American National Standard

practices for respiratory protection

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American National Standard Practices for Respiratory Protection

Secretariat

Mine Safety and Health Administration, U.S. Department of Labor

Approved May 22, 1980

American National Standards Institute, Inc

American National Standard

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Foreword

(This Foreword is not part of American National Standard Practices for Respiratory Protection, ANSI Z88.2-1980.)

This is a revision of American National Standard Practices for Respiratory Protection, ANSI Z88.2-1969. The 1969 standard was a revision of the respiratory protection portions of American National Standard Safety Code for Head, Eye, and Respiratory Protection, ANSI Z2.1-1959.

The purpose of this standard is to help respirator users to establish, implement, and administer an effective respiratory protection program. It retains the format of the previous standard, while expanding certain sections and adding others to reflect the current state of the art. A more conservative approach toward selection and classification of respirators is taken in this revision. New techniques in respirator-fit testing have provided methods of measuring the fit quantitatively, making possible for the first time a method of establishing a protection factor for any respirator-wearer combination. Thus, a table of respirator protection factors is included in the section on respirator selection and represents a major new item in this revision.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Safety Standards for Respiratory Protection, Z88. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the Z88 Committee had the following members:

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Contents

American National Standard Practices for Respiratory Protection

1. Introduction

1.1 **Scope.** This standard sets forth accepted practices for respirator users, provides information and guidance on the proper selection, use, and care of respirators, and contains recommended requirements for establishing and regulating respirator programs. The standard covers the use of respirators to protect persons against the inhalation of harmful air contaminants and against oxygen deficient atmospheres in the workplace. The following are not covered by this standard: (1) underwater breathing devices, (2) aircraft oxygen systems, (3) military masks, and (4) medical inhalators and resuscitators.

1.2 **Purpose.** The purpose of this standard is to provide information and guidance on the proper selection and use of respirators that will help safeguard the health and life of the users. This standard is written for all persons concerned with respiratory protection, but especially for those primarily responsible for establishing and administrating an acceptable respirator program. The standard contains recommended requirements for use by enforcement authorities in establishing regulations or codes on respiratory protection.

1.3 **"Shall" and "Should."** The provisions of this standard are mandatory in nature where the word "shall" is used and advisory in nature where the word "should" is used.

1.4 **Exceptions.** Exceptions to this standard may be granted by an appropriate regulatory agency, provided that equally acceptable requirements are established.

2. Definitions

abrasive-blasting respirator. See *respirator*. A respirator designed to protect the wearer against inhalation of abrasive material and against impact and abrasion from rebounding abrasive material.

aerodynamic diameter. The diameter of a unit density sphere having the same settling velocity as the particle in question of whatever shape and density.

aerosol. A system consisting of particles, solid or liquid, suspended in air.

air-line respirator. See *respirator*.

air-purifying respirator. See *respirator*.

air-regulating valve. An adjustable valve used to regulate, but which cannot completely shut off, the airflow to the facepiece, helmet, hood, or suit of an air-line respirator.

air-supply device. A hand- or motor-operated blower for the hose mask, or a compressor or other source of respirable air for the air-line respirator.

approved. Tested and listed as satisfactory by the Bureau of Mines (BM) of the U.S. Department of Interior, or jointly by the Mining Enforcement and Safety Administration (MESA) of the U.S. Department of Interior and the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Department of Health, Education, and Welfare, or jointly by the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor and the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Department of Health, Education, and Welfare.

bioassay. A determination of the concentration of a substance in a human body by an analysis of urine, feces, blood, bone, or tissue.

breathing tube. A tube through which air or oxygen flows to the facepiece, mouthpiece, helmet, hood, or suit.

canister (air-purifying). A container with a filter, sorbent, or catalyst, or any combination thereof, which removes specific contaminants from the air drawn through it.

canister (oxygen-generating). A container filled with a chemical which generates oxygen by chemical reaction.

carcinogen. A substance known to cause cancer.

cartridge (air-purifying). A small canister.

catalyst. In respirator use, a substance which converts a toxic gas (or vapor) into a less-toxic gas (or vapor).

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canister (oxygen-generating). A container filled with a chemical which generates oxygen by chemical reaction.

carcinogen. A substance known to cause cancer.

cartridge (air-purifying). A small canister.

catalyst. In respirator use, a substance which converts a toxic gas (or vapor) into a less-toxic gas (or vapor).

ceiling concentration. The concentration of an airborne substance that shall not be exceeded.

chemical-cartridge respirator. See *respirator.*

confined space. An enclosure – such as a storage tank, process vessel, boiler, silo, tank car, pipeline, tube, duct, sewer, underground utility vault, tunnel, or pit – having limited means of egress and poor natural ventilation and which may contain hazardous contaminants or be oxygen deficient.

contaminant. A harmful, irritating, or nuisance material that is foreign to the normal atmosphere.

corrective lens. A lens ground to the wearer's individual corrective prescription to permit normal visual acuity.

demand. See demand-type self-contained breathing apparatus and demand-type air-line respirator in Tables 3 and 4.

detachable coupling. A device which permits the respirator wearer, without using hand tools, to detach the air-supply line from that part of the respirator worn on the person.

dust. See Table 2.

emergency respirator use. Wearing a respirator when a hazardous atmosphere suddenly occurs that requires immediate use of a respirator either for escape from the hazardous atmosphere or for entry into the hazardous atmosphere to carry out maintenance or some other task.

exhalation valve. A device that allows exhaled air to leave a respirator and prevents outside air from entering through the valve.

eyepiece. A gas-tight, transparent window(s) in a full facepiece, helmet, hood, or suit, through which the wearer may see.

facepiece. That portion of a respirator that covers the wearer's nose and mouth in a quarter-mask (above the chin) or half-mask (under the chin) facepiece or that covers the nose, mouth, and eyes in a full facepiece. It is designed to make a gas-tight or particle-tight fit with the face and includes the headbands, exhalation valve(s), and connections for an air-purifying device or respirable gas source, or both.

face shield. A device worn in front of the eyes and a portion of, or all of, the face, whose predominant function is protection of the eyes and the face.

fibrosis-producing dust. Dust which, when inhaled, deposited, and retained in the lungs, may produce findings of fibrotic growth that may cause pulmonary disease.

filter. A media component used in respirators to remove solid or liquid particles from the inspired air.

filter respirator. See *respirator.*

fog. See Table 2.

full facepiece. See *facepiece.*

fume. See Table 2.

gas. An aeriform fluid which is in the gaseous state at ordinary temperature and pressure.

gas mask. See *respirator.*

goggle. A device, with contour-shaped eyecups with glass or plastic lenses, worn over the eyes and held in place by a headband or other suitable means for the protection of the eyes and eye sockets.

half-mask facepiece. See *facepiece.*

hazardous atmosphere. Any atmosphere, either immediately or not immediately dangerous to life or health, which is oxygen deficient or which contains a toxic or disease-producing contaminant exceeding the legally established permissible exposure limit (PEL) or, where applicable, the Threshold Limit Value (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH).

head harness. That part of a facepiece assembly which secures the facepiece to the wearer.

helmet. That portion of a respirator which shields the eyes, face, neck, and other parts of the head.

high-efficiency filter. A filter which removes from air 99.97% or more of monodisperse dioctyl phthalate (DOP) particles having a mean particle diameter of 0.3 micrometer.

hood. That portion of a respirator which completely covers the head, neck, and portions of the shoulders.

hose mask. See *respirator.*

immediately dangerous to life or health (IDLH). Any atmosphere that poses an immediate hazard to life or produces immediate irreversible debilitating effects on health.

inhalation valve. A device that allows respirable air to enter a respirator and prevents exhaled air from leaving the respirator through the valve.

irrespirable. Unfit for breathing.

maximum use limit of filter, cartridge, or canister. The maximum concentration of a contaminant for which an air-purifying filter, cartridge, or canister is approved for use.

mist. See Table 2.

mouthpiece. That portion of a respirator which is held in the wearer's mouth and is connected to an air-purifying device or respirable gas source, or both. It is designed to make a gas-tight or particle-tight fit with the mouth.

MPCa. Maximum permissible airborne concentration. These concentrations are set by the National Committee on Radiation Protection. They are recommended maximum average concentrations of radionuclides to which a worker may be exposed, assuming that he works 8 hours a day, 5 days a week, and 50 weeks a year.

negative pressure respirator. A respirator in which the air pressure inside the respiratory-inlet covering is positive during exhalation in relation to the air pressure of the outside atmosphere and negative during inhalation in relation to the air pressure of the outside atmosphere.

nonroutine respirator use. Wearing a respirator when carrying out a special task that occurs infrequently.

nose clamp. A device used with a respirator equipped with a mouthpiece that closes the nostrils of the wearer (sometimes called a nose clip).

not immediately dangerous to life or health. Any hazardous atmosphere which may produce physical discomfort immediately, chronic poisoning after repeated exposure, or acute adverse physiological symptoms after prolonged exposure.

odor threshold limit. The lowest concentration of a contaminant in air that can be detected by the olfactory sense.

oxygen deficiency – immediately dangerous to life or health. An atmosphere which causes an oxygen partial pressure of 100 millimeters of mercury column or less in the freshly inspired air in the upper portion of the lungs which is saturated with water vapor. See Appendix A10.

oxygen deficiency – not immediately dangerous to life or health. An atmosphere having an oxygen concentration below the minimum legal requirement (see Table 1) but above that which is immediately dangerous to life or health.

particulate matter. A suspension of fine solid or liquid particles in air, such as: dust, fog, fume, mist, smoke, or spray. Particulate matter suspended in air is commonly known as an aerosol.

permissible exposure limit (PEL). The legally established time-weighted average (TWA) concentration or ceiling concentration of a contaminant that shall not be exceeded.

pneumoconiosis-producing dust. Dust which, when inhaled, deposited, and retained in the lungs, may produce signs, symptoms, and findings of pulmonary disease.

positive-pressure respirator. A respirator in which the air pressure inside the respiratory-inlet covering is positive in relation to the air pressure of the outside atmosphere during exhalation and inhalation.

powered air-purifying respirator. See *respirator.*

pressure-demand. See pressure-demand-type self-contained breathing apparatus and pressure-demand-type air-line respirator in Tables 3 and 4.

protection factor. The ratio of the ambient concentration of an airborne substance to the concentration of the substance inside the respirator at the breathing zone of the wearer. The protection factor is a measure of the degree of protection provided by a respirator to the wearer. See Appendix A6.4.

rescue respirator use. Wearing a respirator for entry into a hazardous atmosphere to rescue a person(s) in the hazardous atmosphere.

resistance. Opposition to the flow of air, as through a canister, cartridge, particulate filter, orifice, valve, or hose.

respirable. Suitable for breathing.

respirator. A device designed to protect the wearer from the inhalation of harmful atmospheres. See Section 5, Classification, Description, and Limitations of Respirators, and Tables 3 and 4.

respiratory-inlet covering. That portion of a respirator which connects the wearer's respiratory tract to an air-purifying device or respirable gas source, or both. It may be a facepiece, helmet, hood, suit, or mouthpiece/nose clamp.

routine respirator use. Wearing a respirator as a normal procedure when carrying out a regular and frequently repeated task.

sanitization. The removal of dirt and the inhibiting of the action of agents that cause infection or disease.

self-contained breathing apparatus. See *respirator.*

service life. The period of time that a respirator provides adequate protection to the wearer – for example, the period of time that an air-purifying device is effective for removing a harmful substance from inspired air.

smoke. See Table 2.

sorbent. A material which is contained in a cartridge or canister and which removes toxic gases and vapors from the inhaled air.

spray. See Table 2.

supplied-air respirator. See *respirator.*

supplied-air suit. A suit that is impermeable to most particulate and gaseous contaminants and that is provided with an adequate supply of respirable air.

time-weighted average (TWA). The average concentration of a contaminant in air during a specific time period.

valve (air or oxygen). A device which controls the pressure, direction, or rate of flow of air or oxygen.

vapor. The gaseous state of a substance that is solid or liquid at ordinary temperature and pressure.

welding helmet. A device designed to provide protection for the eyes and face against intense radiant energy and molten metal splatter encountered in the welding and cutting of metals.

window indicator. A device on a cartridge or canister that visually denotes the service life of the cartridge or canister.

3. Respirator Program Requirements

3.1 Purpose. This section establishes requirements for a program for the use of respirators. The following requirements are supplemented by recommended practices in subsequent sections of this standard.

3.2 Permissible Practice. In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fumes, sprays, mists, fogs, smokes, vapors, or gases, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted or evaluated, appropriate respirators shall be used pursuant to the following requirements.

3.3 Employer Responsibility.

3.3.1 Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee.

3.3.2 The employer shall provide the respirators which are applicable and suitable for the purpose intended.

3.3.3 The employer shall be responsible for the establishment and maintenance of a respiratory protection program which shall include the general requirements outlined in 3.5.

3.4 Employee Responsibility.

3.4.1 The employee shall use the provided respiratory protection in accordance with instructions and training received.

3.4.2 The employee shall guard against damage to the respirator.

3.4.3 The employee shall report any malfunction of the respirator to a responsible person designated by the written standard operating procedures.

3.5 Minimal Acceptable Respirator Program

3.5.1 Standard Operating Procedures. Written standard operating procedures covering a complete respirator program shall be established and implemented in conformance with 3.5.2 through 3.5.15.

3.5.2 Program Administration. The plant or company industrial hygiene, health physics, or safety engineering department shall administer the respirator program in close liaison with the medical department. Responsibility and authority for the respirator program shall be assigned to a single person. In small plants or companies having no formal industrial hygiene, health physics, or safety engineering department, the respiratory program shall be administered by an upper-level superintendent, foreman, or other qualified person responsible to the principal manager. The administrator shall have sufficient knowledge of respiratory protection to properly supervise the respirator program.

3.5.3 Physiological and Psychological Limitations for Respirator Wearers. A physician shall determine what physiological and psychological conditions are pertinent for the wearing of different types of respirators. The respirator program administrator or his designee, using guidelines established by the physician, shall determine whether or not a person may be assigned to a task requiring the use of a respirator. This determination shall be reviewed at least annually. (See 7.3.1, 7.3.2, 7.3.6, 7.3.7, and 7.3.8, and Appendix A4.)

3.5.4 Approved Respirators. Approved respirators shall be used. For exceptions, see 1.4. Any modification that is not authorized by the approval agencies of an approved respirator voids the approval.

3.5.5 Respirator Selection. The selection of the

proper type of respirator shall be based upon (1) the nature of the hazardous operation or process, (2) the type of respiratory hazard (including physical properties, physiological effects on the body, concentration of toxic material or airborne radioactivity level, established permissible time-weighted average concentration for toxic material, established permissible airborne concentration for radioactive material, and established immediately dangerous to life or health concentration for toxic material), (3) the location of the hazardous area in relation to the nearest area having respirable air, (4) the period of time for which respiratory protection must be provided, (5) the activities of workers in the hazardous area, (6) the physical characteristics and functional capabilities and limitations of the various types of respirators, and (7) respirator protection factors. (See Section 6.)

3.5.6 **Training.** Each respirator wearer shall be given training which shall include explanations and discussions of (1) the respiratory hazard and what happens if the respirator is not used properly, (2) the engineering and administrative controls being used and the need for respirators to provide protection, (3) the reason for selecting a particular type of respirator, (4) the function, capabilities, and limitations of the selected respirator, (5) the method of donning the respirator and checking its fit and operation, (6) the proper wearing of the respirator, (7) respirator maintenance, and (8) recognizing and handling emergency situations. (See 7.2.3.)

3.5.7 **Respirator Fit.** Each respirator wearer shall be provided with a respirator fitted in accordance with 6.11. Each respirator wearer shall be required to check the seal of the respirator by appropriate means prior to entering a harmful atmosphere. (See 7.4.)

3.5.8 **Facial Hair, Contact Lenses, and Eye and Face Protective Devices.** A respirator equipped with a facepiece shall not be worn if facial hair comes between the sealing periphery of the facepiece and the face or if facial hair interferes with valve function. The wearer of a respirator equipped with a full facepiece, helmet, hood, or suit shall not be allowed to wear contact lenses. If a spectacle, goggle, face shield, or welding helmet must be worn with a facepiece, it shall be worn so as not to adversely affect the seal of the facepiece to the face. (See 7.3 and 9.1.)

3.5.9 **Issue of Respirators.** The proper type of respirator for each respiratory hazard shall be listed in written standard operating procedures. Only persons trained to ensure that proper respirators are issued shall be permitted to issue respirators to persons needing them. (See 7.2.2 and 7.5.)

3.5.10 **Respirator Inspection.** The respirator shall be inspected by the wearer prior to its use to ensure that it is in proper working condition. Each respirator stored for emergency or rescue use shall be inspected at least once a month. (See 7.6 and 8.3.)

3.5.11 **Monitoring Respirator Use.** Supervisory personnel shall periodically monitor the use of respirators to ensure that they are worn properly. (See 7.7.)

3.5.12 **Monitoring Respiratory Hazard.** The concentration or the airborne radioactivity level of the respiratory hazard in the work area shall be monitored initially prior to respirator selection and periodically during respirator use to ensure that the proper type of respirator is being utilized. (See 6.4 and 7.8.)

3.15.13 **Medical and Bioassay Surveillance.** When applicable, medical surveillance, including bioassay, shall be carried out periodically to determine if respirator wearers are receiving adequate respiratory protection. A physician shall determine the requirements of the surveillance program. (See 10.4.)

3.15.14 **Respirator Maintenance.** Respirator maintenance shall be performed regularly. Maintenance shall be carried out on a schedule which ensures that each respirator wearer is provided with a respirator that is clean and in good operating condition. Maintenance shall include: (1) washing, sanitizing, rinsing, and drying, (2) inspection for defects, (3) replacement of worn or deteriorated parts, (4) repair if necessary, and (5) storage to protect against dust, sunlight, excessive heat, extreme cold, excessive moisture, damaging chemicals, and physical damage. (See Section 8.)

3.5.15 **Respirator Program Evaluation.** An appraisal of the effectiveness of the respirator program shall be carried out at least annually. Action shall be taken to correct defects found in the program. (See Section 10.)

4. Classification of Respiratory Hazards

4.1 **Introduction.** The purpose of this section is to list and briefly describe various categories of respiratory hazards that might be encountered and that may require use of respirators. The information provides a general background for relating the guidance provided in subsequent sections to the type of hazard encountered. The respirator program administrator, however, may find it necessary to consult references on industrial hygiene and toxicology, and perhaps expert individuals as well, in order to develop the necessary comprehensive information on specific airborne contaminants.

Respiratory hazards, for the purpose of this standard, are classified as follows:

(1) Oxygen deficiency
  (a) Immediately dangerous to life or health
  (b) Not immediately dangerous to life or health

(2) Gas and vapor contaminants
(a) Immediately dangerous to life or health
(b) Not immediately dangerous to life or health
(3) Particulate contaminants (aerosols including dust, fog, fume, mist, smoke, and spray)
(a) Immediately dangerous to life or health
(b) Not immediately dangerous to life or health
(4) Combination of gas, vapor, and particulate contaminants
(a) Immediately dangerous to life or health
(b) Not immediately dangerous to life or health

Respirators may afford some protection against high-temperature atmospheres. (See 9.6.) Further information on the hazards of and use of respirators in high temperatures is presented in a National Fire Protection Association publication, *Fire Officers Guide to Breathing Apparatus for the Fire Service*, published in 1975.

4.2 Classification and Description of Respiratory Hazards. The basic respiratory hazards listed in 4.1 are classified in Table 1 according to expected biological effects of the contaminants. Many respirators, particularly air-purifying respirators, are designed and selected on the basis of chemical and physical properties of the air contaminants. Therefore, gas, vapor, and particulate contaminants are presented in Table 2 according to their physical and chemical properties.

5. Classification, Description, and Limitations of Respirators

5.1 Introduction. The purpose of this section is to provide a description of the various types of respirators, including their limitations and capabilities, as a background for subsequent sections which discuss their selection, use, and maintenance. This information is presented in two tables. Table 3 covers the classification and description of respirators according to the general classifications concerning mode of operation. Table 4 covers capabilities and limitations of respirators arranged to correspond to the subject headings in Table 3.

Respirators fall into the following general classifications, according to mode of operation:
(1) Atmosphere-supplying respirators
(a) Self-contained
(b) Supplied-air
(c) Combination self-contained and supplied-air
(2) Air-purifying respirators
(a) Gas and vapor
(b) Particulate (aerosols including dust, fog, fume, mist, smoke, and spray)
(c) Combination gas, vapor, and particulate
(3) Combination atmosphere-supplying and air-purifying respirators

More detailed information on specific types of respirators can be obtained from respirator manufacturers and from the following manuals:

Respiratory Protective Devices Manual published by the American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists in 1963 (out of print)

A Guide to Industrial Respiratory Protection published by the Los Alamos Scientific Laboratory in 1977

Energy Research and Development Administration, Division of Safety, Standards, and Compliance Respirator Manual published by the Los Alamos Scientific Laboratory in 1976

Manual of Respiratory Protection Against Airborne Radioactive Materials published by the U.S. Nuclear Regulatory Commission in 1976

The colors assigned to cartridges and canisters of air-purifying respirators are listed in the American National Standard for Identification of Cartridges and Canisters used in Air-Purifying Respirators, ANSI K13.1-1973.

