



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TABLE 2B - ATMOSPHERE SUPPLYING RESPIRATORS

| Method of Operation | Self-Contained Types                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                    | Atmosphere Supplying Respirators                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                              |                                                                                                               |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
|                     | Recirculating Self-Contained Type (C-Classes)                                                                                                                                                                                                                                                                                                                              | Demand Type                                                                                                                                                                        | With Blower (Type A Supplied Air Respirator)                                                                                                                                                                                                                                                                                                                                                                              | Without Blower (Type B Supplied Air Respirator)                                                                                                                                                                                                                                                                             | Continuous Flow Air-Line Respirator                                                                                                                                                                                                                                                                          | Demanded Class Air-Line Respirator                                                                            |
| Method of Operation | Exhaled water vapor reacts with a granular chemical to liberate O <sub>2</sub> in a canister. CO <sub>2</sub> is also removed. Purified breath is inhaled through breathing bag.                                                                                                                                                                                           | Air from 2000 psi cylinders supplied to facepiece. Breath inhaled to atmosphere.                                                                                                   | Respirable air is forced through a large diameter flexible hose by a hand blower in a full facepiece.                                                                                                                                                                                                                                                                                                                     | Respirable air is drawn through a large flexible hose by vacuum's breathing effort.                                                                                                                                                                                                                                         | Pressurized air supplied through a small diameter hose to full-face facepiece, full facepiece, or a loose fitting helmet or hood.                                                                                                                                                                            | Source of air: locked by small hose to demand valve actuated by slight negative pressure when wearer inhales. |
| Use                 | Respirator under conditions immediately hazardous to life and health, where 150 ft from a source of respirable air. Protection for limited periods.                                                                                                                                                                                                                        |                                                                                                                                                                                    | Up to 150 ft of travel from source of respirable air. Protection provided for an unlimited period.                                                                                                                                                                                                                                                                                                                        | Nonemergency work, up to 75 ft of travel from source of respirable air. Protection provided for an unlimited period.                                                                                                                                                                                                        | Limits set by manufacturer for air supply hose length and range of air pressure. Protection for unlimited periods.                                                                                                                                                                                           |                                                                                                               |
| Limitations         | No environmental limitations in regard to toxicity or an O <sub>2</sub> concentration. Absorption through the skin or other routes are possible. Environmental conditions may vary and care is required. Fatiguing due to weight.                                                                                                                                          |                                                                                                                                                                                    | No limitation is imposed to toxicity or an O <sub>2</sub> concentration. Absorption through the skin or other routes are possible. Environmental conditions may vary and care is required. Fatiguing due to weight.                                                                                                                                                                                                       | See limitations for Type A at 150 ft. Not for emergency work. Not approved in any situation where atmospheric resistance exceeds 2.5 in. H <sub>2</sub> O or where atmospheric resistance exceeds 2.5 in. H <sub>2</sub> O. Hose shall be fitted with a flow (200) mark and shall be fastened in a case of clean fresh air. | Limited to concentrations of gases or vapors that are not immediately harmful, or from which the wearer can escape unharmed without the aid of the respirator. Not to be worn in oxygen-deficient atmosphere. Travel is limited by the length of the air-supply hose. Route must be retraced. Bulky to wear. |                                                                                                               |
| Remarks             | Approved for 45 min. Must be started in fresh air. Store at temperatures above freezing. Caution: canister is hot after use. For safe disposal of used canister, punch a 1/2 in. hole in each of 2 opposite sides and place in bucket of water until gas (O <sub>2</sub> ) evolution stops. The resulting solution is EOH. Caution: do not get liquid on skin or clothing. | Blowers approved for 30 min. only. Scott Air Pak is an example. Nonemergency and 15-min. Scott Air Pak may be used for self-rescue (1000 psi for 15 min Air Pak) (see par. 7.3.1). | Blower must permit free entrance of air when it is not operating. Helmet should be designed with no other devices than to observe the man in the hazardous atmosphere, attached to the life line, and in emergency, operate the blower. A blower operator also should be provided. A body harness is required to handle the hose line and the life line, which always should be worn as a rescue device (see par. 7.3.2). | See remarks for Type A at 150 ft regarding helmet and harness.                                                                                                                                                                                                                                                              | Noninhalable bases could be used if operating pressure is greater than 5 psi (see par. 7.3.2). Air supplied to facepiece can be attached to the head covering and detached from the whole head rapidly in an emergency. See Standard S1H on air-distribution system.                                         | Helmet or hood used and used with this respirator. See Standard S1H on air-distribution system.               |