5.2 Respirable Air and Oxygen for Self-Contained Breathing Apparatus and Supplied-Air Respirators. Compressed gaseous air, compressed gaseous oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity. Compressed gaseous or liquid oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. Chemically generated oxygen shall meet the requirements of U.S. Department of Defense Military Specification MIL-E-83252 or Military Specification MIL-O-15633c. Compressed gaseous air shall meet at least the requirements of the specification for Type I – Grade D breathing air, and liquid air shall meet at least the requirements for Type II – Grade B breathing air as described in American National Standard Commodity Specification for Air, ANSI Z86.1-1973 (Compressed Gas Association Commodity Specification for Air, G-7.1, 1973).

Compressed gaseous air may contain low concentrations of oil. If high-pressure oxygen passes through an oil- or grease-coated orifice, an explosion or fire may occur. Therefore, compressed gaseous oxygen shall not be used in supplied-air respirators or in open-circuit-type self-contained breathing apparatus that have previously used compressed air.

Breathing air may be supplied to respirators from cylinders or air compressors. Cylinders shall be tested

and maintained in accordance with applicable Department of Transportation specifications for shipping containers (Title 49, *Code of Federal Regulations*, Part 173, General Requirements for Shipments and Packagings, and Part 178, Shipping Container Specifications). A compressor shall be constructed and situated so as to avoid entry of contaminated air into the air-supply system and shall be equipped with a suitable in-line air-purifying sorbent bed and filter to further assure breathing air quality. If an oil-lubricated compressor is used, it shall be equipped with a high-temperature alarm or a carbon-monoxide alarm, or both.

Breathing air couplings shall be incompatible with outlets for nonrespirable plant air or other gas systems to prevent inadvertent servicing of air-line respirators with nonrespirable gases.

Breathing-gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, ANSI Z48.1-1954 (R1971); Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B-675d, September 23, 1976, Breathing Apparatus, Self-Contained. Further details on sources of compressed air and its safe use will be found in Compressed Gas Association Pamphlet G-7, 1976, Compressed Air for Human Respiration.

6. Selection of Respirators

6.1 **Approved Respirators.** Only approved respirators shall be selected. For exceptions, see 1.4. (See Appendix A3.)

6.2 **General Considerations.** The selection of a proper respirator for any given situation shall require consideration of the following factors:

(1) The nature of the hazard (see 6.3, 6.4, 6.9.1, 6.9.2, and 6.9.3)

(2) The characteristics of the hazardous operation or process (see 6.5)

(3) The location of the hazardous area with respect to a safe area having respirable air (see 6.6)

(4) The period of time for which respiratory protection may be provided (see 6.7)

(5) The activity of workers in the hazardous area (see 6.8)

(6) The physical characteristics, functional capabilities, and limitations of respirators of various types (see 6.9)

(7) The respirator-protection factors and respirator fit (see 6.10, 6.11, 6.12, 6.13, 6.14, and 6.15)

6.3 **Nature of Hazard.** The following factors concerning the nature of the hazard requiring the use of respirators shall be considered in respirator selection:

(1) Type of hazard
  (a) Oxygen deficiency
  (b) Contaminant
(2) Physical properties
(3) Chemical properties
(4) Physiological effects on the body
(5) Actual concentration of a toxic material or airborne radioactivity level
  (a) Average
  (b) Peak
(6) Established permissible time-weighted average or peak concentration of a toxic material, or both, or established maximum permissible airborne radioactivity level for radioactive substances
(7) Whether the hazard is an immediately-dangerous-to-life-or-health concentration of a toxic material
(8) Warning properties

See Section 4 for classification and discussion of respiratory hazards.

6.4 **Initial Monitoring of Respiratory Hazard.** Recognition and evaluation of the respiratory hazard [oxygen deficiency or contaminant(s)] shall be an essential part of selecting a respirator except in emergency or rescue operations. Initial monitoring of the respiratory hazard shall be carried out to obtain data needed for the selection of proper respiratory protection. The data should include:

(1) Identification of the type of respiratory hazard
  (a) Oxygen deficiency
  (b) Specific contaminant(s)
(2) Nature of contaminant(s)
  (a) Particulate matter
  (b) Vapor(s) or gas(es)
(3) Concentration of respiratory hazard

See Appendix A8 for a discussion of the monitoring of respiratory hazards.

6.5 **Characteristics of Hazardous Operation or Process.** The following factors concerning the hazardous operation or process shall be taken into account in selecting the proper respirator:

(1) Operation or process characteristics
(2) Work-area characteristics
(3) Materials, including raw materials, end products, and byproducts (actual and potential)
(4) Worker activities

Modification in the operation or process shall be taken into account, since this may change the hazard and hence require the selection of a different respirator.

Table 1
Classification of Respiratory Hazards According to Their Biological Effect

Oxygen Deficiency

Minimum legal requirements: 19.5% by volume for respirable air at sea-level conditions. (See Note 1.)

Occurrence: Confined or unventilated cellars, wells, mines, ship holds, tanks, burning buildings, and enclosures containing inert atmospheres.

Atmospheric oxygen content (percent by volume) versus expected conditions:

20.9%: Oxygen content of normal air at sea-level conditions.

Oxygen Volume Percent at Sea Level	*Physiological Effects*
16%–12%	loss of peripheral vision, increased breathing volume, accelerated heartbeat, impaired attention and thinking, impaired coordination.
12%–10%	Very faulty judgment, very poor muscular coordination, muscular exertion causes fatigue that may cause permanent heart damage, intermittent respiration.
10%–6%	Nausea, vomiting, inability to perform vigorous movement, unconsciousness followed by death.
Less than 6%	Spasmatic breathing, convulsive movements, death in minutes.

Gas and Vapor Contaminants

Asphyxiants: Interfere with utilization of oxygen in the body.

Simple asphyxiants: Physiologically inert substances that dilute oxygen in the air (for example: nitrogen, hydrogen, helium, methane). See Oxygen Deficiency, Column 1.

Chemical asphyxiants: Low concentrations interfere with supply or utilization of oxygen in the body (for example: carbon monoxide, hydrogen cyanide, cyanogen, and nitrites).

Irritants: Corrosive in action. May cause irritation and inflammation of parts of the respiratory system (also skin and eyes) and pulmonary edema (for example: ammonia hydrogen chloride, formaldehyde, sulfur dioxide, chlorine, ozone, nitrogen dioxide, phosgene, and arsenic trichloride).

Anesthetics: Cause loss of feeling and sensation with unconsciousness and death possible (for example: nitrous oxide, hydrocarbons, and ethers). Some anesthetics injure body organs (for example: carbon tetrachloride [liver and kidneys], chloroform [liver and heart], benzene [bone marrow], and carbon disulfide [nervous system]).

Sensitizers: Cause increased probability of physiological reactions (for example: isocyanates, epoxy resin systems).

Systemic poisons: Damage organs and systems in the body (for example: mercury [nervous system and various organs], phosphorus [bone], hydrogen sulfide [respiratory paralysis], and arsine [red blood cells and liver]).

Carcinogens: Produce cancer in some individuals after a latent period (for example: vinyl chloride, benzene).

Particulate Contaminants
(Dust, fog, fume, mist, smoke, and spray)

Relatively inert: May cause discomfort and minor irritation, but generally without injury at reasonable concentrations (for example: marble, gypsum).

Pulmonary-fibrosis-producing: Produce nodulation and fibrosis in the lung, possibly leading to complications (for example: quartz, asbestos).

Carcinogens: Produce cancer in some individuals after latent period (for example: asbestos, chromates, radioactive particulates).

Chemical irritants: Produce irritation, inflammation, and ulceration in upper respiratory tract (for example: acidic mists, alkalies).

Systemic poisons: Produce pathologic reactions in various systems of the body (for example: lead, manganese, cadmium).

Allergy-producing: Produce reactions such as itching, sneezing, and asthmas (for example: pollens, spices, and animal fur).

Febrile-reaction-producing: Produce chills followed by fever (for example: fumes of zinc and copper).

Combinations of Gas, Vapor, and Particulate Contaminants

Combinations of contaminants may occur simultaneously in the atmosphere. Contaminants may be entirely different substances (dusts and gases from blasting) or the particulate and vapor forms of the same substance. Synergistic effects (joint action of two or more agents that results in an effect which is greater than the sum of their individual effects) may occur. Such effects may require extraordinary protective measures.

NOTE 1: See definition in Section 2 for "oxygen deficiency – not immediately dangerous to life or health" and "oxygen deficiency – immediately dangerous to life or health," and Appendix A10.

Table 2
Classification of Respiratory Hazards According to Their Properties Which Influence Respirator Selection

Gas and Vapor Contaminants	Particulate Contaminants
Inert: Substances that do not react with other substances under most conditions, but create a respiratory hazard by displacing air and producing oxygen deficiency (for example: helium, neon, argon).	Particles are produced by mechanical means by disintegration processes such as grinding, crushing, drilling, blasting, and spraying; or by physiochemical reactions such as combustion, vaporization, distillation, sublimation, calcination, and condensation. Particles are classified as follows:
Acidic: Substances that are acids or that react with water to produce an acid. In water, they produce positively charged hydrogen ions (H^{+}) and a pH of less than 7. They taste sour, and many are corrosive to tissues (for example: hydrogen chloride, sulfur dioxide, fluorine, nitrogen dioxide, acetic acid, carbon dioxide, hydrogen sulfide, and hydrogen cyanide).	**Dust:** A solid, mechanically produced particle with sizes varying from submicroscopic to visible or macroscopic.
Alkaline: Substances that are alkalies or that react with water to produce an alkali. In water, they result in the production of negatively charged hydroxyl ions (OH^{-}) and a pH greater than 7. They taste bitter, and many are corrosive to tissues (for example: ammonia, amines, phosphine, arsine, and stibine).	**Spray:** A liquid, mechanically produced particle with sizes generally in the visible or macroscopic range.
Organic: The compounds of carbon. Examples are saturated hydrocarbons (methane, ethane, butane), unsaturated hydrocarbons (ethylene, acetylene), alcohols (methyl ether, ethyl ether), aldehydes (formaldehyde), ketones (methyl ketone), organic acids (formic acid, acetic acid), halides (chloroform, carbon tetrachloride), amides (formamide, acetamide), nitriles (acetonitrile), isocyanates (toluene diisocyanate), amines (methylamine), epoxies (epoxyethane, propylene oxide), and aromatics (benzene, toluene, xylene).	**Fume:** A solid condensation particle of extremely small particle size, generally less than one micrometer in diameter.
Organometallic: Compounds in which metals are chemically bonded to organic groups (for example: ethyl silicate, tetraethyl lead, and organic phosphate).	**Mist:** A liquid condensation particle with sizes ranging from submicroscopic to visible or macroscopic.
Hydrides: Compounds in which hydrogen is chemically bonded to metals and certain other elements (for example: diborane and tetraborane).	**Fog:** A mist of sufficient concentration to perceptibly obscure vision.
	Smoke: A system which includes the products of combustion, pyrolysis, or chemical reaction of substances in the form of visible and invisible solid and liquid particles and gaseous products in air. Smoke is usually of sufficient concentration to perceptibly obscure vision.

Table 3
Classification and Description of Respirators by Mode of Operation

Atmosphere-Supplying Respirators

A respirable atmosphere independent of the ambient air is supplied to the wearer.

Self-Contained Breathing Apparatus (SCBA)

A supply of air, oxygen, or oxygen-generating material is carried by the wearer. Normally equipped with full facepiece, but may be equipped with a quarter-mask facepiece, half-mask facepiece, helmet, hood, or mouthpiece and nose clamp.

(1) Closed-Circuit SCBA (oxygen only, negative pressure[a] or positive pressure[b]).

(a) Compressed or liquid oxygen type. Equipped with a facepiece or mouthpiece and nose clamp. High-pressure oxygen from a gas cylinder passes through a high-pressure reducing valve and, in some designs, through a low-pressure admission valve to a breathing bag or container. Liquid oxygen is converted to low-pressure gaseous oxygen and delivered to the breathing bag. The wearer inhales from the bag, through a corrugated tube connected to a mouthpiece or facepiece and a one-way check valve. Exhaled air passes through another check valve and tube into a container of carbon-dioxide removing chemical and reenters the breathing bag. Make-up oxygen enters the bag continuously or as the bag deflates sufficiently to actuate an admission valve. A pressure-relief system is provided, and a manual bypass system and saliva trap may be provided depending upon the design.

Supplied-Air Respirators

(1) Hose Mask

Equipped with a facepiece, breathing tube, rugged safety harness, and large-diameter heavy-duty nonkinking air-supply hose. The breathing tube and air-supply hose are securely attached to the harness. The facepiece is equipped with an exhalation valve. The harness has provision for attaching a safety line.

(a) Hose mask with blower. Air is supplied by a motor-driven or hand-operated blower. The wearer can continue to inhale through the hose if the blower fails. Up to 300 feet (91 meters) of hose length is permissible.

(b) Hose mask without blower. The wearer provides motivating force to pull air through the hose. The hose inlet is anchored and fitted with a funnel or like object covered with a fine mesh screen to prevent entrance of coarse particulate matter. Up to 75 feet (23 meters) of hose length is permissible.

(2) Air-Line Respirator

Respirable air is supplied through a small-diameter hose from a compressor or compressed-air cylinder(s). The hose is attached to the wearer by a belt or other suitable means and can be detached rapidly in an emergency. A flow-control valve

Air-Purifying Respirators

Ambient air, prior to being inhaled, is passed through a filter, cartridge, or canister which removes particles, vapors, gases, or a combination of these contaminants. The breathing action of the wearer operates the nonpowered type of respirator. The powered type contains a blower – stationary or carried by the wearer – which passes ambient air through an air-purifying component and then supplies purified air to the respirator-inlet covering. The nonpowered type is equipped with a facepiece or mouthpiece and nose clamp. The powered type is equipped with a facepiece, helmet, hood, or suit.

Vapor- and Gas-Removing Respirators

Equipped with cartridge(s) or canister(s) to remove a single vapor or gas (for example: chlorine gas), a single class of vapors or gases (for example: organic vapors), or a combination of two or more classes of vapors or gases (for example: organic vapors and acidic gases) from air.

Particulate-Removing Respirators

Equipped with filter(s) to remove a single type of particulate matter (for example: dust) or a combination of two or more types of particulate matter (for example: dust and fume) from air. Filter may be a replaceable part or a permanent part of the respirator. Filter may be of the single-use or the reusable type.

Combination Particulate- and Vapor- and Gas-Removing Respirators

Equipped with cartridge(s) or canister(s) to remove particulate matter, vapors, and gases from air. The filter may be a permanent part or a replaceable part of a cartridge or canister.

(b) Oxygen-generating type. Equipped with a facepiece or mouthpiece and nose clamp. Water vapor in the exhaled breath reacts with chemical in the canister to release oxygen to the breathing bag. The wearer inhales from the bag through a corrugated tube and one-way check valve at the facepiece. Exhaled air passes through a second check valve/breathing tube assembly into the canister. The oxygen-release rate is governed by the volume of exhaled air. Carbon dioxide in the exhaled breath is removed by the canister fill.

(2) Open-Circuit SCBA (compressed air, compressed oxygen, liquid air, liquid oxygen). A bypass system is provided in case of regulator failure except on escape-type units.

(a) Demand type.[c] Equipped with a facepiece or mouthpiece and nose clamp. The demand valve permits oxygen or air flow only during inhalation. Exhaled breath passes to ambient atmosphere through a valve(s) in the facepiece.

(b) Pressure-demand type.[d] Equipped with a facepiece only. Positive pressure is maintained in the facepiece. The apparatus may have provision for the wearer to select the demand or pressure-demand mode of operation, in which case the demand mode should be used only when donning or removing the apparatus.

or orifice is provided to govern the rate of air flow to the wearer. Exhaled air passes to the ambient atmosphere through a valve(s) or opening(s) in the enclosure (facepiece, helmet, hood, or suit). Up to 300 feet (91 meters) of hose length is permissible.

(a) Continuous-flow class. Equipped with a facepiece, hood, helmet, or suit. At least 115 liters (four cubic feet) of air per minute to tight-fitting facepieces and 170 liters (six cubic feet) of air per minute to loose-fitting helmets, hoods, and suits is required. Air is supplied to a suit through a system of internal tubes to the head, trunk, and extremities through valves located in appropriate parts of the suit.

(b) Demand type.[c] Equipped with a facepiece only. The demand valve permits flow of air only during inhalation.

(c) Pressure-demand type.[d] Equipped with a facepiece only. A positive pressure is maintained in the facepiece.

Combination Air-Line Respirators with Auxiliary Self-Contained Air Supply include an air-line respirator with an auxiliary self-contained air supply. To escape from a hazardous atmosphere in the event the primary air supply fails to operate, the wearer switches to the auxiliary self-contained air supply. Devices approved for both entry into and escape from dangerous atmospheres have a low-pressure warning alarm and contain at least a 15-minute self-contained air supply.

Combination Atmosphere-Supplying and Air-Purifying Respirators

Provide the wearer with the option of using either of two different modes of operation: (1) an atmosphere-supplying respirator with an auxiliary air-purifying attachment which provides protection in the event the air supply fails or (2) an air-purifying respirator with an auxiliary self-contained air supply which is used when the atmosphere may exceed safe conditions for use of an air-purifying respirator.

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[a] Device produces negative pressure in respiratory-inlet covering during inhalation.

[b] Device produces positive pressure in respiratory-inlet covering during both inhalation and exhalation.

[c] Equipped with a demand valve that is activated on initiation of inhalation and permits the flow of breathing atmosphere to the facepiece. On exhalation, pressure in the facepiece becomes positive and the demand valve is deactivated.

[d] A positive pressure is maintained in the facepiece by a spring-loaded or balanced regulator and exhalation valve.

Table 4
Capabilities and Limitations of Respirators

Atmosphere-Supplying Respirators

(See 5.2 for specifications on respirable atmospheres.)

Atmosphere-supplying respirators provide protection against oxygen deficiency and toxic atmospheres. The breathing atmosphere is independent of ambient atmospheric conditions.

General limitations: Except for some air-line suits, no protection is provided against skin irritation by materials such as ammonia and hydrogen chloride, or against sorption of materials such as hydrogen cyanide, tritium, or organic phosphate pesticides through the skin. Facepieces present special problems to individuals required to wear prescription lenses (see 9.1). Use of atmosphere-supplying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions (see Table 5 and 9.3 and 9.4).

Self-Contained Breathing Apparatus (SCBA)

The wearer carries his own breathing atmosphere.

Limitations: The period over which the device will provide protection is limited by the amount of air or oxygen in the apparatus, the ambient atmospheric pressure (service life of open-circuit devices is cut in half by a doubling of the atmospheric pressure), and the type of work being performed. Some SCBA devices have a short service life (less than 15 minutes) and are suitable only for escape (self-rescue) from an irrespirable atmosphere.

Chief limitations of SCBA devices are their weight or bulk, or both, limited service life, and the training required for their maintenance and safe use.

(1) Closed-Circuit SCBA.
The closed-circuit operation conserves oxygen and permits longer service life at reduced weight. The negative-pressure type produces a negative pressure in the

Supplied-Air Respirators

The respirable air supply is not limited to the quantity the individual can carry, and the devices are lightweight and simple.

Limitations: Limited to use in atmospheres from which the wearer can escape unharmed without the aid of the respirator.

The wearer is restricted in movement by the hose and must return to a respirable atmosphere by retracing his route of entry. The hose is subject to being severed or pinched off.

(1) Hose Mask.
The hose inlet or blower must be located and secured in a respirable atmosphere.

(a) Hose mask with blower.
If the blower fails, the unit still provides protection, although a negative pressure exists in the facepiece during inhalation.

(b) Hose mask without blower.
Maximum hose length may restrict application of device.

Air-Purifying Respirators

General limitations: Air-purifying respirators do not protect against oxygen-deficient atmospheres nor against skin irritations by, or sorption through the skin of, airborne contaminants.

The maximum contaminant concentration against which an air-purifying respirator will protect is determined by the design efficiency and capacity of the cartridge, canister, or filter and the facepiece-to-face seal on the user. For gases and vapors, the maximum concentration for which the air-purifying element is designed is specified by the manufacturer or is listed on labels of cartridges and canisters.

Nonpowered air-purifying respirators will not provide the maximum design protection specified unless the facepiece or mouthpiece/nose clamp is carefully fitted to the wearer's face to prevent inward leakage (see 7.4). The time period over which protection is provided is dependent on canister, cartridge, or filter type; concentration of contaminant; humidity levels in the ambient atmosphere; and the wearer's respiratory rate.

The proper type of canister, cartridge, or filter must be selected for the particular atmosphere and conditions. Nonpowered air-purifying respirators may cause discomfort due to a noticeable resistance to inhalation. This problem is minimized in powered respirators. Respirator facepieces present special problems to individuals required to wear prescription lenses (see 9.1). These devices do have the advantage of being small, light, and simple in operation.

Use of air-purifying respirators in atmospheres immediately dangerous to life or health is limited to specific devices under specified conditions (see Table 5 and 9.3 and 9.4).

Vapor- and Gas-Removing Respirators

Limitations: No protection is provided against particulate contaminants. A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air.

An uncomfortably high temperature indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

Use should be avoided in atmospheres

Particulate-Removing Respirators

Limitations: Protection against nonvolatile particles only. No protection against gases and vapors.

Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions (see Table 5).

(1) Full Facepiece Respirator.
Provides protection against eye irritation in addition to respiratory protection.

respiratory-inlet covering during inhalation, and the mask may permit inward leakage of contaminants; whereas the positive-pressure type always maintains a positive pressure in the respiratory-inlet covering and is free of to permit inward leakage of contaminants.

(3) Open-Circuit SCBA.
The demand type produces a negative pressure in the respiratory-inlet covering during inhalation, whereas the pressure-demand (type maintains a positive pressure in the respiratory-inlet covering during inhalation and is free of to permit inward leakage of contaminants.

(2) Air-Line Respirator (Continuous Flow, Demand, and Pressure-Demand Type)
The demand type produces a negative pressure in the facepiece on inhalation, whereas continuous-flow and pressure-demand types maintain a positive pressure in the respiratory-inlet covering and are free of to permit inward leakage of contaminants.

Air-line suits may protect against atmospheres that irritate the skin or that may be absorbed through the unbroken skin.

Limitations. Air-line respirators provide no protection if the air supply fails. Some contaminants, such as tritium, may penetrate the material of an air-line suit and limit its effectiveness.

Other contaminants, such as fluorine, may react chemically with the material of an air-line suit and damage it.

Combination Airline Respirator with Auxiliary SC Air Supply

The auxiliary self-contained air supply on this type of device allows the wearer to escape from a dangerous atmosphere. This device with auxiliary self-contained air supply is approved for escape and may be used for entry when it contains at least a 15-minute auxiliary self-contained air supply. (See Table 5).

where the contaminant(s) lacks adequate warning properties (that is: odor, taste, or irritation at a concentration in air at or above the permissible exposure limit.) (Vapor- and gas-removing respirators are not approved for contaminants that lack adequate warning properties.)

Not for use in atmospheres immediately dangerous to life or health unless the device is a powered-type respirator with escape provisions (see Table 5).

(1) Full Facepiece Respirator.
Provides protection against eye irritation in addition to respiratory protection.

(2) Quarter-Mask and Half-Mask Facepiece Respirator. A fabric covering (facial) available from some manufacturers shall not be used.

(3) Mouthpiece Respirator.
Shall be used only for escape applications. Mouth breathing prevents detection of contaminant by odor. Nose clamp must be securely in place to prevent nasal breathing.

A small, lightweight device that can be donned quickly.

(2) Quarter-Mask and Half-Mask Facepiece Respirator. A fabric covering (facial) available from some manufacturers shall not be used unless approved for use with respirator.

(3) Mouthpiece Respirator.
Shall be used only for escape applications. Mouth breathing prevents detection of contaminant by odor. Nose clamp must be securely in place to prevent nasal breathing.

A small, lightweight device that can be donned quickly.

Combination Particulate- and Vapor- and Gas-Removing Respirators

The advantages and disadvantages of the components sections of the combination respirator as described above apply.

Combination Atmosphere-Supplying and Air-Purifying Respirators

The advantages and disadvantages, expressed above, of the mode of operation being used will govern. The mode with the greater limitations (air-purifying mode) will mainly determine the overall capabilities and limitations of the respirator, since the wearer may for some reason fail to change the mode of operation even though conditions would require such a change.

6.6 Location of Hazardous Area. The location of the hazardous area with respect to a safe area having respirable air shall be considered in selecting a respirator, since this will permit planning for the escape of workers if an emergency occurs, for the entry of workers to perform maintenance duties, and for rescue operations.

6.7 Respirator Use Time Period. The period of time that a respirator must be worn is an important factor that shall be taken into account in selecting a respirator. Consideration shall be given to the type of respirator application, such as for routine, nonroutine, emergency, or rescue use. It would not be desirable, for example, to select respirators that are heavy or that offer high resistance to breathing for routine wearing for many hours each day.

6.8 Worker Activity. Worker activities and worker locations in hazardous areas shall be considered in selecting the proper respirator (for example, whether the worker is in the hazardous area continuously or intermittently during the work shift and whether the work rate is light, medium, or heavy).

6.9 Respirator Characteristics, Capabilities, and Limitations. The physical characteristics, the functional capabilities, and the performance limitations of the various types of respirators shall be considered in selecting a respirator. (See Section 5.)

6.9.1 Respirators for Oxygen-Deficient Atmosphere. Only respirators that provide an independent, respirable atmosphere shall be used in an oxygen-deficient atmosphere. Respirators for use in atmospheres that are oxygen deficient and immediately dangerous to life or health (see definition) and respirators for use in atmospheres that are oxygen deficient but not immediately dangerous to life or health (see definition) are listed in Table 5.

6.9.2 Respirators for Atmospheres Immediately Dangerous to Life or Health. Respirators for use in atmospheres that contain adequate oxygen but are immediately dangerous to life or health because of the presence of toxic contaminants are listed in Table 5.

6.9.3 Respirators for Atmospheres Not Immediately Dangerous to Life or Health. All types of respirators listed in Table 5 may be used in contaminated atmospheres that contain adequate oxygen and are not immediately dangerous to life or health.

6.10 Respirator Protection Factor (PF). Respirators shall be selected according to the characteristics of the hazards involved, the capabilities and limitations of the respirators, and the ability of each respirator wearer to obtain a satisfactory fit with a respirator. Taking into account the capabilities and limitations of respirators and the results of respirator-fitting tests, a table of respirator protection factors has been prepared (see Table 5).

A respirator protection factor is a measure of the degree of protection provided by a respirator to a wearer. Multiplying either (1) the permissible time-weighted average concentration or the permissible ceiling concentration, whichever is applicable, for a toxic substance, or (2) the maximum permissible airborne concentration for a radionuclide by a protection factor assigned to a respirator gives the maximum concentration of the hazardous substance in which the respirator can be used. Limitations of filters, cartridges, and canisters also shall be considered (see Table 5).

6.11 Respirator-Fitting Tests. A qualitative or quantitative respirator-fitting test shall be used to determine the ability of each individual respirator wearer to obtain a satisfactory fit with a negative-pressure respirator. (The National Institute for Occupational Safety and Health recommends that only a program of quantitative-fit testing can provide adequate worker protection.) The results of qualitative or quantitative respirator-fitting tests shall be used to select specific types, makes, and models of negative-pressure respirators for use by individual respirator wearers. A respirator-fitting test shall be carried out for each wearer of a negative-pressure respirator at least annually. Respirator-fitting tests shall not be required for positive-pressure respirators.

Qualitative Respirator-Fitting Test – A person wearing a respirator is exposed to an irritant smoke, an odorous vapor, or other suitable test agent. An air-purifying respirator must be equipped with an air-purifying element(s) which effectively removes the test agent from inspired air. If the respirator wearer is unable to detect penetration of the test agent into the respirator, the respirator wearer has achieved a satisfactory fit with the respirator. (See Appendix A5.)

Quantitative Respirator-Fitting Test – A person wears a respirator in a test atmosphere containing a test agent in the form of an aerosol, vapor, or gas. Instrumentation, which samples the test atmosphere and the air inside the respiratory-inlet covering of the respirator, is used to measure quantitatively the penetration of the test agent into the respiratory-inlet covering. (See Appendix A6.)

When carrying out a qualitative or quantitative respirator-fitting test, the respirator wearer shall carry out a series of exercises which simulate work movements. (See Appendix A5 and A6).

When carrying out respirator-fitting tests, it shall be acceptable procedure to make the following modifications to respirators provided that such modifications do not affect the seal of the respirators to wearers.

(1) When carrying out a qualitative or quantitative respirator-fitting test which uses an aerosol as the test

Table 5
Respirator Protection Factors[a]

Type of Respirator	Permitted for Use in Oxygen-Deficient Atmosphere	Permitted for Use in Immediately-Dangerous-to-Life-or-Health Atmosphere[f]	Respirator Protection Factor	
			Qualitative Test	Quantitative Test
Particulate-filter, quarter-mask or half-mask facepiece[b,c]	No	No	10	As measured on each person with maximum of 100.
Vapor- or gas-removing, quarter-mask or half-mask facepiece[c]	No	No	10, or maximum use limit of cartridge or canister for vapor or gas, whichever is less.	As measured on each person with maximum of 100, or maximum use limit of cartridge or canister for vapor or gas[i,j], whichever is less.
Combination particulate-filter and vapor- or gas-removing, quarter-mask or half-mask facepiece[b,c]	No	No	10, or maximum use limit of cartridge or canister for vapor or gas, whichever is less.	As measured on each person with maximum of 100, or maximum use limit of cartridge or canister for vapor or gas[i,j], whichever is less.
Particulate-filter, full facepiece[b]	No	No	100	As measured on each person with maximum of 100 if dust, fume, or mist filter is used, or maximum of 1000 if high-efficiency filter is used.
Vapor- or gas-removing, full facepiece	No	No	100, or maximum use limit of cartridge or canister for vapor or gas, whichever is less.	As measured on each person with maximum of 1000, or maximum use limit of cartridge or canister for vapor or gas[i,l], whichever is less.
Combination particulate-filter and vapor- or gas-removing, full facepiece[b]	No	No	100, or maximum use limit of cartridge or canister for vapor or gas, whichever is less.	As measured on each person with maximum of 100 if dust, fume, or mist filter is used and maximum of 1000 if high-efficiency filter is used, or maximum use limit of cartridge or canister for vapor or gas[i,l], whichever is less.
Powered particulate-filter, any respiratory-inlet covering[b,c,d]	No	No (yes, if escape provisions are provided[g])	N/A	N/A
			No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 100 if dust, fume, or mist filter is used and 3000 if high-efficiency filter is used.	
Powered vapor- or gas-removing, any respiratory-inlet covering[c,d]	No	No (yes, if escape provisions are provided[g])	N/A	N/A
			No tests are required due to positive pressure operation of respirator. The maximum protection factor is 3000, or maximum use limit of cartridge or canister for vapor or gas[i,j], whichever is less.	
Powered combination particulate-filter and vapor- or gas-removing, any respiratory-inlet covering[b,c,d]	No	No (yes, if escape provisions are provided[g])	N/A	N/A
			No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 100 if dust, fume, or mist filter is used and 3000 if high-efficiency filter is used, or maximum use limit of cartridge or canister for vapor or gas[i,j], whichever is less.	

Table 5 (Continued)
Respirator Protection Factors[a]

Type of Respirator	Permitted for Use in Oxygen-Deficient Atmosphere	Permitted for Use in Immediately-Dangerous-to-Life-or-Health Atmosphere[f]	Respirator Protection Factor	
			Qualitative Test	Quantitative Test
Air-line, demand, quarter-mask or half-mask facepiece, with or without escape provisions[c,g]	Yes[f]	No	10	As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.
Air-line, demand, full facepiece, with or without escape provisions[c]	Yes[f]	No	100	As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.
Air-line, continuous-flow or pressure-demand type, any facepiece, without escape provisions[c]	Yes[f]	No	N/A	N/A
			No tests are required due to positive-pressure operation of respirator. The protection factor provided by the respirator is limited to use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.	
Air-line, continuous-flow or pressure-demand type, any facepiece, with escape provisions[c,g]	Yes[g]	Yes	N/A	N/A
			No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus.[h]	
Air-line, continuous flow, helmet, hood, or suit, without escape provisions	Yes[f]	No	N/A	N/A
			No tests are required due to positive-pressure operation of respirator. The protection factor provided by the respirator is limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.	
Air-line, continuous-flow, helmet, hood, or suit, with escape provisions[c]	Yes[g]	Yes	N/A	N/A
			No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus.[h]	
Hose mask, with or without blower, full facepiece	Yes[f]	No	10	As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.
Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, quarter-mask or half-mask facepiece[c]	Yes[f]	No	10	As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values.
Self-contained breathing apparatus, demand-type open-circuit or negative-pressure-type closed-circuit, full facepiece or mouthpiece/nose clamp[c]	Yes[f] (Yes[g], if respirator is used for mine rescue and mine recovery operations.)	No (yes, if respirator is used for mine rescue and mine recovery operations.)	100	As measured on each person, but limited to the use of the respirator in concentrations of contaminants below the immediately-dangerous-to-life-or-health (IDLH) values, except when the respirator is used for mine rescue and mine recovery operations.

Self-contained breathing apparatus, pressure-demand-type open-circuit or positive-pressure-type closed-circuit, quarter-mask or half-mask facepiece, full facepiece, or mouthpiece/nose clamp[c]	Yes[g]	Yes	N/A	N/A No tests are required due to positive-pressure operation of respirator. The maximum protection factor is 10 000 plus.[h]
Combination respirators not listed.	The type and mode of operation having the lowest respirator protection factor shall be applied to the combination respirator.			

N/A means not applicable since a respirator-fitting test is not carried out.

[a]A respirator protection factor is a measure of the degree of protection provided by a respirator to a respirator wearer. Multiplying the permissible time-weighted average concentration or the permissible ceiling concentration, whichever is applicable, for a toxic substance, or the maximum permissible airborne concentration for a radionuclide, by a protection factor assigned to a respirator gives the maximum concentration of the hazardous substance for which the respirator can be used. Limitations of filters, cartridges, and canisters used in air-purifying respirators shall be considered in determining protection factors.

[b]When the respirator is used for protection against airborne particulate matter having a permissible time-weighted average concentration less than 0.05 milligram particulate matter per cubic meter of air or less than 2 million particles per cubic foot of air, or for protection against airborne radionuclide particulate matter, the respirator shall be equipped with a high-efficiency filter(s).

[c]If the air contaminant causes eye irritation, the wearer of a respirator equipped with a quarter-mask or half-mask facepiece or mouthpiece and nose clamp shall be permitted to use a protective goggle or to use a respirator equipped with a full facepiece.

[d]If the powered air-purifying respirator is equipped with a facepiece, the escape provision means that the wearer is able to breathe through the filter, cartridge, or canister and through the pump. If the powered air-purifying respirator is equipped with a helmet, hood, or suit, the escape provision shall be an auxiliary self-contained supply of respirable air.

[e]The escape provision shall be an auxiliary self-contained supply of respirable air.

[f]For definition of "oxygen deficiency – not immediately dangerous to life or health" see Section 2.

[g]For definition of "oxygen deficiency – immediately dangerous to life or health" see Section 2 and A10.

[h]The protection factor measurement exceeds the limit of sensitivity of the test apparatus. Therefore, the respirator has been classified for use in atmospheres having unknown concentrations of contaminants.

[i]The service life of a vapor- or gas-removing cartridge or canister depends on the specific vapor or gas, the concentration of the vapor or gas in air, the temperature and humidity of the air, the type and quantity of the sorbent in the cartridge or canister, and the activity of the respirator wearer. Cartridges and canisters may provide only very short service lives for certain vapors and gases. Vapor/gas service life testing is recommended to ensure that cartridges and canisters provide adequate service lives. Reference should be made to published reports which give vapor/gas life data for cartridges and canisters.

[j]Vapor- and gas-removing respirators are not approved for contaminants that lack adequate warning properties of odor, irritation, or taste at concentrations in air at or above the permissible exposure limits.

NOTE: Respirator protection factors for air-purifying-type respirators equipped with a mouthpiece/nose clamp form of respiratory-inlet covering are not given, since such respirators are approved only for escape purposes.

agent, it shall be acceptable procedure to equip an air-purifying respirator with a high-efficiency filter.

(2) When carrying out a qualitative or quantitative respirator-fitting test which uses a vapor or gas as the test agent, it shall be acceptable procedure to equip an air-purifying respirator with an appropriate cartridge or canister which removes the vapor or gas from air.

(3) When carrying out a quantitative respirator-fitting test, it shall be acceptable procedure to attach a sampling probe to the respirator which is connected by flexible tubing to an instrument which measures the penetration of the test agent into the respirator.

When carrying out quantitative respirator-fitting tests, it shall be an acceptable procedure to carry out a single test for each available make and model of respirator in order to select a respirator for use by a person. However, three additional quantitative respirator-fitting tests involving the wearing of the selected make and model of respirator by the person shall be carried out to determine a protection factor for that particular respirator and person. The lowest protection factor determined by these three tests shall be assigned to a particular person wearing a specific make and model of respirator.

If a qualitative respirator-fitting test has been used in respirator selection, a person shall be allowed to use only the specific make(s) and model(s) of respirator(s) for which the person obtained a satisfactory fit, and the respirator protection factor listed under "qualitative test" in Table 5 shall apply. Under no circumstances shall a person be allowed to use any respirator if the results of the qualitative respirator-fitting test indicates that the person is unable to obtain a satisfactory fit.

If a quantitative respirator-fitting test has been used in selecting a respirator, the test results shall be used to assign a respirator protection factor to each person for each specific make and model of respirator tested. The assigned respirator protection factor shall be applied when the person wears the specific respirator in a hazardous atmosphere, but it shall not exceed the respirator protection factor listed under "quantitative test" in Table 5 for the particular type of respirator.

6.12 Respirator-Fitting-Test Records. Records of respirator-fitting tests shall be kept for at least the duration of employment. These records shall include the following information:

(1) Type of respirator-fitting test used
(2) Specific make and model of respirator tested
(3) Name of person tested
(4) Name of test operator
(5) Date of test
(6) Results of respirator-fitting tests

(a) Success or failure of person to obtain satisfactory fit if a qualitative respirator-fitting test was carried out

(b) Respirator protection factor based upon test results if a quantitative respirator-fitting test was carried out

6.13 Respirator Protection Factor Assignment. When a group of persons wear respirators in a given work area, a single respirator protection factor shall be assigned to all respirator wearers in the group. When negative-pressure respirators are being used, this respirator protection factor shall correspond to the lowest value established by qualitative or quantitative respirator-fitting tests for any person of the group with the specific make and model of respirator which that person will wear in the given work area.

6.14 Face Dimensions and Facepiece Sizes. The wide range of face dimensions requires more than a single size of respirator facepiece to provide a proper fit to all respirator users. Therefore, respirator facepieces of more than one size shall be available in any respirator-selection program involving respirators equipped with facepieces.

6.15 Employee Acceptance. Employee acceptance of a particular respirator model within a class shall be considered in selecting a respirator since this may determine whether or not he wears the respirator properly. Acceptance factors to be considered include discomfort, breathing resistance, weight, and interference with vision or the work to be performed. If the results of respirator-fitting tests show that the person can obtain an acceptable fit with two or more respirator models of the selected class of respirator, then the person should be permitted to use the respirator model which he or she prefers.

7. Use of Respirators

7.1 Standard Operating Procedures. Written standard operating procedures shall cover a complete respirator program (see 3.5.1) and shall include information necessary for the proper use of respirators, including training of respirator wearers, respirator sealing tests, issuance of respirators, inspection of respirators prior to use, monitoring respirator use, monitoring respiratory hazard, and planning for routine, nonroutine, emergency, and rescue uses of respirators.

The written standard operating procedures shall include plans necessary to ensure the safe routine use and nonroutine use of respirators. Emergency and rescue uses of respirators shall be anticipated, and the writ-

ten standard operating procedures shall include plans necessary to ensure the safe emergency and rescue uses of respirators. Persons who wear respirators routinely, who wear respirators nonroutinely, and who may be required to wear respirators for emergency and rescue work shall be given adequate information concerning plans covering these respirator uses to ensure the safe use of respirators.

7.1.1 **Standard Operating Procedures for Emergency and Rescue Use of Respirators.** It is recognized that it is not possible to foresee every emergency and rescue use of respirators for every kind of operation. Nevertheless, a wide variety of possible conditions requiring the emergency or rescue use of respirators can be envisioned and an adequate emergency and rescue respirator-response capability can be achieved through a serious effort to anticipate the worst possible consequences of particular malfunctions or mishaps.

The written standard operating procedures governing the emergency and rescue uses of respirators shall be developed in the following manner:

(1) An analysis of the emergency and rescue uses of respirators that may occur in each operation shall be made by careful consideration of materials, equipment, processes, and personnel involved. Such an analysis shall be reviewed by the person who is thoroughly familiar with the particular operation. Consideration shall be given to past occurrences requiring emergency or rescue uses of respirators as well as conditions which resulted in such respirator applications. The possible consequences of equipment or power failures, uncontrolled chemical reactions, fire, explosion, or human error shall be given consideration. All potential hazards which may result in emergency or rescue use of respirators shall be listed.

(2) Based upon the analysis, appropriate types of respirators shall be selected, an adequate number shall be provided for each area where they may be needed for emergency or rescue use, and these respirators shall be maintained and stored so that they are readily accessible and operational when needed.