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TABLE 2C - AIR PHASE RESPIRATORS

|                     | Chemical Filter Type                                                                                                                                                                                                                                                                                                |                               |                         | Mechanical Filter Type Respirators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Combination Chemical and Mechanical Filter Respirators                                                                                                                                                                                                                                                                                         |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | Canister Gas Mask                                                                                                                                                                                                                                                                                                   | Chemical Canister Respirators | Self-Rescue Respirators |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                |
| Method of Operation | Toxic gases or vapors removed from inspired air by absorption, chemical reaction, or canisters by the granular fill of the canister or canisters. Exhaled breath goes to atmosphere.                                                                                                                                |                               |                         | Respirators remove particulate matter such as dust, fumes, or mist, from inspired air by capture on the filter, which is usually a fibrous pad.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Some gas mask canisters contain special filters which provide respiratory protection against particulate matter, as well as against gases and vapors. Some chemical canister respirators contain filters for the same purpose.                                                                                                                 |
| Use                 | Provides respiratory protection against single or combination of 2 or more gases and vapors. Provides greatest protection consistent with use of device. The degree of protection usually falls between that provided by gas masks and by chemical canister respirators.                                            |                               |                         | Designed to provide respiratory protection against a single specific dust, fume, or mist, a single class such as toxic dusts or a combination of several classes of particulate matter such as dusts, fumes, and mists.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | For particulate matter, gases and vapors in concentration within capacity of the device.                                                                                                                                                                                                                                                       |
| Limitations         | See par. 4.2 to 4.4. Cannot be used in atmospheres inhaling to the skin.<br><br>See par. 4.2 to 4.4. Limited to concentrations not in excess of 1000 ppm by vol (6.1%) organic vapor in air and to atmospheres containing at least 16.5% by vol oxygen. Cannot be used in atmospheres inhaling to the skin or eyes. |                               |                         | Practical limit of concentration is determined by time required to plug filter. Not to be used when plugging occurs, or when, for which conditions the above limiting values should be used. See Table 20. Does not protect against oxygen deficiency and low oxygen or gases. The use of dust and fume respirators in high concentrations of fumes, contaminants requires frequent replacement of disposable filters, or frequent cleaning of reusable filters.                                                                                                                                                                                                                                  | The limitations of the combination are generally the same as for each type of respirator given on the left. The limitations of dust filters in regard to protection against gases and vapors in mechanical filter type is modified by the protection afforded by the chemical filter respirator against gases and vapors. See par. 4.2 to 4.4. |
| Remarks             | Consists of canister called for replacement. See par. 7.3.6 on replacement of canisters.                                                                                                                                                                                                                            |                               |                         | See par. 7.3.7. U. S. Dept of Agriculture approves respiratory devices for certain insecticides. See par. 2.4.3. Fineness of the particles to be filtered out of the air controls the fineness of the filtering element, and nature of the toxicity hazard is a governing factor in selection of equipment. U. S. Bureau of Mines approves mechanical filter respirators according to the following classifications: (1) **Pneumonia - Producing and Nuisance - Dust Respirators. (2) ***Toxic - Dust Respirators (not significantly more toxic than lead). (3) ****Dust Respirators (not significantly more toxic than lead), and (4) Fume Respirators (not significantly more toxic than lead). |                                                                                                                                                                                                                                                                                                                                                |

\* Best - Dispersoids or particulate matter, smaller than 100 microns, formed when solid materials are disintegrated by such processes as crushing, grinding, and shredding.

Figures in parentheses are percentages of total respondents.

**Notes** - Liquid dispersoids formed when liquid is disintegrated as in spray, coating, and emulsifying.

2 and 3 are presented in figures 1 and 2 respectively.

\* Some approved under 4 are approved for protection of diets that are not significantly more toxic than food.

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TABLE 3 - SELECTION OF RESPIRATORY PROTECTIVE DEVICE

| Hazard                                                                                                                 | Respirator                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Oxygen deficiency                                                                                                      | Self-contained breathing apparatus<br>Hose mask with blower                                                                                                              |
| Gaseous contaminant<br>Immediately dangerous to life<br>Not immediately dangerous to life                              | Self-contained breathing apparatus<br>Hose mask with blower<br>Air-line respirator<br>Hose mask without blower<br>Chemical-cartridge respirator                          |
| Particulate contaminant                                                                                                | Mechanical filter respirator<br>Air-line respirator<br>Abrasive-blasting respirator                                                                                      |
| Combination gaseous and particulated contaminant<br>Immediately dangerous to life<br>Not immediately dangerous to life | Self-contained breathing apparatus<br>Hose mask with blower<br>Air-line respirator<br>Hose mask without blower<br>Combination chemical and mechanical filter respirators |

NOTE: The self-contained breathing apparatus and the hose mask with blower would give respiratory protection against any of the hazards listed, but these devices are not included in the list of respirators that could be used in the less hazardous situations.

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