7.2 **Training.** The supervisor, the person issuing respirators, and the respirator wearers shall be given adequate training by a qualified person(s) to ensure the proper use of respirators. Written records shall be kept of the names of persons trained and the dates when training occurred.

7.2.1 **Training of Supervisor.** A supervisor – that is, a person who has the responsibility of overseeing the work activities of one or more persons who must wear respirators – shall be given adequate training to ensure the proper use of respirators. Supervisor training shall include but shall not necessarily be limited to the following subjects:

(1) The basic respiratory-protection practices (see Section 3)

(2) The nature and extent of respiratory hazards to which persons under his supervision may be exposed (see Section 4 and 6.4 and 7.8)

(3) The principles and criteria of selecting respirators (see Sections 5 and 6)

(4) The training of respirator wearers (see 7.2.3)

(5) The issuance of respirators (see 7.2.2 and 7.5)

(6) The inspection of respirators (see 7.6 and 8.3)

(7) The use of respirators, including monitoring of use (see 7.3, 7.4, 7.7, 7.8, 7.9, and 9.)

(8) The maintenance and storage of respirators (see Section 8)

(9) The regulations concerning respirator use

7.2.2 **Training of Person Issuing Respirators.** A person assigned the task of issuing respirators to persons who must wear respirators for protection against harmful atmospheres shall be given adequate training to ensure that the correct respirator is issued for each application in accordance with written standard operating procedures. (See 7.5.)

7.2.3 **Training of Respirator Wearer.** To ensure the proper and safe use of a respirator, the minimum training of each respirator wearer shall include the following elements:

(1) The reasons for the need of respiratory protection (see 3.2)

(2) The nature, extent, and effects of respiratory hazards to which the person may be exposed (see Section 4 and 6.3)

(3) An explanation of why engineering controls are not being applied or are not adequate and of what effort is being made to reduce or eliminate the need for respirators (see 3.2)

(4) An explanation of why a particular type of respirator has been selected for a specific respiratory hazard (see Section 6)

(5) An explanation of the operation, and the capabilities and limitations, of the respirator selected (see Section 5 and 6.5 and 6.6)

(6) Instruction in inspecting, donning, checking the fit of, and wearing the respirator (see 7.2.3.1(1) and (2) and 7.4 and 7.6)

(7) An opportunity for each respirator wearer to handle the respirator, learn how to don and wear it properly, check its seals, wear it in a safe atmosphere, and wear it in a test atmosphere (see 7.2.3.1(3) and (4) and 7.4 and 7.6)

(8) An explanation of how maintenance and storage of the respirator is carried out (see Section 8)

(9) Instructions in how to recognize and cope with emergency situations (see 7.1.1)

(10) Instructions as needed for special respirator use (see Section 9)

(11) Regulations concerning respirator use

7.2.3.1 **Wearing Instructions and Training.** Wearing instructions and training, including practice demonstrations, shall be given to each respirator wearer and shall cover:

(1) Donning, wearing, and removing the respirator

(2) Adjusting the respirator so that its respiratory-inlet covering is properly fitted on the wearer and so that the respirator causes a minimum of discomfort to the wearer

(3) Allowing the respirator wearer to wear the respirator in a safe atmosphere for an adequate period of time to ensure that the wearer is familiar with the operational characteristics of the respirator

(4) Providing the respirator wearer an opportunity to wear the respirator in a test atmosphere to demonstrate that the respirator provides protection to the wearer. A test atmosphere is any atmosphere in which the wearer can carry out activities simulating work movements and respirator leakage or respirator malfunction can be detected by the wearer.

7.2.3.2 **Retraining.** Each respirator wearer shall be retrained at least annually.

7.3 **Respirator Sealing Problems.** Respirators shall not be worn when conditions prevent a seal of the respirator to the wearer.

7.3.1 A person who has hair (stubble, moustache, sideburns, beard, low hairline, bangs) which passes between the face and the sealing surface of the facepiece of the respirator shall not be permitted to wear such a respirator.

7.3.2 A person who has hair (moustache, beard) which interferes with the function of a respirator valve(s) shall not be permitted to wear the respirator.

7.3.3 A spectacle which has temple bars or straps which pass between the sealing surface of a respirator full facepiece and the wearer's face shall not be used.

7.3.4 A head covering which passes between the sealing surface of a respirator facepiece and the wearer's face shall not be used.

7.3.5 The wearing of a spectacle, a goggle, a face shield, a welding helmet, or other eye and face protective device which interferes with the seal of a respirator to the wearer shall not be allowed.

7.3.6 If scars, hollow temples, excessively protruding cheekbones, deep creases in facial skin, the absence of teeth or dentures, or unusual facial configurations prevent a seal of a respirator facepiece to a wearer's face, the person shall not be permitted to wear the respirator.

7.3.7 If missing teeth or dentures prevent a seal of a respirator mouthpiece in a person's mouth, the person shall not be allowed to wear a respirator equipped with a mouthpiece.

7.3.8 If a person has a nose of a shape or size which prevents the closing of the nose by the nose clamp of a mouthpiece/nose-clamp type of respirator, the person shall not be permitted to wear this type of respirator.

7.4 **Respirator Sealing Tests.** To ensure proper protection, the wearer of a respirator equipped with a facepiece shall check the seal of the facepiece prior to each entry into a hazardous atmosphere. This may be done using procedures recommended by respirator manufacturers or by any of the field tests described in Appendix A7.

7.5 **Issuance of Respirators.** The proper respirator shall be specified for each application and shall be listed in the written standard operating procedures. If a respirator is marked for the worker to whom it is assigned or for other identification purposes, the markings shall not affect the respirator performance in any way.

7.6 **Respirator Inspection Prior to Use.** Each person issued a respirator for routine, nonroutine, emergency, or rescue use shall inspect the respirator prior to its use to ensure that it is in good operating condition.

7.7 **Monitoring Respirator Use.** The use of respirators on a routine or nonroutine basis shall be monitored to ensure that the correct respirators are being used, that the respirators are being worn properly and that the respirators being used are in good working condition.

7.8 **Monitoring Respiratory Hazard During Use.** The level of the respiratory hazard in the workplace to which a person wearing a respirator is exposed shall be monitored periodically. The time-weighted average concentration of the respiratory hazard shall be determined to ensure that the proper type of respirator is being utilized (see Appendix A8).

7.9 **Leaving a Hazardous Area.** A respirator wearer shall be permitted to leave the hazardous area for any respirator-related cause. Reasons which may cause a respirator wearer to leave a hazardous area include, but are not limited to, the following:

(1) Failure of the respirator to provide adequate protection

(2) Malfunction of the respirator

(3) Detection of leakage of air contaminant into the respirator

(4) Increase in resistance of respirator to breathing

(5) Severe discomfort in wearing the respirator

(6) Illness of respirator wearer, including: sensation of dizziness, nausea, weakness, breathing difficulty, coughing, sneezing, vomiting, fever, and chills

8. Maintenance of Respirators

8.1 General. A program for the maintenance of respirators shall include the following:

(1) Cleaning and sanitizing
(2) Inspection for defects
(3) Repair
(4) Storage

Each respirator shall be properly maintained to retain its original shape and effectiveness.

8.2 Cleaning and Sanitizing. Each respirator shall be cleaned and sanitized to ensure that the respirator wearer is provided with a clean and sanitized respirator at all times. A respirator issued for other than continuous personal use by a particular worker, such as with routine, nonroutine, emergency, or rescue use, shall be cleaned and sanitized after each use.

8.3 Inspection. Each respirator shall be inspected routinely before and after use. A respirator shall be inspected by the user immediately prior to each use to ensure that it is in proper working condition.

After cleaning and sanitizing, each respirator shall be inspected to determine if it is in proper working condition, if it needs replacement of parts or repairs, or if it should be discarded. Each respirator stored for emergency or rescue use shall be inspected at least monthly. Respirator inspection shall include a check for tightness of connections; for the condition of the respiratory-inlet covering, head harness, valves, connecting tubes, harness assemblies, filters, cartridges, canisters, end-of-service-life indicator, and shelf life date(s); and for the proper function of regulators, alarms, and other warning systems.

Each rubber or other elastomeric part shall be inspected for pliability and signs of deterioration. Each air and oxygen cylinder shall be inspected to ensure that it is fully charged according to the manufacturer's instructions.

A record of inspection dates, findings, and remedial actions shall be kept for each respirator maintained for emergency or rescue use.

8.4 Part Replacement and Repair. Replacement of parts or repairs shall be done only by persons trained in proper respirator assembly and correction of possible respirator malfunctions and defects. Replacement parts shall be only those designed for the specific respirator being repaired. Reducing or admission valves, regulators, and alarms shall be returned to the manufacturer or to a trained technician for repair or adjustment. Instrumentation for valve, regulator, and alarm adjustments and tests must be approved by the valve, regulator, or alarm manufacturer.

8.5 Storage. Respirators shall be stored in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators shall be stored to prevent distortion of rubber or other elastomeric parts. Respirators shall not be stored in such places as lockers and tool boxes unless they are protected from contamination, distortion, and damage. Emergency and rescue-use respirators that are placed in work areas shall be quickly accessible at all times, and the storage cabinet or container in which they are stored shall be clearly marked.

9. Special Problems

9.1 Vision. When a respirator user must wear corrective lenses, a protective spectacle or goggle, a face shield, a welding helmet, or other eye and face protective device, the item shall be fitted to provide good vision and shall be worn in such a manner as not to interfere with the seal of the respirator to the wearer.

Temple bars or straps of a corrective spectacle which pass between the sealing surface of a respirator full facepiece and the respirator wearer's face may prevent a good seal of the facepiece to the face and therefore such a spectacle shall not be used when a respirator equipped with a full facepiece must be worn. As a temporary measure, a corrective spectacle with short temple bars that do not protrude between the sealing surface of a full facepiece and the respirator wearer's face may be taped to the respirator wearer's head. Special corrective lenses which are made to be mounted inside a full facepiece are available and should be used by a person who needs corrective lenses.

The wearing of contact lenses by persons who must wear a respirator equipped with a full facepiece, helmet, hood, or suit shall not be permitted.

9.2 Communications. Speech transmission while wearing a respirator is often necessary to perform specific tasks. Although a respirator facepiece distorts the human voice to some extent, the respirator's exhalation valve usually provides a pathway for some speech transmission over short distances in relatively quiet areas. However, talking while wearing a respirator equipped with a facepiece may adversely affect the seal of the facepiece, especially a quarter-mask or half-mask facepiece, to the wearer's face.

A mechanical speech-transmission device, called a speaking diaphragm, is an integral part of the facepiece in some respirators. It usually consists of a resonant cavity and diaphragm which transmit sound. The diaphragm also acts as a barrier to the ambient atmos-

phere and thus should be handled carefully to prevent possible puncture which would permit leakage of an air contaminant into the respirator. Various methods of electronically transmitting and amplifying speech through the respirator are available. These utilize a microphone connected to a speaker, telephone, or radio transmitter. Usually, the microphone is mounted inside the respiratory-inlet covering, while the amplifier, power pack, and speaker or transmitter are attached to the exterior of the respiratory-inlet covering, carried on the body, or remotely located. Respirators with electronic speech-transmission devices having a battery power supply should be used with caution in explosive atmospheres. When an electronic speech-transmission device is used in underground mining, it shall be certified as complying with the Mine Safety and Health Administration's requirements for permissibility and intrinsic safety which are set forth in a document entitled Electric Motor-Driven Mine Equipment and Accessories, *Code of Federal Regulations*, Part 18, Chapter I, Subchapter D, Title 30 (formerly Bureau of Mines Schedule 2G). Sealed power sources shall be checked for integrity of the seals. Connecting cables from microphones inside the respiratory-inlet covering shall have gas-tight seals where they pass through the covering. When the speaker diaphragm is part of the barrier between the respirator wearer and the ambient atmosphere, it shall be frequently inspected for leakage and should be adequately protected from puncture or rupture. A microphone mounted on the respirator wearer's throat or head or a microphone/speaker worn in the respirator wearer's ear does not require penetration of a respirator facepiece by a cable.

9.3 Use of Respirators for Entry into Atmospheres Immediately Dangerous to Life or Health. When respirators are required for entry into atmospheres immediately dangerous to life or health, at least one standby person shall be present in a safe area. The standby person shall have the proper equipment available to assist the respirator wearers in case of emergency. Communications (visual, voice, signal-line, telephone, radio, or other suitable means) shall be maintained between the standby person and the respirator wearers. Respirator wearers in atmospheres immediately dangerous to life or health shall be equipped with safety harnesses and safety lines to permit them to be removed from the dangerous atmospheres to safe areas, if necessary; otherwise, equivalent provisions for the rescue of the respirator wearers from the dangerous atmospheres shall be used.

9.4 Respirator Use in Confined Spaces. All confined spaces shall be considered to be immediately dangerous to life or health unless proven otherwise. Before a person is allowed to enter a confined space, tests shall be carried out to determine the concentration of any known or expected flammable or toxic contaminant present and to determine the concentration of oxygen. A person shall not be allowed to enter a confined space without wearing the proper type of respirator. Even if the concentrations of air contaminants in a confined space are found to be below the established limits and sufficient oxygen is present (see "Oxygen Deficiency" in Table 1), the safest procedure is to continuously ventilate the enclosed space and to continuously monitor the concentration of air contaminants and of oxygen if persons are to work in the confined space.

An air-purifying respirator may be worn by a person in a confined space only if tests show that the atmosphere is not legally oxygen deficient (see Table 1 for minimum legal oxygen requirement) and only if tests show that the concentrations of air contaminants are not immediately dangerous to life or health. While a person is wearing an air-purifying respirator in a confined space, the level of respiratory hazards in the atmosphere of the confined space shall be monitored.

An air-line-type or hose-mask-type supplied-air respirator may be worn by a person in a confined space only if tests show that the atmosphere is not deficient in oxygen to a degree that would be immediately dangerous to life or health (see definitions in Section 2 for "oxygen deficiency – immediately dangerous to life or health" and "oxygen deficiency – not immediately dangerous to life or health") and only if tests show that concentrations of air contaminants are not immediately dangerous to life or health. While a person is wearing an air-line-type or hose-mask-type supplied-air respirator in a confined space, the level of respiratory hazards in the atmosphere of the confined space shall be monitored.

When the results of monitoring the atmosphere in a confined space, prior to entry of a person into the space, shows that the atmosphere is immediately dangerous to life or health [oxygen deficient or excessive concentration(s) of a contaminant(s) including concentration(s) of a substance(s) above the lower flammable limits], then a person who is required to enter the confined space shall wear either a positive-pressure self-contained breathing apparatus or a combination positive-pressure air-line respirator with an auxiliary self-contained air supply. An oxygen-type open-circuit self-contained breathing apparatus shall not be worn in a confined space where the possibility of fire or explosion hazard is increased.

When respirators are used in a confined space, the provisions for a standby person given in 9.3 shall be carried out.

9.5 Respirator Use in Low-Temperature Environments. A low-temperature environment may cause fogging of the lens in a respiratory-inlet covering and freezing or improper sealing, or both, of the exhalation valve. Coating the inside surface of the lens may prevent fogging at low atmospheric temperatures approaching 0°C (32°F), but severe fogging of the lens may occur at temperatures below −18°C (0°F). Full facepieces are available with nose cups that direct the warm and moist exhaled air through the exhalation valve without contacting the lens, and these facepieces should provide satisfactory vision at temperatures as low as −32°C (−25°F). At very low atmospheric temperatures, the exhalation valve of a respirator may freeze open or closed due to the presence of moisture. Dry respirable air should be used with an air-line respirator and with the type of self-contained breathing apparatus that employs a cylinder of air when these devices are used in a low-temperature atmosphere. The dew point of this breathing air should be appropriate to the temperature of the atmospheric air. High-pressure connections on self-contained breathing apparatus may leak because of metal contraction at low atmospheric temperature. These connections should not be overtightened, since they may break when the apparatus is returned to an atmosphere at normal room temperature. Some air-line-type supplied-air respirators may be equipped with a device called a vortex tube to warm the air supplied to the respirator-inlet covering of the respirator. Emergency-use respirators that are stored in low-temperature environments may require special elastomeric components that will retain their elasticity at low temperatures (regulator diaphragms, gaskets, and breathing tubes). Facepieces stored in low-temperature environments can become stiff and distorted to a degree that may prevent an adequate seal of the face to the facepiece. Special care shall be used to prevent distortion of facepieces stored at low temperatures. Some self-contained-breathing-apparatus models have cold-temperature accessories that may be utilized to help overcome these problems. The manufacturer's instructions shall be followed when utilizing these cold-temperature accessories.

9.6 Respirator Use in High-Temperature Environments. A person working in an atmosphere having a high temperature is under stress. Wearing a respirator in such an environment applies additional stress on the person. The additional stress due to the wearing of a respirator in a high-temperature environment should be minimized by using a respirator having a low weight and offering a low resistance to breathing. The air-line-type supplied-air respirator is recommended for use in a high-temperature environment. Air-line-type supplied-air respirators equipped with a vortex tube to cool the air supplied to the respiratory-inlet covering will substantially reduce the temperature of the air supplied to the respirator. Elastomeric components of respirators stored in high-temperature environments may deteriorate at an accelerated rate and the facepiece may become permanently distorted. Special care shall be used to prevent facepiece distortion. All such respirators shall be inspected and maintained at a frequency rate that will prevent the use of respirators with deteriorated elastomeric components.

10. Evaluation of Respirator Program Effectiveness

10.1 General. Periodic evaluation of the effectiveness of the respirator program is essential to ensure that persons are being provided with adequate respiratory protection. Improvement of the program and elimination of any deficiencies in the program cannot be carried out unless the program is appraised for effectiveness at periodic intervals. The effectiveness of the respirator program shall be evaluated at least annually and corrective action shall be taken to correct defects found in the program.

10.2 Wearer Acceptance. Wearer acceptance of respirators is an important matter to consider in evaluating the effectiveness of the respirator program. Respirator wearers shall be consulted periodically about their acceptance of wearing respirators. Numerous factors affect the acceptance of respirators. These factors include: comfort, resistance to breathing, fatigue, interference with vision, interference with communications, restriction of movement, interference with job performance, and confidence in the effectiveness of the respirator to provide adequate protection.

10.3 Inspection of Respirator Program Operation. Frequent inspection of the operation of the respirator program shall be conducted to ensure that proper types of respirators are selected, that respirator wearers are trained properly, that the correct respirators are issued and used, that respirators are worn properly, that respirators being used are in good operating condition, that respirators are inspected and maintained properly, that respirator storage is satisfactory, that respiratory hazards are monitored, and that medical and, when necessary, bioassay surveillance of respirator wearers is carried out.

10.4 Appraisal of Protection Afforded. Medical and, when necessary, bioassay surveillance of respirator wearers shall be conducted periodically to determine

if respirator wearers are being provided with adequate respiratory protection. These data, when considered with the results of monitoring respiratory hazards, can serve as an indication of the degree of protection provided by the respirators and the effectiveness of the respirator program.

10.5 **Evaluation.** The results of investigating wearer acceptance of respirators, inspecting respirator program operation, and appraising protection provided by respirators shall be utilized to evaluate the effectiveness of the respirator program. Evidence of excessive exposure of respirator wearers to respiratory hazards shall be followed up by investigation to determine why inadequate respiratory protection was provided. Action shall be taken to correct any defects found in the respirator program. The findings of the respirator-program evaluation shall be documented, and this documentation shall list plans to correct faults in the program and target dates for the implementation of the plans.

11. References to Other Standards, Regulations, and Manuals

11.1 **American National Standards Institute.** When any of the following American National Standards is superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

(1) American National Standard Identification of Air-Purifying Respirator Canisters and Cartridges, ANSI K13.1-1973

(2) American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, ANSI/CGA C-4-1954 (R1971)

(3) American National Standard Commodity Specification for Air, ANSI/CGA G-7.1-1973

(4) American National Standard Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1979

11.2 **American Industrial Hygiene Association and American Conference of Governmental Industrial Hygienists**

Respiratory Protective Devices Manual, 1963.

11.3 **Compressed Gas Association**

(1) Compressed Air for Human Respiration, Pamphlet G-7, 1976.

(2) Commodity Specification for Air, G-7.1, 1973.

11.4 **National Fire Protection Association**

(1) *Respiratory Protective Equipment for Fire Fighters*, NFPA 19B, 1971.

(2) *Breathing Apparatus for the Fire Service, A Fire Officer's Guide*, FSP-29B, 1975.

11.5 **University of California, Los Alamos Scientific Laboratory**

(1) Energy Research and Development Administration, Division of Safety, Standards and Compliance, Respirator Manual, LA-6370-M, August 1976.

(2) A Guide to Industrial Respiratory Protection, LA-6671-M, March 1977.

11.6 **U.S. Department of the Interior, Bureau of Mines**

(1) Schedule 13E, Self-Contained Breathing Apparatus, *Code of Federal Regulations*, Part 11, Chapter 1, Subchapter B, Title 30.

(2) Schedule 14F, Gas Masks, *Code of Federal Regulations*, Part 13, Chapter 1, Subchapter B, Title 30.

(3) Schedule 19B, Supplied-Air Respirator, *Code of Federal Regulations*, Part 14, Chapter 1, Subchapter B, Title 30.

(4) Schedule 21B, Filter-Type Dust, Fume and Mist Respirators, *Code of Federal Regulations*, Part 14, Chapter 1, Subchapter B, Title 30.

(5) Schedule 23B, Non-emergency Gas Respirators (Chemical Cartridge Respirators), *Code of Federal Regulations*, Part 14a, Chapter 1, Subchapter B, Title 30.

(6) Respiratory Protective Devices; Tests for Permissibility; Fees, *Code of Federal Regulations*, Part 11, Chapter 1, Subchapter B, Title 30.

(7) Information Circular 8559, Respirators Approved by the Bureau of Mines as of May 24, 1972.

11.7 **U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health**

NIOSH Certified Personal Protective Equipment (February 1974 and supplements published periodically).

11.8 **U.S. Department of Labor, Mine Safety and Health Administration**

Electric Motor-Driven Mine Equipment and Accessories, *Code of Federal Regulations*, Part 18, Chapter 1, Subchapter D, Title 30 (formerly Bureau of Mines Schedule 2G).

11.9 **U.S. Department of Labor, Occupational Safety and Health Administration**

General Industry Safety and Health Standards, Part 1910, Title 29, *Code of Federal Regulations*, Subpart Z – Toxic and Hazardous Substances.

11.10 U.S. Department of Transportation, Interstate Commerce Commission

Code of Federal Regulations, Title 49, Part 173, General Requirements for Shipments and Packagings, and Part 178, Shipping Container Specifications.

11.11 U.S. Nuclear Regulatory Commission, Office of Standards Development

Manual of Respiratory Protection Against Airborne Radioactive Materials, NUREG-0041, October 1976.

11.12 General Services Administration

(1) Federal Specification BB-A-1034a (June 21, 1968). Air, Compressed for Breathing Purposes.

(2) Interim Federal Specification GG-B-675d (September 23, 1976), Breathing Apparatus, Self-Contained.

11.13 U.S. Department of Defense

(1) Military Specification MIL-E-83252 (February 20, 1970), Emergency Oxygen Supply, Chlorate Candle, Aircraft CRU-74/P.

(2) Military Specification MIL-O-1563c (September 25, 1964), Oxides, Oxygen Producing.

11.14 Reference Books

(1) *Patty's Industrial Hygiene and Toxicology*. Volume I, Third Revised Edition. G. D. Clayton and F. E. Clayton (Editors), John Wiley and Sons, Incorporated, 1978.

(2) *Physiology of Respiration*. J. H. Comroe, Yearbook Medical Publishers Incorporated, 1965.

Appendix

(This Appendix is not part of American National Standard Practices for Respiratory Protection, ANSI Z88.2-1980, but is included for information purposes only.)

A1. Approval Agencies

A1.1 **Bureau of Mines (BM).** The Bureau of Mines (BM), U.S. Department of Interior, tested and approved respirators from 1919 until 1972. Approvals were issued under the provisions of various schedules until May 25, 1972, the effective date of Title 30, *Code of Federal Regulations* (CFR), Part 11, "Respiratory Protective Devices; Tests for Permissibility; Fees." Title 30, CFR, Part 11 superseded and revoked the previous respirator approval schedules.

A1.2 **National Institute for Occupational Safety and Health (NIOSH).** Title 30, CFR, Part 11 gave jurisdiction for joint approval of respirators to the National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, and to the Bureau of Mines (BM), U.S. Department of the Interior.

A1.3 **Mining Enforcement and Safety Administration (MESA).** In 1974, a reorganization of the U.S. Department of the Interior resulted in the formation of the Mining Enforcement and Safety Administration (MESA), which assumed the health and safety activities of the Bureau of Mines (BM), including the respirator testing and approving functions. Subsequent respirator approvals were issued jointly by the National Institute for Occupational Safety and Health (NIOSH) and the Mining Enforcement and Safety Administration (MESA).

A1.4 **Mine Safety and Health Administration (MSHA).** The Federal Mine Safety and Health Amendments Act of 1977 transferred in March 1978 the authority for enforcement of mining safety and health from the U.S. Department of Interior to the U.S. Department of Labor. The act created in the U.S. Department of Labor the Mine Safety and Health Administration (MSHA) which replaced the Mining Enforcement and Safety Administration (MESA) of the U.S. Department of Interior. The Mine Safety and Health Administration (MSHA) has assumed the respirator testing and approving functions of the Mining Enforcement and Safety Administration (MESA). Respirator approvals are now issued jointly by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

A2. Status of Approved Respirators

The status of respirators approved under the provision of BM Schedules is different from the status of respirators approved under provisions of Title 30, CFR, Part 11. Amendments to Title 30, CFR, Part 11 published in the *Federal Register* on November 22, 1974 provide that:

(1) *After* June 30, 1975, respirators are approved for purchase and use if they have been approved jointly by MSHA (formerly BM and MESA) and NIOSH under provisions of Title 30, CFR, Part 11. However, gas masks which have been approved by the BM under provisions of BM Schedule 14F continue to be approved for purchase and use until further notice.

(2) Respirators, other than gas masks, which have been approved by the BM under provisions of certain BM Schedules, if purchased on or before June 30, 1975, and which are maintained in approved condition, shall be approved for use until the following dates: March 31, 1979 for self-contained breathing apparatus approved under provisions of BM schedules 13-13E; March 31, 1980 for supplied-air respirators approved under provisions of BM schedule 19B; March 31, 1976, for particulate-removing respirators approved under provisions of BM schedule 21B; March 31, 1976, for chemical-cartridge-type vapor- and gas-removing respirators approved under provisions of BM schedule 23B.

A3. Lists of Approved Respirators

Respirators approved by the BM under provisions of BM schedules were listed periodically through the years in BM information circulars. The last BM information circular listing approved respirators is IC-8559, "Respirators Approved by the Bureau of Mines as of May 24, 1972." Respirators approved jointly by NIOSH and MSHA under provisions of Title 30, CFR,

Part 11 are listed in "NIOSH Certified Personal Protective Equipment." Supplements are issued periodically. Copies are available from:

Publications Dissemination, DTS
National Institute for Occupational Safety and Health
U.S. Department of Health, Education, and Welfare
4676 Columbia Parkway
Cincinnati, Ohio 45226

A4. Physiological and Psychological Limitations for Respirator Wearers

It is recommended that a physician determine if a person should or should not wear a respirator if the person has any of the following:

(1) Emphysema
(2) Chronic obstructive pulmonary disease
(3) Bronchial asthma
(4) X-ray evidence of pneumoconiosis
(5) Evidence of reduced pulmonary function
(6) Coronary artery disease or cerebral blood vessel disease
(7) Severe or progressive hypertension
(8) Epilepsy, grand mal or petit mal
(9) Anemia, pernicious
(10) Diabetes, insipidus or mellitus
(11) Punctured eardrum
(12) Pneumomediastinum gap
(13) Communication of sinus through upper jaw to oral cavity
(14) Breathing difficulty when wearing a respirator
(15) Claustrophobia or anxiety when wearing a respirator

A5. Suggested Procedures for Carrying Out Qualitative Respirator-Fitting Tests

A5.1 Irritant Smoke Test. The irritant smoke test can be used for both air-purifying respirators and atmosphere-supplying respirators. When an air-purifying respirator is tested, it should be equipped with a high-efficiency filter. The irritant smoke is produced by air flowing through a commercially available smoke tube normally used to check the performance of ventilation systems. Ventilation should be provided when carrying out a test to prevent contaminating the room where the test is carried out with smoke. The respirator wearer should keep his eyes closed during the test, even if the respirator offers eye protection. If the respirator wearer detects the penetration of the smoke into the respirator during the test, the wearer should be permitted to readjust the seal of the respirator. The test operator operates the smoke tube to direct smoke over the respirator, keeping the smoke tube about two feet from the respirator, and watches the reactions of the respirator wearer. If the respirator wearer does not detect penetration of smoke into the respirator, the test operator moves the smoke tube closer to the respirator and observes the reactions of the respirator wearer. When the smoke tube has been moved to within six inches of the respirator and the respirator wearer still has not detected penetration of smoke into the respirator, the smoke may be directed at potential points of leakage in the seal of the respirator to the wearer. If the respirator wearer still does not detect penetration of the smoke into the respirator, the wearer should carry out a series of exercises such as deep breathing, turning head from side to side, nodding head up and down, and talking while smoke is directed at the respirator. If the respirator wearer is unable to detect the penetration of smoke into the respirator, the wearer has achieved a satisfactory fit with the respirator.

A5.2 Odorous Vapor Test. The odorous vapor test can be used for both air-purifying respirators and atmosphere-supplying respirators. When an air-purifying respirator is tested, it should be equipped with a cartridge or canister which removes the test vapor from the air. An odorous material commonly used in the test is isoamyl acetate. If isoamyl acetate is employed as the test agent, an air-purifying respirator should be equipped with an organic vapor cartridge or canister. The simplest means of carrying out the test is to saturate a piece of fabric or sponge with liquid isoamyl acetate or to fill a stencil brush with liquid isoamyl acetate and then move the fabric, sponge, or stencil brush around the respirator worn by a person. The fabric, sponge, or stencil brush should be passed close to the potential points of leakage in the seal of the respirator while the wearer carries out exercises such as normal breathing, deep breathing, turning head from side to side, nodding head up and down, and talking. If the respirator wearer detects the odor of isoamyl acetate vapor during the test, the wearer should be permitted to readjust the seal of the respirator. If the respirator wearer is unable to detect the odor of isoamyl acetate vapor, the wearer has achieved a satisfactory fit with the respirator.

An improved qualitative respirator-fitting test using isoamyl acetate vapor as the test agent may be carried out using a hood, chamber, or room containing a known concentration of isoamyl acetate in the air. The

concentration of isoamyl acetate vapor in air commonly used is 100 parts per million by volume. The respirator wearer enters the enclosure containing the test atmosphere and carries out a series of exercises such as normal breathing, deep breathing, turning head from side to side, nodding head up and down, and talking. If the respirator wearer detects the odor of isoamyl acetate vapor during the test, the wearer should be permitted to readjust the seal of the respirator. If the respirator wearer is unable to detect the odor of isoamyl acetate vapor, the wearer has achieved a satisfactory fit with the respirator.

The use of isoamyl acetate vapor as a test agent has the following two major drawbacks: the odor threshold varies widely among persons, although most persons can detect by odor a concentration of isoamyl acetate vapor in air as low as 0.1 parts per million by volume; and olfactory fatigue may cause a person to fail to detect the odor of a low concentration of isoamyl acetate vapor in air. Before performing this test, all persons should be tested to determine their ability to sense the odor of isoamyl acetate vapor in air. Since the odorous vapor test is subjective, the validity of the test result depends on honest indication by the respirator wearer as to whether or not an odor was detected during the test.

A5.3 Other Qualitative Respirator-Fitting Tests. A stream of coal dust or talcum powder may be directed at the interface of a respirator facepiece with the wearer's face while the wearer carries out a series of exercises such as normal breathing, deep breathing, turning head from side to side, nodding head up and down, and talking. After removing the respirator facepiece from the wearer's face, any observation of coal dust or talcum powder on areas of the wearer's face which had been covered by the facepiece will indicate that the wearer did not obtain a satisfactory fit with the facepiece. A spray of fluorescein liquid particles may be directed at the interface of a respirator facepiece with the wearer's face while the wearer carries out a series of exercises such as normal breathing, deep breathing, turning head from side to side, nodding head up and down, and talking. After removing the respirator facepiece from the wearer's face, and with the wearer's eyes closed, ultraviolet light is directed at the wearer's face; any observation of fluorescein on areas of the wearer's face which had been covered by the facepiece will indicate that the wearer did not obtain a satisfactory fit with the facepiece. Negative-pressure and positive-pressure respirator sealing tests are not considered to be qualitative-type respirator-fitting tests, and these sealing tests should not be used for selecting specific makes and models of respirators for use by respirator wearers.

A6. Suggested Procedures for Carrying Out Quantitative Respirator-Fitting Tests

All quantitative respirator-fitting tests involve exposing the respirator wearer to a test atmosphere containing an easily detectable, relatively nontoxic aerosol, vapor, or gas as the test agent and then measuring the penetration of the test agent into the respirator. While wearing the respirator in the test atmosphere, the respirator wearer carries out a series of exercises simulating work movements. The respirator is equipped with a sampling probe which is connected by means of flexible tubing to an instrument which measures the penetration of the test agent into the respirator. Quantitative respirator-fitting tests can be used for both air-purifying respirators and atmosphere-supplying respirators. When carrying out a quantitative respirator-fitting test which uses an aerosol as the test agent, it is an acceptable procedure to equip an air-purifying respirator with a high-efficiency filter. When carrying out a quantitative respirator-fitting test which uses a vapor or gas as the test agent, it is an acceptable procedure to equip an air-purifying respirator with an appropriate cartridge or canister which removes the vapor or gas from the air.

A6.1 Exercises Carried Out by Respirator Wearers. A respirator wearer should carry out a series of exercises which stimulate work movements. The kinds of exercises carried out depend on the type of respirators. Each exercise should be carried out for at least two minutes.

The series of exercises for testing a respirator equipped with a facepiece should include but not be limited to the following:

(1) Normal breathing
(2) Deep breathing
(3) Turning head from side to side
(4) Nodding head up and down
(5) Talking
(6) Normal breathing

The series of exercises for testing a respirator equipped with a helmet, hood, or suit should include but not be limited to the following:

(1) Standing still, arms hanging downward along sides of body, normal breathing
(2) Bending forward and touching toes
(3) Raising arms above head and looking upward
(4) Bending knees and squatting
(5) Standing while holding a tubular rod about 76 centimeters in length with hands approximately 30 centimeters apart, twisting torso from side to side in an 180° arc, and slowly raising the arms from a downward direction to an upward direction having an angle of 45° with the horizontal plane

Table A1
Test Agents Suitable for
Carrying Out Quantitative Respirator-Fitting Tests

Test Agent	Concentration of Test Agent in Test Atmosphere	Particle Size if Test Agent is an Aerosol
Polydisperse sodium chloride aerosol	10–20 milligrams particulate matter per cubic meter of air	Mass median aerodynamic diameter of 0.5 to 0.7 micrometer with standard deviation of 2.0 to 2.4
Polydisperse DOP (dioctyl phthalate) aerosol	20–30 milligrams particulate matter per cubic meter of air	Mass median aerodynamic diameter of 0.5 to 0.7 micrometer with standard deviation of 2.0 to 2.4
Dichlorodifluoromethane (Freon 12) gas	250–1000 parts per million by volume	Not applicable

(6) Running in place

(7) Standing still, arms hanging downward along sides of body, normal breathing

A6.2 Test Atmospheres. Test atmospheres containing the test agents specified in Table A1 are suitable for carrying out quantitative respirator-fitting tests.

A6.3 Test Chambers. It is recommended that test chambers used to carry out quantitative respirator-fitting tests have the following characteristics:

(1) The design of the chamber and equipment used to generate the test atmosphere should ensure that the concentration of the test agent in the test atmosphere inside the chamber does not vary more than ±5% during a test.

(2) The design of the chamber and equipment used to disperse the test atmosphere in the chamber should ensure that the test agent is uniformly distributed in the test atmosphere throughout the chamber.

(3) The size of the chamber must permit a respirator wearer to carry out all of the designated exercises.

(4) The chamber should contain provisions to permit the test operator to visually observe the respirator wearer inside the chamber.

A6.4 Protection Factor Determination. The instrument which measures the penetration of the test agent into the respirator worn by a person in the test atmosphere should be connected to a fast-response recorder which records the penetration values. The average of the peaks of the penetration of the test agent into the respirator for each type of exercise carried out by the respirator wearer should be determined. The protection factor for a given make and model of respirator worn by a person in a test should be calculated by using the following equation:

$$\text{Protection factor} = \frac{100}{S/N}$$

where

S = The sum of average peak penetrations for all exercises (in percent)

N = The number of exercises

A7. Recommended Procedures for Field Testing the Seal of the Respirator to the Wearer

The seal of a respirator to a wearer can be tested in the field by procedures recommended by respirator manufacturers or by any of the following tests:

A7.1 Irritant or Odorous Test Agent. The person wearing a respirator is exposed to an irritant smoke, odorous isoamyl acetate vapor, or other suitable test agent easily detectable by irritation, odor, or taste (an air-purifying respirator must be equipped with the appropriate air-purifying element). If the respirator wearer is unable to detect the penetration of the test agent into the respirator, it can be reasonably assured that the seal of the respirator to the wearer is satisfactory.

A7.2 Negative-Pressure Sealing Test. A negative-air-pressure respirator sealing test can be used on air-purifying respirators equipped with tight-fitting respiratory-inlet coverings and on atmosphere-supplying respirators equipped with tight-fitting respiratory-inlet coverings and breathing tubes which can be squeezed

or blocked at the inlet to prevent the passage of air. This test may be difficult or impossible to carry out on valveless respirators. The inlet opening of the respirator's canister(s), cartridge(s), or filter(s) is closed off by covering with the palm of the hand(s), by replacing the inlet seal on a canister(s), or by squeezing a breathing tube or blocking its inlet so that it will not allow the passage of air. Then the wearer inhales gently and holds his breath for at least 10 seconds. If a facepiece collapses slightly and no inward leakage of air into the facepiece is detected, it can be reasonably assured that the fit of the respirator to the wearer is satisfactory. For a respirator equipped with a mouthpiece and nose clamp, if leakage of air into the nose or the mouth cannot be detected, then it can be reasonably assured that the fit of the respirator to the wearer is satisfactory.

A7.3 Positive-Pressure Sealing Test. A positive-air-pressure test can be used on respirators equipped with tight-fitting respiratory-inlet coverings which contain both inhalation and exhalation valves. This test may be difficult or impossible to carry out on valveless respirators. The exhalation valve or breathing tube, or both, is closed off and then the wearer exhales gently. The fit of a respirator equipped with a facepiece is considered to be satisfactory if a slight positive pressure can be built up inside the facepiece without the detection of any outward leakage of air between the sealing surface of the facepiece and the respirator wearer's face. The fit of a respirator equipped with a mouthpiece and nose clamp is considered satisfactory if the respirator wearer senses a buildup of positive pressure and is unable to detect any outward leakage of air through the nose and in the area between the mouth and the mouthpiece. For some respirators, this test method requires that the respirator wearer first remove an exhalation cover from the respirator and then replace it after completion of the test. These tasks often are difficult to carry out without disturbing the fit of the respirator to the wearer.

A7.4 Warning Concerning Negative-Pressure and Positive-Pressure Sealing Tests. Care must be taken in carrying out a negative-pressure or positive-pressure sealing test; otherwise, the results of the sealing test may be unreliable. Thorough training in carrying out these tests should be given to respirator wearers.

A8. Monitoring of Respiratory Hazards

The intensity of potential exposures and actual exposure of respirator wearers to respiratory hazards is determined by using instruments to measure the concentrations of air contaminants or oxygen in the breathing zone of the respirator wearers. Adequate air sampling and analysis or appropriate calculations should be carried out to determine both the time-weighted average concentration and the peak concentration of the respiratory hazard to which a respirator wearer may be potentially exposed or is actually exposed. Concentrations of a substance causing a respiratory hazard should be determined during the work shift in order to accurately define both the time-weighted average concentration and the peak concentration of the substance. The concentrations of a substance in air may be affected by changes in process operation, changes in rate and direction of air movement, changes in temperature from day to night operation, and changes in seasons; these factors should be taken into account in carrying out a program of monitoring respiratory hazards.

It is essential that the volume of air sampled during a sampling test contain a sufficient quantity of the hazardous substance for accurate determination of the concentration of the substance in the workplace atmosphere. The volume of air to be sampled or the duration of the air-sampling period depends upon the following factors:

(1) Estimated concentration of the substance in air

(2) Sensitivity of the sampling instrument and sampling procedures

(3) Established permitted time-weighted average concentration and established permitted peak concentration for the substance in air

Although it is recognized that the concentration of a hazardous substance which occurs during an emergency cannot always be measured or calculated, every reasonable effort should be made to estimate what this concentration would be.

Consideration should be given to the use of a continuously operating air monitor and alarm to alert respirator wearers when a high concentration of a hazardous substance suddenly occurs.

A9. Recommended Procedures for Cleaning and Sanitizing Respirators

Recommended procedures for cleaning and sanitizing respirators are as follows:

(1) Remove, when necessary, the following components of respiratory-inlet covering assemblies before cleaning and sanitizing:

(a) Filters, cartridges, canisters

(b) Speaking diaphragms

(c) Demand and pressure-demand valve assemblies

(d) Any components recommended by the respirator manufacturers

(2) Wash respiratory-inlet covering assemblies in warm (49°C or 120°F maximum temperature) cleaner-sanitizer solution. A stiff bristle (not wire) brush may be used to facilitate removal of dirt or other foreign material.

(3) Rinse respiratory-inlet covering assemblies in clean, warm (49°C or 120°F maximum temperature) water.

(4) Drain all water and air-dry the respiratory-inlet covering assemblies.

(5) Clean and sanitize all parts removed from respiratory-inlet covering as recommended by the manufacturers.

(6) Hand wipe respiratory-inlet covering assemblies, all parts, and all gasket and valve sealing surfaces with damp, lint-free cloth as needed to remove water residues and all foreign materials.

(7) Inspect parts and replace any which are defective.

(8) Reassemble parts on respiratory-inlet covering assemblies.

(9) Attach new filters, cartridges, and canisters to respiratory-inlet coverings.

(10) Visually inspect and, where possible, test parts and respirator assemblies for proper function.

(11) Place assembled respirators in appropriate containers for storage.

Machines may be used to expedite the cleaning, sanitizing, rinsing, and drying of large numbers of respirators. Extreme care must be taken to ensure against tumbling, agitation, or exposure to temperatures above those recommended by the manufacturer (normally 49°C or 120°F maximum), as these conditions are likely to result in damage to the respirators. Ultrasonic cleaners, clothes-washing machines, dishwashers, and clothes dryers have been specially adapted and successfully used for cleaning and drying respirators.

Cleaner-sanitizers that effectively clean the respirator and contain a bactericidal agent are commercially available. The bactericidal agent frequently used is a quaternary ammonium compound.

Strong cleaning and sanitizing agents and many solvents can damage rubber or elastomeric respirator parts. These materials must be used with caution.

Alternatively, respirators may be washed in a detergent solution and then sanitized by immersion in a sanitizing solution. Some sanitizing solutions which have proven effective are: (1) a hypochlorite solution (50 parts per million chlorine), 2-minute immersion; (2) an aqueous iodine solution (50 parts per million of iodine), 2-minute immersion; or (3) a quaternary ammonium solution (200 parts per million of quaternary ammonium compounds in water with less than 500 parts per million total hardness), 2-minute immersion.

Different concentrations of quaternary ammonium salts are required to achieve a sanitizing solution with waters of varying hardness. Inflammation of the skin of the respirator user (dermatitis) may occur if the quaternary ammonium compounds are not completely rinsed from the respirator. The hypochlorite and iodine solutions are unstable and break down as time progresses; they may cause deterioration of rubber or other elastomeric parts and may be corrosive to metallic parts. Immersion times should not be extended beyond the mentioned time periods, and the sanitizers must be thoroughly rinsed from the respirator parts.

Respirators may become contaminated with toxic materials. If the contamination is light, normal cleaning procedures should provide satisfactory decontamination; otherwise separate decontamination steps may be required before cleaning.

A10. Oxygen Deficiency – Immediately Dangerous to Life or Health

An atmosphere which causes an oxygen partial pressure of 100 millimeters of mercury column or less in the freshly inspired air in the upper portion of the lungs which is saturated with water vapor is classified as "oxygen deficiency – immediately dangerous to life or health." The rationale for this classification is that an oxygen partial pressure of 100 millimeters of mercury column in the freshly inspired air in the upper portion of the lungs, which is saturated with water vapor, corresponds to an oxygen partial pressure of 60 millimeters of mercury column in the alveoli of the lungs with a carbon dioxide partial pressure of 40 millimeters of mercury column is present in the alveoli of the lungs, and at these alveolar conditions the hemoglobin of the alveolar blood is 90% saturated with oxygen. When the oxygen content of the hemoglobin of the alveolar blood drops below 90% saturation, oxygen-deficiency symptoms become noticeable. Further details concerning oxygen deficiency will be found on pages 16 to 18 of "A Guide to Industrial Respiratory Protection," LA-6677-M, published by the Los Alamos Scientific Laboratory; on pages 140-148 of Volume I of "Patty's Industrial Hygiene and Toxicology," published by John Wiley and Sons, Incorporated, 1978; and in "Physiology of Respiration," published by Yearbook Medical Publishers Incorporated, 1965.

APPENDIX

The oxygen partial pressure in the freshly inspired air in the upper portion of the lungs which is saturated with water vapor is calculated using the following equation:

Partial pressure of oxygen in freshly inspired air in upper portion of lungs in units of millimeters of mercury column =

$$\left(\begin{array}{l}\text{Atmospheric air pressure in units of millimeters of mercury column}\end{array} - \begin{array}{l}\text{47.0 millimeters of mercury column}\end{array}\right) \times \begin{array}{l}\text{Decimal fraction by volume of oxygen in atmospheric air in workplace}\end{array}$$

NOTE: 47.0 millimeters of mercury column is the partial pressure of water vapor in the air in the upper portion of the lungs which is saturated with water vapor. The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Examples of calculations:

(1) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at sea level when the atmospheric air in the workplace has a normal oxygen concentration.

The atmospheric air pressure at sea level is 760.0 millimeters of mercury column.

The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$(760.0 - 47.0) \times 0.2095 =$ 149.37 millimeters of mercury column

(2) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at an altitude of 5000 feet above sea level when the atmospheric air has a normal oxygen concentration.

The atmospheric air pressure at an altitude of 5000 feet above sea level is 632.7 millimeters of mercury column.

The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$(632.7 - 47.0) \times 0.2095 =$ 122.7 millimeters of mercury column

(3) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at an altitude of 10 000 feet above sea level when the atmospheric air has a normal oxygen concentration.

The atmospheric air pressure at an altitude of 10 000 feet above sea level is 522.7 millimeters of mercury column.

The concentration of oxygen in normal atmospheric air is 20.95% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$(522.7 - 47.0) \times 0.2095 =$ 99.66 millimeters of mercury column

(4) Determine the partial pressure of oxygen in the upper portion of the lungs of a person in a workplace at sea level when the concentration of oxygen in the atmospheric air in the workplace is 14.0% by volume.

The atmospheric air pressure at sea level is 760.0 millimeters of mercury column.

The concentration of oxygen in the atmospheric air in the workplace is 14.0% by volume.

Partial pressure of oxygen in freshly inspired air in upper portion of lungs =

$(760.0 - 47.0) \times 0.14 =$ 99.82 millimeters of mercury column

American National Standards

The standard in this booklet is one of more than 10,000 standards approved to date by the American National Standards Institute.

The Standards Institute provides the machinery for creating voluntary standards. It serves to eliminate duplication of standards activities and to weld conflicting standards into single, nationally accepted standards under the designation "American National Standards."

Each standard represents general agreement among maker, seller, and user groups as to the best current practice with regard to some specific problem. Thus the completed standards cut across the whole fabric of production, distribution, and consumption of goods and services. American National Standards, by reason of Institute procedures, reflect a national consensus of manufacturers, consumers, and scientific, technical, and professional organizations, and governmental agencies. The completed standards are used widely by industry and commerce and often by municipal, state, and federal governments.

The Standards Institute, under whose auspices this work is being done, is the United States clearinghouse and coordinating body for voluntary standards activity on the national level. It is a federation of trade associations, technical societies, professional groups, and consumer organizations. Some 1000 companies are affiliated with the Institute as company members.

The American National Standards Institute is the United States member of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Through these channels U.S. standards interests make their positions felt on the international level. American National Standards are on file in the libraries of the national standards bodies of more than 60 countries.

American National Standards Institute, Inc
1430 Broadway
New York, N.Y. 10018

APPENDIX III

APPENDIX III

MEDICAL RESPIRATOR EVALUATION

MEDICAL HISTORY:

DO YOU HAVE ANY OF THE FOLLOWING? IF YES, CIRCLE NUMBER.

1) Chronic lung disease
2) Ischemic heart disease
3) Hypertension
4) Hemorrhagic disorders
5) Thyroid enlargement
6) Epilepsy
7) Diabetes
8) Cerebrovascular accident
9) Facial abnormalities
10) Serious defects in visual acuity
11) Ruptured ear drum
12) Other disabilities

BELOW IS FOR COMPLETION BY PHYSICIAN:

	NORMAL	ABNORMAL
FACIAL CONTOURS	☐	☐
INTRA-NASAL EVALUATION	☐	☐
EAR DRUMS (PREFORATION)	☐	☐
CARDIOVASCULAR STATUS	☐	☐
PULMONARY STATUS	☐	☐

BASED ON EVALUATION OF THE ABOVE FACTORS:
CLASS (CHECK)

☐ No restrictions on respirator use.

☐ Some specific use restrictions.

RESTRICTIONS: _____

_____

_____

_____

_____

☐ No respirator use permitted.

(Signature) _____ M.D.

APPENDIX IV

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NO. 1A

AMMONIUM HYDROXIDE (28-30%)

Date April 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: AMMONIUM HYDROXIDE (28-30%)
OTHER DESIGNATIONS: Aqua Ammonia, Ammonium Hydrate, Ammonia Water (Strong), "Spirit of Hartshorn", NH_4OH, GE Material D4B2, CAS #001 336 216
MANUFACTURER: Available from many suppliers, including:

J.T. Baker Chemical Corp.
222 Red School Lane
Philipsburg, NJ 08865

Canadian Industries Limited
Chemicals, Box 10
Montreal, QUE., Canada H3C 2R3

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Ammonia, Anhydrous (See MSDS #1)	28-30	8-hr TWA 50 ppm* or 35 mg/m^3
Water	70-72	
Material is prepared by dissolving ammonia in water under controlled conditions. Purity depends on the purity of the ammonia and of the water used.		Human, oral LDLo 43 mg/kg
*Current OSHA value; ACGIH (1979) TLV is 25 ppm. NIOSH has proposed a ceiling level of 50 ppm for ammonia.		Human, inhalation LCLo 5000 ppm
		Rat, oral LD_{50} 350 mg/kg

SECTION III. PHYSICAL DATA

Temperature at which solution is saturated with NH_3 at 1 atm, deg F ---------- ca 80-85
Vapor pressure of NH_3, 15.5 C, mm Hg - 420-475
Water solubility ---------- Completely Soluble

Specific gravity (15.5/4 C) - 0.90
Formular weight, NH_4OH ------ 35.05
Moles NH_3/liter of solution - ca 15
Freezing point, deg C ------- >-73

Appearance & Odor: A clear, colorless liquid with a strong, pungent odor of ammonia. The odor, which is detectable at 5 ppm and irritating at 25-50 ppm of NH_3, provides a warning of hazardous concentrations in air.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
N/A	1204 F (as NH_3)	Volume % (NH_3)	16	27

Extinguishing Media: Use media appropriate to surrounding fire conditions. Use cold water spray to control vapors and cool fire-exposed containers.
When heated, material will emit NH_3 vapors which necessitates respiratory and eye protection for firefighters. Use protective clothing.

SECTION V. REACTIVITY DATA

Material is stable in cool storage in closed containers. It does not polymerize.
Ammonium hydroxide is strongly alkaline and is incompatible with acid materials and with copper, tin, zinc, aluminum, and their alloys and with galvanized surfaces. Violent reactions can occur, for example, with dimethyl sulfate, or fluorine. Explosive materials can result from reaction with iodine or with several silver compounds.
Adding NaOH to this material and/or heating will volatize NH_3.

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RSV 0021470

SECTION VI. HEALTH HAZARD INFORMATION

TLV 25 ppm/50 ppm (See Sect. II)

Ammonium hydroxide is irritating and corrosive to body tissues. Excessive inhalation of vapors is irritating to the mucous membranes of the respiratory tract and can result in headache, coughing, severe lung congestion (edema and difficulty in breathing). Skin contact with liquid can irritate, redden and cause burns. Liquid contact with the eye can be severely damaging and can result in loss of vision. Ingestion is corrosive to the digestive tract.

FIRST AID:

Eye Contact: Immediately flush with lots of running water for at least 15 min., including under the eyelids; then contact physician immediately, preferably an opthalmologist. Speed and thoroughness in rinsing eyes is important to avoid permanent injury.

Skin Contact: Immediately flush with lots of water while removing contaminated clothing and shoes. Get medical help promptly if large areas are affected or irritation persists.

Inhalation: Remove to fresh air. Restore breathing if required and/or have trained person administer oxygen if breathing is difficult. Keep warm and at rest. Contact physician promptly.

Ingestion: If conscious, promptly give lots of water or dilute vinegar or citrus juice to drink, followed by milk. Do not induce vomiting. Contact physician.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Prepare written plans for emergency. Inform safety personnel of large spills and evacuate area. Provide ventilation. Those involved in clean up need protection against contact with liquid and inhalation of mist or vapors. Contain spill for recovery when feasible or flush with water to holding area for neutralization (do not flush directly to sewer or surface water.)

DISPOSAL: Follow Federal, State and Local regulations for pH, NH_3 content, and salts content for effluents. Ammonium hydroxide can be diluted with water, neutralized as required with dilute HCl or dilute H_2SO_4, and then hightly diluted with water for discharge. Suitable scrap ammonium hydroxide might be considered for use in neutralizing acidic wastes. If desired, aqueous NH_3 can be recovered from scrap for use or sale.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation as required to meet TLV. For emergency and nonroutine conditions above the TLV a chemical cartridge respirator with a full-facepiece respirator is suitable for exposures below 300 ppm; above 300 ppm or if concentration unknown use approved self-contained respirator with full facepiece.

Use splash-proof, chemical safety goggles, and where needed, a faceshield or mask to protect against splashes and from mists and NH_3. Use a rubber suit, boots, gloves, apron, or other protective clothing as required for workplace conditions to prevent contact with ammonium hydroxide solutions.

An eyewash station and a safety shower must be immediately accessible to workers where this material is used or handled. Washing facilities and large amounts of clean water must be available for emergency use where spills may occur.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a cool (below 80 F to avoid pressurization above 1 atm) area in closed containers, away from sources of heat, direct sunlight, and incompatible materials (see, for example, Sec. V). Handle as a corrosive liquid. Prevent damage to containers. Above 50 F, the ammonia vapor from this material can be a serious hazard in a spill situation. Use caution in opening sealed containers for proper pressure relief. Drain emptied containers well & flush with water before discarding.

Work practices and equipment must be arranged to prevent contact of ammonium hydroxide with the worker's body and to avoid inhalation of vapors. Train workers in proper handling of ammonium hydroxide.

Preplacement and periodic medical exam is recommended for ammonia workers and additional exams should be provided if excessive exposure occur. Keep records. Preclude from exposure workers with eye or pulmonary diseases.

DATA SOURCE(S) CODE: 1-12, 14, 34

APPROVALS: MIS, CRD

Industrial Hygiene and Safety 5-16-80

MEDICAL REVIEW: June 1980

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 316

BENZENE

Revision C

Date November 1978

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: BENZENE

OTHER DESIGNATIONS: Benzol, Phenylhydride, Phene, C_6H_6, GE Material D5B53, ASTM D835, D836, D2359, CAS #000 071 432

MANUFACTURER: Available from many sources.

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Benzene *Current OSHA and ACGIH (1978) permissible exposure level. Note that the OSHA standard on benzene which would reduce the TLV to 1 ppm with a 5 ppm ceiling, forbid contact with liquid with over 0.5% benzene, and legally classify benzene as a human carcinogen has been struck down by U.S. Court of Appeals. ACGIH (1978) lists benzene as a suspected carcinogen for humans.	ca 100	8-hr TWA 10 ppm (skin)* with 25 ppm ceiling level and 50 ppm 10 minute peak

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F (C)	176 (80)	Specific gravity, 20/4 C	0.879
Vapor pressure at 20 C, mm Hg	74.6	Volatiles, %	ca 100
Vapor density (Air=1)	2 77	Evaporation rate (BuAc=1)	1.0 5./
Solubility in water, wt. %	0.06	Molecular weight	78.12
		Melting point, deg F (C)	42 (5.5)

Appearance & Odor: Clear, colorless liquid having a characteristic aromatic odor. The odor recognition threshold (100% of panel) is 4.68 ppm (unfatigued) in air. Odor is is not an adequate warning of hazard.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air Volume %	LOWER	UPPER
12°F (-11C) (TCC)	1044°F (562°C)		1.3	7.1

Extinguishing Media: Water fog, CO_2, dry chemical or foam. Use a blanketing effect to smother fire. A water stream will scatter the fire. A water spray can be used to cool fire exposed containers.

Firefighters should wear approved self-contained breathing apparatus.

This material can form explosive and flammable mixtures with air at room temperature. It is a severe explosion hazard and toxic hazard in a fire situation. Vapors can flow along surfaces to distant ignition sources and flash back.

SECTION V. REACTIVITY DATA

Benzene is a stable compound under normal storage and use conditions; it does not polymerize.

Benzene will react vigorously with strong oxidizers such as ozone, permanganate, sulfuric or nitric acids, potassium peroxide, sodium peroxide, et al. It is a flammable liquid. OSHA Class IB. Heating greatly increases the fire and explosion hazards.

Oxidation in air will produce oxides of carbon and nitrogen.

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RSV 0021472

SECTION VI. HEALTH HAZARD INFORMATION

TLV 10 ppm or 30 mg/m^3 (skin)

Excessive inhalation or prolonged skin exposure may cause headache, weariness, loss of appetite and lassitude with incipient blood effects including decreased cell counts, mild lymphotosis and eosinopenia. The most significant toxic effect of benzene is insidious and often irreversible injury to the blood forming tissue from chronic low level exposures. Development of leukemia may occur from chronic excessive exposure! Eye contact yields irritation from liquid or high vapor concentrations. Skin contact will also yield a defatting effect. Inhalation may result in collapse, bronchitis and pneuomonia.

FIRST AID:

Eye contact: Wash eyes well with water for 15 minutes. Contact physician.

Skin contact: Wash skin well with water. Contaminated clothing should be removed at once.

Inhalation: Remove victim to fresh air. Restore breathing if required and administer oxygen for labored breathing. Contact physician.

Ingestion: Give edible fats or oils to swallow. Do not induce vomiting (aspiration hazard). Contact a physician immediately.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

If a significant spill occurs, notify safety personnel and evacuate the area. Remove all ignition sources. Provide maximum, explosion-proof ventilation. Clean-up personnel must use approved self-contained breathing apparatus and other protective equipment to avoid contact with benzene.

Remove free liquid. Pick up residue with an inert absorbant, such as vermiculite, and placed in a closed metal container for disposal, using non-sparking tools. When necessary, benzene may be flushed away from a critical area with water, but flush to open area only, not to sewer or to surface waters.

DISPOSAL: Incinerate waste benzene or dispose of via a licensed solvent disposal company. Do not send (or allow run off) to the sewer!

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and local exhaust ventilation where benzene is used, handled, or stored to meet TLV requirements. Self-contained breathing apparatus should be available for emergencies and non-routine situations. Approved cartridge or canister type respirators can be used for benzene concentrations up to 50 ppm for short periods. A full facepiece is required above 10 ppm

To prevent skin contact, gloves, aprons, boots, etc of neoprene or other benzene-resistant materials should be used. Chemical goggles or face shields should be used if splashing is possible. Eyewash station should be available where splashing is probable.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Whenever possible, less toxic solvents should be substituted for benzene. Consult health and safety services before benzene is used in plant operations. Do not breathe vapors. Prevent contact with liquid. It is a suspected cancer causing agent!

Keep away from heat, sources of ignition, and oxidizing agents. No smoking in areas of use. Store and handle as OSHA Class IB liquid.

Pre-placement detailed medical examination is needed. Workers who show heart, lung, kidney, liver, nervous disease, or any blood abnormality should not be assigned. Periodic physical examinations and area monitoring is required.

DATA SOURCE(S) CODE: 2-9, 12, 21

APPROVALS:	
MIS, CRD	J. M. Nielsen
Industrial Hygiene and Safety	
Corporate Medical Staff	George F. Mattson MD

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 15A

CHRYSOTILE ASBESTOS

Date November 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CHRYSOTILE ASBESTOS
DESCRIPTION: A crystalline serpentine mineral, or layered, hydrated magnesium silicate in fine fiber form (asbestiform). The end of a sliver of this material with a cross-section of 0.1 mm² can show about 20 million tubules (scroll-like fibrils about 0.01 µm diameter) in approximate parallel orientation. It is possible to strip from a fiber bundle very fine chrysotile threads, each an agglomerate of hundreds or thousands of hollow fibrils. (90% of asbestos used is chrysotile.)
OTHER DESIGNATIONS: Asbestos, CAS #001 332 214, GE Material D4E11

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Idealized Chrysotile (unit cell) - $Mg_3Si_2O_5(OH)_4$* *Impurities include low levels of Mn, Fe^{+2}, Fe^{+3}, and Al in the structure, replacing randomly 4% av. of the Mg atoms. Impurities depend on the mineral source; the unit cell hydroxyl content can also vary with an average of 4.25. **Current OSHA TLV. OSHA (1975) proposed TLV of 0.5 fb/cc with a Ceiling of 5 fb/cc (15 min. sample). NIOSH (1976) proposed 0.1 fb/cc. ACGIH (1979 Intended Changes List) has retained TLV of 2 fb/cc for chrysotile asbestos. Asbestos is carcinogenic and/or co-carcinogenic for humans!	ca 95	8-hr TWA 2 fibers/cc,** Ceiling 10 fibers/cc, (>5 µm in length) "Asbestos" Human, inhal. TDLo 1.2 fb/cc for 19 years (Pulmonary effects)

SECTION III. PHYSICAL DATA

Melting point ---------- Decomposes (see Sect. V)
Vapor pressure ---------- Nil
Water solubility ---------- Insoluble (slowly breaks down in hot water)

Appearance: White, fibrous solid, as long flexible textile fibers down to dust-like filler power. [Milled chrysotile asbestos (powder-like) has an aspect ratio (ratio of length/diameter) as high as 50 for most particles.]

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
N/A	N/A	N/A		

This material is not combustible in air. Use extinguishing media as appropriate for the surrounding materials in a fire situation.

SECTION V. REACTIVITY DATA

This material is inert under ordinary room temperature and heated use conditions. It is resistant to heat, but it will decompose and alter its microscopic fiber structure (see Sect. I) above 600 C (1112 F): Chrysotile dehydroxylates at 600-780 C; the "asbestos anhydride" in turn breaks down to mixture of silica (SiO_2) and fosterite (Mg_2SiO_4) at 800-850 C. Above 1000 C (1832 F) magnesium pyroxenes are formed which melt at about 1450 C.
Strong acids can attack chrysotile and rapidly extract its MgO and H_2O content; it can be decomposed by glacial acetic acid. Hot water slowly breaks down chrysotile. It, like other forms of asbestos, resists strong alkali (5 M NaOH at least up to 100 C).

GENIUM PUBLISHING

RSV 0021474

SECTION VI. HEALTH HAZARD INFORMATION

TLV 2 fibers/cc >5 um in length (See Sect.II)

As a particulate material, chrysotile asbestos can be irritating to the respiratory tract, skin or eyes. However, the significant industrial hazards arise from excessive dust inhalation with damage requiring years to become evident. Chronic inhalation of high levels of asbestos particles can produce asbestosis, a disabling fibrosis of the lungs which gradually reduces lung capacity and efficiency. (Usually over 4 years is required for a serious condition to develop.) Excessive inhalation can also cause pleural plaque, a thickening of the lung lining. Compliance with TLV is expected to control these hazards.

Cancer can result from excessive inhalation of asbestos particulate, which may require decades to develop. Lung cancer is a special risk to those who smoke cigarettes regularly in addition to having asbestos exposure. Rare mesotheliomas of the pleura and peritoneum (lining around the lungs or abdominal cavity) and possibly cancers of the GI tract and larynx (also smoking related) have been associated with inhalation exposure to asbestos particles. (Crocidolite asbestos has been suggested as the major mesothelioma risk.)

In groups of workers exposed to asbestos, lung cancer death is 3 or 4 times more common than mesothelioma death, and 97.5% of asbestos-related lung cancers occur with those workers who also smoke cigarettes! For non-smokers asbestos exposure increases risk of lung cancer 5X.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of spills! Exclude all from spill area except trained clean-up personnel who have approved respiratory protection against dust. Provide exhaust ventilation with capture filtration, but do not stir up the dust. Use a wet method or an approved vacuum cleaning system to pick up spills. The techniques used must collect particulate without dispersing dust into the air. Waste must be placed in dust-tight containers or sealed plastic bags for disposal. Label properly!

DISPOSAL: Deposit waste containers in a secured landfill where asbestos will remain buried. Follow Federal, State and local regulations. Also note that chrysotile can be converted into non-asbestos waste by heating at high temperature (see Sect.V).

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide exhaust ventilation and capture filtration to remove airborne asbestos particulate from the workplace (as much as possible) without dispersing it into the environment. Isolate work areas (also post signs) where asbestos particulate may occur at excessive levels.

For nonroutine or emergency conditions where excessive dust is present, approved respirators must be used: Single use or re-usable air-purifying respiratory up to 10X TLV: full-facepiece powered air-purifying respirator up to 100X TLV; full-facepiece air-supplied (continuous flow or pressure-demand type) respirator above 100X TLV.

Depending on exposure levels, it may be necessary to provide body-covering work clothes, special vacuuming facilities for clothes and suitable laundering or disposal arrangements, change areas with dual lockering facilities, showers before changing to street clothing after work, etc. Be sure workers do not carry asbestos dust home on their clothing or person. Prevent asbestos dust from being carried to rest rooms, to eating areas, to non-asbestos workplaces, etc.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store asbestos in closed containers (dust tight) in a clean, secure area. Protect containers from physical damage. Do not open containers that can release asbestos dust without providing proper enclosure or control measures. Use dust suppression control measures at all stages of asbestos handling, use and disposal. Follow good housekeeping practices to prevent accumulations of asbestos-containing dust. Avoid inhalation of asbestos. The effects on cancer incidence of chronic exposure are not yet fully known. Monitor areas where asbestos dust is present to be sure of worker exposure levels; keep records to define exposures and retain for at least 20 years. Provide preplacement and annual medical examinations for those exposed in the workplace to 8-hr TWA of 0.1 asbestos fibers or more/cc which are >5 um in length. Retain medical records for at least 20 years.

DATA SOURCE(S) CODE: 2-4,6,12,14,20,26,32

APPROVALS: MIS, CRD J.M.Nielsen

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 121

CUPRIC CHLORIDE

DATE October 1983

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CUPRIC CHLORIDE
OTHER DESIGNATIONS: Copper (II) Chloride, $CuCl_2$, CAS #007 447 394; $CuCl_2 \cdot 2H_2O$, CAS #013 933 170; also CAS #001 344 678
MANUFACTURER: Available from several suppliers, including:

Mallinckrodt, Inc.
P.O. Box M
Paris, KY 40361
Tel: (606) 987-7000

G. Frederick Smith Chemical Co.
867 McKinley Ave
P.O. Box 23214
Columbus, OH 43223 Tel: (614) 224-5343

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Cupric Chloride (forms the dihydrate, $CuCl_2 \cdot 2H_2O$ in moist air)		8-hr TWA 1.0 mg/m^3* (dust or mist, as Cu)
		$CuCl_2$
		Rat Oral LI_0 140 mg/kg
		Mouse, Oral LD_{50} 190 mg/kg
		Human, Oral LDL_0 200 mg/kg

*Current OSHA PEL and ACGIH (1983) TLV. STEL is 2.0 mg/m^3 (dust or mist, as Cu)

SECTION III. PHYSICAL DATA

	$CuCl_2$	$CuCl_2 \cdot 2H_2O$
Boiling pt, 1 atm, deg C (at 5300 C (decomposes to CuCl and Cl_2)	993 (dec)	loses water 70-200C
Specific gravity, 25/4C	3.39	2.54
Melting point, deg C	620	100
Soluble in water, @ 0 C, g/100 ml	70.6	110.4
pH (0.2 molar soln)	3.6	3.6
Molecular weight	134.4	170.5
Appearance & Odor	Yellow to brown hygroscopic powder	Fine, light blue-green needle-like crystal

May have an HCl odor

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp	Flammability Limits in Air	Lower	Upper
None				

Extinguishing media: Non-combustible. Use any media appropriate for the surrounding fire. Use water spray to cool fire-exposed containers. Material exposed in a fire situation will decompose at extreme temperatures releasing chlorine gas.
Firefighters should wear self-contained breathing apparatus and protective clothing.

SECTION V. REACTIVITY DATA

This is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.
Cupric Chloride ($CuCl_2$) is hygroscopic. Forms dihydrate in moist air.
A mixture of either potassium or sodium with cupric chloride produces a strong explosion on impact. Incompatible with hydrazine and nitromethane. Corrosive to aluminum with moisture present.
Aqueous solutions are acidic (See Section III).
Thermal-oxidative degradation can produce chlorine gas, which can also be generated on reaction with strong oxidizing agents.

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SECTION VI. HEALTH HAZARD INFORMATION

TLV 1.0 mg/m^3 (dust or mist, as Cu) (See Sect II)

Inhalation of dusts or mists results in coughing, sore throat and irritation of the upper respiratory tract. Skin contact can cause redness and irritation with possible dermatitis. Eye contact will cause redness, pain and possible blurred vision from its corrosive effects. Ingestion will cause abdominal pain, vomiting and diarrhea. Copper is an essential trace element in the body, but can be toxic in excessive exposures.

FIRST AID:

Eye Contact: Irrigate with running water for 15 min. including under eyelids.
Skin Contact: Wash affected area with soap and water.
Inhalation: Remove to fresh air.
Ingestion: Give several glasses of water to drink to dilute. Induce vomiting.

Seek medical assistance for further treatment, observation and support after first aid.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel. Provide adequate ventilation. Clean up personnel need protection against possible inhalation of dust and contact with solid or solution (corrosive). Carefully sweep up dry material and collect in a suitable container for reclamation or disposal, avoiding dusty conditions. Avoid flushing directly to sewers (except, possibly, a few grams or trace residues with high dilution) or surface waters. Material dissolved in water can be neutralized with soda ash to precipitate copper; separate precipitate for disposal.

DISPOSAL: Waste may be buried in an approved landfill.

Follow Federal, State and Local regulations.

EPA(CWA) Reportable Quantity is 10 lbs. (40 CFR 117)

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide adequate general exhaust ventilation to meet TLV requirements. Exhaust filtration to collect dust may be required or desirable.

Use a NIOSH approved dust mask when handling large quantities of material or where dusting conditions exist.

Wear protective clothing (rubber gloves, apron, boots) appropriate for the work situation to avoid skin contact. Use chemical safety goggles to prevent eye contact.

Eyewash station and washing facilities should be accessible to areas of use and handling.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers under dry conditions to preserve anhydrous salt or the crystalline hydrate. Protect containers from physical damage.

Use good housekeeping techniques. Copper chloride solutions are acidic and corrosive.

Avoid inhalation of dust or mist. Prevent skin and eye contact. Do not ingest. Wash hands and face thoroughly after handling. Follow good hygiene practices.

DOT Classification: ORM-B I.D. No. UN2802 Label: (None)

DATA SOURCE(S) CODE: 1,2,4-7,9,10,12,14

APPROVALS: MIS/CRD J. M. Nielsen

INDUST. HYGIENE/SAFETY 10-3-83

MEDICAL REVIEW: 8 October 1983

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE

Date August 1978

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: ETHYL BENZENE
OTHER DESIGNATIONS: Phenylethane, Ethylbenzol, $C_2H_5C_6H_5$, CAS# 000 100 414
MANUFACTURER: Available from several suppliers.

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Ethyl Benzene	ca 100	8-hr TWA 100 ppm*
*Current OSHA permissable exposure level. A Standard was proposed by OSHA in October 1975 which includes an action level of 50 ppm, and detailed requirements of monitoring, medical surveillance, employee training, etc., when exposure exceeds 50 ppm. It has not yet issued as a legal requirement.		Human, inhalation TCLo 100 ppm for 8 hr (irritation) Rat, Oral LD_{50} 3500 mg/kg

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C	136	Specific gravity 20/4C	0.867
Vapor pressure at 25.9 C, mm Hg	10	Volatiles, %	ca 100
Vapor density (Air=1)	3.66	Evaporation rate (BuAc=1)	<1
Water solubility at 20 C Wt. %	0.015	Melting point, deg C	-95
		Molecular weight	106.16

Appearance & Odor: Clear, colorless liquid with an aromatic hydrocarbon odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air Volume %	LOWER	UPPER
59 F (15 C) (closed cup)	810 F (432 C)		1.0	6.7

Extinguishing media: Carbon dioxide, dry chemical or "alcohol" foam. A water spray may be ineffective to put out fire, but may be used to cool fire-exposed containers. A stream of water can spread fire of burning liquid.

This is a flammable liquid (OSHA Class IB) which can readily form explosive mixtures with air, especially when heated. Heavier-than-air vapors can flow along surfaces to reach distant ignition sources, and then flash back. Firefighters should use self-contained breathing equipment and eye protection to fight fires in enclosed places.

SECTION V. REACTIVITY DATA

This material is stable in storage in closed containers at room temperature. It does not polymerize.

This flammable material should be kept separated from oxidizing agents, strong acids and bases and ammonia. Thermal-oxidative degradation can produce toxic products, including carbon monoxide.

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SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm

Excessive exposure to vapors will irritate the eyes and mucous membranes of the upper respiratory tract. Sustained high levels can produce headache, depression of the central nervous system, narcosis and coma.

Liquid contact is irritating to the eyes and irritation and defatting to the skin, leading to dermatitis on prolonged or repeated exposures. Ingestion may lead to aspiration of liquid into the lungs small amounts of aspirated ethyl benzene cause extensive edema and hemorrhage of lung tissue. FIRST AID:

Eye contact: Wash eyes well with plenty of running water. Get medical help if irritation persists.

Skin contact: Wash exposed areas of skin. Promptly remove contaminated clothing.

Inhalation: Remove victim to fresh air. Restore breathing if necessary. Get medical help for serious exposure.

Ingestion: Get prompt medical help! (The danger of aspirating ethyl benzene into the lungs indicates medical direction before inducing vomiting.)

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Personnel involved in leak or spill control and clean-up must use protective equipment to avoid inhalation of vapors and contact with liquid. Eliminate ignition sources. Provide maximum explosion-proof ventilation.

Pick-up spilled material for recovery or disposal. Absorb with sand, etc. for disposal in a sanitary landfill or with paper towels or cloths for burning. Water can be used to flush liquid away from sensitive areas to special catch basins or ground, but not to sewer or surface water.

DISPOSAL: Scrap material can be burned in approved incinerators in accordance with Federal, State and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide expolosion-proof general and local exhaust ventilation to meet TLV requirements. Approved respirators must be available for non-routine or emergency use. A full face respirator with organic vapor cartridge can be used up to 1000 ppm; a gas mask with organic vapor canister can be used up to 5000 ppm. a self-contained respirator is needed for high and unknown concentrations of vapor.

Use impervious gloves and clothing and a face shield to prevent repeated or prolonged contact with the liquid. Where splashing is possible chemical goggles should be used. Clothing contaminated with ethyl benzene should be promptly removed and not reused until free of the contaminant.

Exposures above the action level, liquid contact, or working where fire and explosion hazards exist may require instituting employee training, medical surveillance, vapor concentration monitoring, record keeping, etc. when the proposed standard issues.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store this material in tightly closed containers in cool, well-ventilated areas, away from oxidizing agents, heat and sources of ignition. Use non-sparking tools around this material. Containers must be electrically bonded and grounded for transfers of liquid. Use safety cans for small amounts. No Smoking! where this material is stored or used.

Screen workers for history of kidney, liver, skin and lung problems which could give increased sensitivity and risk in ethyl benzene exposure.

Avoid breathing of vapors and contact with liquid. Do not ingest. Chronic properties are not fully known; use with care.

DATA SOURCE(S) CODE: 2-9, 11, 12

APPROVALS:	
MIS, CRD	J. M. Nida
Industrial Hygiene and Safety	
Corporate Medical Staff	G. F. Mantle M.D.

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 30A

HYDROCHLORIC ACID
Revision A

DATE June 1984

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: HYDROCHLORIC ACID
DESCRIPTION: This material is a water solution of hydrogen chloride gas.
OTHER DESIGNATIONS: Muriatic Acid, Concentrated Hydrochloric Acid, GE Material D4A3, CAS# 007 647 010, Aqueous Hydrochloric Acid
MANUFACTURER: Available from many suppliers.

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Hydrogen Chloride (HCl)	<38	8-hr TWA 5 ppm or 7 mg/m³ (C)*
Impurities (depends on acid grade)	Traces	
Water	Balance	
		Human, Inhalation TCLo 1300ppm/30 M
		Rabbit, Oral LD_{50} 900 mg/kg
		Rat, Oral (20°Be') LD_{50} 700 mg/kg
		Rabbit, Skin (20°Be') LD_{50} >5g/kg, 24 H-C

*Current OSHA PEL and ACGIH (1983) TLV Ceiling Level.

SECTION III. PHYSICAL DATA

	18°Be'	20°Be'	22°Be'	23°Be'
Weight % HCl	27.9	31.5	35.2	37.1
Boiling pt, 1 atm, deg F	208	182	144	123
Freezing point, deg F (approx)	-43	-63	-86	-101
Specific gravity, 60/60 F	1.142	1.162	1.179	1.189
Vap. Press., 25C, HCl/Total, mm Hg	∿7/15	∿25/33	∿87/92	∿186/190

All materials are completely water soluble with ∿100% volatiles and pH <1.
Appearance & Odor: Clear, colorless to lt. yellow, fuming* liquid with a pungent, irritating odor. 1-5 ppm HCl detected by smell; 5-10 ppm is disagreeable.
*Higher conc. tend to be fuming liquids at room temperature.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
N/A	N/A	N/A	-	-

Extinguishing media: Select that suitable for surrounding fire. Use a water spray to cool fire exposed containers to prevent rupture.
Nonflammable, but acid can react with many metals, such as iron, to produce flammable hydrogen gas. (Flammable conc. may accumulate inside metal equipment.) Neutralize acid with limestone, slaked lime or soda ash to minimize formation of potentially explosive hydrogen gas.
Firefighters should use full protective clothing and self-contained breathing apparatus when this material is involved in a fire situation.

SECTION V. REACTIVITY DATA

This material is stable when properly contained and handled. It is a strong mineral acid and is, thus, highly reactive with materials such as metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials. It is highly corrosive to many materials; it must have proper containment for handling and storage.
It liberates significant levels of HCl gas by vapor pressure at room temperature when concentrated and large amounts of HCl when heated.
Reaction with most metals will produce flammable hydrogen gas.
Incompatible with materials such as cyanides, sulfides, sulfites and formaldehyde (may release HCN, H_2S, SO_2, bischloromethyl ether, respectively).

GENIUM PUBLISHING

RSV 0021480

NO. 30A

SECTION VI. HEALTH HAZARD INFORMATION

TLV 5 ppm Ceiling Level (as HCl)

Aqueous HCl and its vapors are strong irritants of the eyes, mucous membranes, and skin. Severity of eye injury from splashes [from irritation to severe burns] depends on quantity, conc. and duration of contact. Excessive acute exposure to HCl vapors/mists promptly irritates the upper respiratory tract and can result in coughing, burning of the throat, choking sensation and, if inhaled deeply, pulmonary edema. Prolonged or repeated low level exposure may cause teeth erosion. Skin exposure can cause burns; repeated or prolonged exposure to dilute soln. may cause dermatitis. Ingestion can cause severe burns and possible laryngeal spasm. FIRST AID:

Eye Contact: Contact physician! Immediately flush with running water for 15 min. including under eyelids.

Skin Contact: Flush affected area well with water. Remove grossly contaminated clothing under safety shower. Get medical help if large skin area contacted or if irritation persists.

Inhalation: Remove to fresh air. Restore and/or support breathing as needed. Use O_2 therapy for coughing, difficult breathing. Get medical help. Keep warm and at rest.

Ingestion: If victim is conscious, give 2-3 glasses of water, then milk of magnesia or limewater. Contact physician! Do not induce vomiting!

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Report large spills to safety personnel. Evacuation may be needed; keep upwind. Remove sources of ignition if H_2 is a hazard. Provide optimum ventilation. Those involved in clean-up of large spills must use full protective clothing, boots, and self-contained breathing apparatus.

Small spills and residues can be covered with excess of a mixture of soda ash and slaked lime to neutralize, and the slurry picked up for landfill burial or flushed with much water.

Contain large spills. Collect or flush with water to holding area for neutralization. Do not flush directly to sewer or surface waters.

DISPOSAL: Dispose of acid via licensed contractor or neutralize with limestone, soda ash or slaked lime. Flushing to sewer depends on allowable neutral salt concentrations in effluent water. Follow Federal, State and Local regulations. Consider use of waste acid to neutralize alkaline wastes. EPA (CWA) RQ is 5000 lb.(40 CFR 117)

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide adequate exhaust ventilation to meet TLV requirements. Face velocity of hoods should exceed 100 lfm. Use approved respirator or self-contained breathing apparatus for emergency or non-routine conditions with full facepiece above 50 ppm.

Those handling hydrochloric acid should use protective clothing and equipment to prevent body contact with the liquid. Use rubber gloves or gauntlets, apron, boots, long sleeved shirt, body suit, etc. Use chemical safety goggles and/or face shield for eye protection against splashing of acid.

An eyewash station, washing facilities, and safety shower must be readily available to areas of use and handling.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store closed containers out of direct sunlight, in a clean, cool, open or well-ventilated area, away from oxidizing agents, away from alkaline material and sources of heat. Area should have acid resistant floor and approved drainage. Protect containers from physical damage. Use nonsparking tools in areas around tanks and pipes where hydrogen might be generated.

Use with good ventilation. Avoid inhalation of HCl vapors. Odor of HCl gives adequate warning for a prompt voluntary withdrawal from excessive exposure. Do not get in eyes or on skin or clothing. Wash thoroughly after handling.

Provide emergency neutralization materials and equipment near storage and use areas.

DOT Classification: CORROSIVE MATERIAL I.D. No. UN1789 Label: CORROSIVE
IMO Class 8

DATA SOURCE(S) CODE: 1-12,14-16,27,31,34,37,38,47-49

APPROVALS: MIS/CRD J. M. Nielsen

INDUST. HYGIENE/SAFETY 6-7-84

MEDICAL REVIEW: 15 June 1984

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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From Genium's MSDS Collection, to be used as a reference.

MSDS # G 354
METHYL ALCOHOL
Revision C

Issued:
Revised: September, 1985

SECTION 1. MATERIAL IDENTIFICATION

17

MATERIAL NAME: METHYL ALCOHOL
OTHER DESIGNATIONS: Methanol, Wood Alcohol, Carbinol, Wood Naphtha, Methyl Hydroxide, Monohydroxy Methane, CH_3OH, CAS #67-56-1
MANUFACTURER/SUPPLIER: Available from several suppliers, including; E.I. DuPont DeNemours & Co. (302- 774-2290
Chemicals & Pigments Dept (800) 441-9442
1007 Market St. Wilmington, DE 19898

SECTION 2. INGREDIENTS AND HAZARDS	%	HAZARD DATA
METHYL ALCOHOL CH_3-OH • Current OSHA Standard; ACGIH (1985-86) TLV adds (skin) notation. NIOSH has recommended a TWA standard of 200 ppm with a fifteen minute ceiling of 800 ppm. This ceiling is well above the TLV STEL of 250 ppm.	ca 100	8 hr TWA: 200 ppm, or 260 mg/m^3* (Skin) STEL: 250 ppm, or 310 mg/m^3 HUMAN Eye: 5 ppm, primary irritation dose Oral: LDLo: 340 mg/kg Inhalation: TCLo: 86,000 mg/m^3 - Toxic irritant effects (systemic)

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ..... 148.5°F (64.7°C)
Vapor density (Air=1) 1.11
Vapor pressure @ 21°C, mmHg ... 100
@ 50°C, mmHg ... 400
Water Solubility ..... Totally Miscible
Viscosity @ 20°C, cps 0.59
Specific gravity, 20°/4°C ... 0.791
Melting point ..... -144°F (-97.8°C)
Volatiles, % ..... ca 100
Evaporation rate (BuAc=1) ... 5.9
Molecular weight 32.04

APPEARANCE & ODOR: Clear, colorless, highly polar liquid with a characteristic alcohol odor. The odor recognition threshold (100% of test panel) is 53.3 ppm

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
60.8°F (12°C) Closed Cup	725°F (385°C)	% by Volume	6	36.5

EXTINGUISHING MEDIA: Use carbon dioxide, dry chemical, or alcohol type foam. Do not use a solid stream of water since the stream will scatter and spread the fire. Use water spray to cool fire-exposed tanks/containers. Fires involving Methyl Alcohol are Class IB; use a blanketing effect to smother fire.
Methyl Alcohol is a moderate explosion hazard and a dangerous fire hazard when exposed to heat, sparks, flame or oxidizers. Its vapors are heavier than air and may travel a considerable distance to an ignition source and flashback. Firefighters should wear self-contained breathing apparatus and full protective clothing when fighting fires involving Methyl Alcohol.

SECTION 5. REACTIVITY DATA

Methyl Alcohol is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material may react violently with chromic anhydride; iodine plus ethyl alcohol, and mercuric oxide; lead perchlorate; perchloric acid plus ethyl alcohol; dimethyl formamide plus phosphorous; potassium hydroxide plus chlorloform; sodium hydroxide plus chloroform. It may also react with metallic aluminum at high temperatures.
Methyl Alcohol is incompatible with strong oxidizing agents (eg., nitrates, perchlorate or sulfuric acid), active metals, acetaldehyde, ethylene oxide, isocyanates, beryllium dihydride, chloroform, and potassium tert-butoxide. It may attack some forms of plastics and rubber. Thermal decomposition or burning will produce carbon monoxide, carbon dioxide and possible toxic formaldehyde and unburned methanol.

RSV 0021482

Revised: 9/85

MSDS # G 354, Issued _____ METHYL ALCOHOL (Rev. C)

SECTION 6. HEALTH HAZARD INFORMATION

TLV 200 ppm (skin) or 260 mg/m^3

Methanol is a poisonous, narcotic chemical that may exert its effects through inhalation, skin absorption, or ingestion. Elimination of Methanol from the body is slow, and the toxic effects can be compounded by repeated excessive exposures over several days. Toxic effects are exerted upon the CNS, especially the optic nerve and possibly the retinae. Symptoms of overexposure include dizziness, visual impairment, nausea, respiratory failure, muscular incoordination and narcosis. Visual disturbances may clear temporarily then reoccur and progress to blindness. Prolonged or repeated contact with the skin may cause dermatitis, erythema, and scaling. Vapors of Methanol are mildly irritating to the eyes, while direct contact with the liquid may cause irritation, pain and transient corneal opacity. Ingestion of Methanol can cause blindness and death. The fatal dose is 100-250 ml, although death from ingestion of less than 33 ml has been reported.
FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with plenty of running water for at least 15 minutes. Get medical attention if irritation persists. SKIN CONTACT: Flush exposed area with water while removing contaminated clothing. Wash with soap and water. Get medical attention if irritation persists. INHALATION: Remove victim to fresh air. Restore and/or support breathing as needed. Get medical help (Inplant Paramedic, community). INGESTION: Give victim 3-4 glasses of water or milk and induce vomiting by sticking finger to back of throat. Contact a Poison Control Center or physician. Transport victim to a medical facility immediately. Do not induce vomiting or give anything to drink if victim is unconscious or having convulsions. Get medical attention (Inplant, paramedic, community).

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate all personnel from the area except for those involved in clean-up. Remove leaking container to safe place if feasible. Clean-up personnel should wear protective clothing, gloves, boots, and a self-contained breathing apparatus. Absorb small quantities on paper towel, vermiculite, or other absorbent and place in closed container for disposal. Dike large spills and collect for reclamation or disposal. Water spray may be used to knock down vapor and to dilute and flush spill away from sensitive areas. Do not flush to sewer. Keep out of watersheds and waterways.
DISPOSAL: Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Waste solvent may be reclaimed via filtration and distillation procedures. Methyl Alcohol has been designated as a hazardous waste by the EPA (RCRA CFR 261.33). The EPA Hazardous Waste No. is U154. Aquatic Toxicity Rating: TLm96: Over 1000 ppm.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion-proof) to meet TLV requirements. For emergency or non-routine exposures where the TLV may be exceeded, wear an appropriate NIOSH-approved respirator. All electrical service in use or storage areas should have an explosion-proof design.
Prevent skin and eye contact by wearing rubber gloves and splash goggles or safety glasses. Use protective aprons, boots and face shield as necessary when splashing may occur.
Eyewash stations and safety showers should be available in areas of use and handling. Provide suitable training to those working with Methanol. Monitor the workplace and keep accurate records.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed containers in a dry, well-ventilated area away from strong oxidizing agents, heat, sparks and open flame. Protect container from physical damage. When transferring or pouring Methyl Alcohol, ground and bond containers and equipment to prevent static sparks. Use non-sparking tools.
Do not smoke in areas of use or storage. Use with adequate ventilation. Do not breathe vapors. Avoid contact with eyes and skin. This material is poisonous when introduced into the body metabolism. DO NOT INGEST!!!
Provide preplacement medical exams and periodic medical surveillance for industrially exposed workers with emphasis on neurological and visual functions, liver, and kidney systems.
DOT CLASSIFICATION: Flammable liquid, UN1230 DOT LABEL: Flammable liquid.

DATA SOURCE(S) CODE (See Glossary) 1, 2, 4-12, 16, 19, 20, 23-26, 31, 34, 37-39, 43, 47, 63, 79. R.

APPROVALS [signature] 11/85

INDUST. HYGIENE/SAFETY [signature] 11-85

MEDICAL REVIEW: [signature] Dec 85

GENIUM PUBLISHING

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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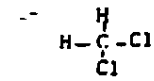
MSDS # G 310
METHYLENE CHLORIDE
Revision E
Issued:
Revised: September, 1985

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: METHYLENE CHLORIDE (Revision E)
OTHER DESIGNATIONS: Dichloromethane, FREON 30, Methane Dichloride, CH_2Cl_2; CAS#75-09-2.
MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Dow Chemical USA
2020 Dow Center
Midland, MI 48640
(517) 636-1000

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
METHYLENE CHLORIDE 	ca 100	8 hr TWA: 100 ppm or 350 mg/m³*
		Human, Inhalation: TCLo: 500 ppm/8 hr. (Blood effects)
		TCLo: 500 ppm/ 1 year-I (CNS effects)
		Rat, Oral: LD50: 2000 mg/kg

* ACGIH TLV/TWA (1985-86). OSHA PEL is 500 ppm with a ceiling of 1000 and a permissible peak exposure of 2000 ppm for 5 minutes per any two-hour period.

NIOSH recommends a 10 hr. TWA or 75 ppm with a ceiling concentration of 500 ppm (15 minute TWA). NIOSH also warns that toxic hazards associated with exposure to methylene chloride are increased by the presence of alcohol and/or carbon monoxide and by heavy labor and smoking.

SECTION 3. PHYSICAL DATA

Boiling point, 1 atm	104°F (40°C)	Specific gravity, 25/25C	1.32
Vapor pressure @ 20°C, mmHg	340	Volatiles, %	ca 100
Vapor density (Air=1)	2.9	Evaporation rate (CCl_4=1)	1.47
Solubility in water, wt. % @ 20°C	~1.6	Freezing point	-140.8°F (-96°C)
		Molecular weight	84.94

APPEARANCE & ODOR: Colorless liquid with a penetrating ether-like, sweetish odor. The unfatigued recognition threshold for 100% of test panel is 214 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
None (T.C.C.)	1031°F (555°C)	Vol % at 100°C in O_2	12	66.4

EXTINGUISHING MEDIA: Use extinguishing media that are appropriate for the surrounding fire. Use water spray to cool fire-exposed tanks/containers. When heated, methylene chloride forms weakly combustible mixtures in air. It will form flammable and explosive mixtures in an oxygen-enriched atmosphere. Methylene chloride has a high vapor pressure; when spilled, its vapor concentration in air may increase rapidly. Containers of methylene chloride may rupture violently during a fire.

Firefighters should wear self-contained breathing apparatus with face piece and full protective clothing. Vapors of methylene chloride can flow to low-lying areas.

SECTION 5. REACTIVITY DATA

This material is stable at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. Methylene chloride is incompatible with alkali metals including sodium-potassium alloy, finely powdered aluminum and magnesium, n-Methyl-n-nitroso-urea, and potassium hydroxide, and potassium tert-butoxide. Contact with these materials may cause violent reaction or explosion. Prolonged exposure to water may cause noticeable hydrolysis to highly corrosive hydrochloric acid when temperature is above 60°C. Avoid contact with oxidizing agents and caustics. In organic-enriched atmospheres or when heated (>100°C) vapors may be readily ignited. Exposure to high temperatures (from open flames, hot surfaces, welding arcs, etc.) can produce corrosive and toxic thermal oxididative decomposition products such as hydrogen chloride and small quantities of phosgene.

Revised: 9/85

MSDS # G 310 Issued _____ METHYLENE CHLORIDE (Rev. E)

SECTION 6. HEALTH HAZARD INFORMATION

TLV 100 ppm (see Section 2)

Methylene Chloride enters the body mainly by inhalation and skin absorption. Vapors of methylene chloride are narcotic and may cause toxic encephalopathy. Excessive inhalation of vapor (300-700 ppm for 3-5 hrs.) causes slight loss of coordination and equilibrium. Symptoms of overexposure can also include dizziness, nausea, tingling of extremities, stupor, lethargy, convulsions and diminished vision. Severe exposures may cause unconsciousness and death. Symptoms of overexposure to methylene chloride are usually delayed in onset. The liquid is irritating to the eyes and may cause burns if not promptly removed. Prolonged or repeated contact with the skin may cause redness, irritation, dermatitis, frostbite or burns. It may be absorbed through the skin in toxic amounts. Ingestion of methylene chloride causes irritation of the gastrointestinal tract and symptoms resembling those from inhalation of vapor. Long-term exposure to mild or moderate doses of methylene chloride may cause delayed onset (24-48 hrs.) of dizziness, headache, mental confusion, slurred speech, double vision and sleeplessness. Medical recovery may be slow. NOTE: Methylene chloride is stored in body fat and metabolizes to carbon monoxide, which increases and sustains carboxyhemoglobin levels in the blood, reducing its oxygen-carrying capacity. It may damage the liver, kidneys, or blood. Alert medical attendants to its secondary hazard.

FIRST AID: EYE CONTACT: Promptly flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists (in-plant, paramedic, or community). SKIN CONTACT: Flush exposed area with water while removing contaminated clothing. Get medical attention if irritation persists. INHALATION: Remove to fresh air. Restore and/or support breathing (O_2 therapy) as required. Keep warm and at rest. Get medical help. Advise physician not to use adrenalin. INGESTION: Get prompt medical help! Do not induce vomiting. If vomiting occurs spontaneously, position victim's head below trunk to resist aspiration hazard. Advise physician not to use adrenalin.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate all personnel from the area except for those involved in clean-up. Remove leaking container to safe place if feasible. Absorb small spills with an absorbent material such as paper towel or vermiculite. Evaporate off solvent in an exhaust hood and place absorbent in a closed container for disposal. Dike large spills and collect for recovery or disposal. Pick up residue with absorbent (as with small spills) or flush to ground (not to sewer) to evaporate. Clean-up personnel should wear respiratory equipment and protective clothing to prevent inhalation of vapor and contact with skin/eyes. DISPOSAL: Reclaim waste solvent by filtration and distillation procedures. Place in closed containers for disposal by a licensed contractor, or burn in an approved incinerator.

Methylene chloride is designated as a hazardous waste by the EPA. The EPA (RCRA) H.W. No. is U080 (40CFR261).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion-proof) to meet TLV requirements. Floor level ventilation and sump ventilation may also be necessary. For emergency or non-routine exposures, wear an appropriate NIOSH-approved respirator. All electrical service in use or storage areas should have an explosion-proof design. When handling liquid, wear neoprene, PVA, or vitron gloves and safety glasses. In case of leak or spill or unusual handling where repeated or prolonged contact may occur, use protective clothing, apron, boots, and splash goggles or face shield as necessary. Remove contaminated clothing promptly and do not reuse until it has been properly laundered. Eye wash stations and safety showers should be readily available in use and handling areas. Contact lenses pose a special hazard; soft lenses absorb; all lenses concentrate irritants. NOTE: CO and CH_2Cl_2 content of workplace air are additive and both must be monitored where methylene chloride exposures occur. Preplacement and annual physical exams should emphasize the nervous and respiratory systems liver, kidneys, skin, eyes and carboxyhemoglobin levels. Those with a history of cardiovascular disease or who are heavy drinkers or smokers should avoid exposure to this material.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from combustibles and sources of heat and ignition. Open containers slowly and with caution. Protect containers from physical damage. Keep containers and storage tanks free of water and moist air. Be careful when handling this compound. Use only with adequate ventilation. Don't breathe vapors. Avoid contact with eyes, skin and clothing. When methylene chloride vapors are drawn into the combustion chamber of a space heater, severe corrosion damage to the heater can occur, even at levels well below the TLV. LARC Review (1979) listed animal carcinogenic determination as indefinite. A substantial risk notice to EPA (TSCA, 8e) reports a high incidence of lung and liver tumors in mice in long-term inhalation studies at 2000-4000 ppm (1984, preliminary).

DOT CLASSIFICATION: ORM-A DOT I.D. No. UN1593 LABEL: None (or St. Andrew's Cross)

IMO CLASS: 6.1

DATA SOURCE(S) CODE (See Glossary) 1-12, 14, 16, 23, 25, 31, 34, 37, 38, 47, 48.R.

APPROVALS JOA Approved, 11/85

INDUST. HYGIENE/SAFETY [signature] 11-85

MEDICAL REVIEW: [signature] Dec 85

GENIUM PUBLISHING

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NO. 1156

NEU-TRI SOLVENT

Date September 1978

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: NEU-TRI SOLVENT
DESCRIPTION: Trichloroethylene with up to 3% of proprietary stabilizer mixture
OTHER DESIGNATIONS: Stabilized Trichloroethylene; TCE, Stabilized; GE Material D5B56D, CAS# 000 079 016
MANUFACTURER: Dow Chemical Company
Midland, MI 48640 Telephone: (517) 636-4400

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Trichloroethylene (See also MSDS# 312)	>95	8-hr TWA 100 ppm**
Proprietary Stabilizer Mixture*	< 3	None established
*Stabilizer includes several compounds, including amines and epoxies; epichlorohydrin (ACGIH, 1978, TLV change to 2 ppm) is present at less than 0.5% in this blend.		TCE Human, inhalation TCLo 160 ppm/83 minutes (central nervous system)
**NIOSH (1978) has requested OSHA to lower this exposure level because of evidence of a potential carcinogenic hazard to man. TLV of 25 ppm was indicated as readily achievable.		

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C	87	Specific gravity at 25 C	1.46
Vapor pressure at 20 C, mm Hg	66	Volatiles, %	ca 100
Vapor density (Air=1)	4.5	Evaporation rate (CCl_4=1)	ca 0.7
Solubility in water at 25 C, g/100 g	0.1		

Appearance & Odor: A colorless liquid with a sweet, ether-like odor

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None	788 F	Volume % at 100 C	7.8	32

Extinguishing media: Water fog
This material is generally considered noncombustible; however, at vapor temperatures above 50 C in air it can be made to burn.
Firefighters must use self-contained breathing apparatus when this material is involved in a fire situation.

SECTION V. REACTIVITY DATA

This material is stable under normal conditions of handling and storage. The stabilizer content is required against oxidation, degradation and polymerization when heated (as in a vapor degreaser) or exposed to sunlight. High energy exposure, such as a welding arc or open flame can generate phosgene (toxic) and HCl.
It will react with strong alkali (KOH or NaOH) to form explosive chloroacetylene, but soda ash does not react in this manner.
Aluminum chloride can catalyze the polymerization of trichloroethylene.

GENIUM PUBLISHING

SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm (See Sect. II)

Excessive inhalation causes irritation of respiratory passages and can produce headache, dizziness, nausea, unconsciousness and even death. Eye exposure to vapor can be irritating and to liquid is irritating and causes minor corneal injury. Prolonged or repeated contact with the skin produces irritation and dermatitis. Direct, confined skin contact can cause burns. Ingestion irritates the GI tract and produces narcosis; unconsciousness and kidney failure can occur in severe cases. FIRST AID:

Eye contact: Flush immediately with plenty of running water. Continue washing eyes for at least 15 minutes; then get prompt medical attention.

Skin contact: Promptly remove contaminated clothing. Wash exposed areas with soap and water.

Inhalation: Remove to fresh air; restore breathing if required. Keep at rest and warm. Immediately consult physician. (Advise him not to give adrenalin.)

Ingestion: Do not induce vomiting! Get immediate medical help. (Warn physician not to use adrenalin.)

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Evacuate area; provide maximum ventilation; eliminate ignition sources. Confine spill; do not allow to run to sewer. Pick up spill with vacuum or an absorbent solid and store in closed container for disposal. Notify safety personnel for large spills. Clean-up personnel should use protection against inhalation of vapors and contact with liquid.

DISPOSAL: Send to a reclaimer to recover TCE, or dispose of adsorbed material in an approved landfill, or burn waste in an approved incinerator with HCl scrubber. Follow Federal, State and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and local exhaust ventilation to meet TLV requirements. Do not use in confined area without proper ventilation or respirator use. Approved respirators should be available for emergency and non-routine use. Above 1000 ppm or for unknown concentrations use approved self-contained or air-supplied breathing apparatus. Use full facepiece cartridge (1-2 hrs max) or cannister respirator for exposures above the TLV or ceiling limit (300 ppm for 5 minutes in any 2 hours).

Prevent prolonged or repeated skin contact by use of neoprene gloves and, where splashing is possible, an apron. Use splash-proof goggles for eye protection. Gas-tight goggles should be used by maintenance and emergency personnel. An eye wash station should be available where splashing is probable.

Provide adequate ventilation to sumps and low areas to disperse any collection of heavy TCE vapor.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a cool, dry, well-ventilated place away from high temperature sources. No smoking in storage or use areas. Store away from strong acids or bases.

Only trained personnel should operate a degreaser with this material. Monitor stabilizer level (see supplier). Avoid collecting aluminum fines or chips in a vapor degreaser.

TCE continues to be under study as a suspected carcinogen in man. Exercise due caution in use. Avoid skin contact. Avoid breathing vapors. Preclude from exposure those with prior disease of the lungs, liver, kidneys, or central nervous system. Medical surveillance and biological monitoring is recommended.

DATA SOURCE(S) CODE: 1-4, 6, 8, 12

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

Corporate Medical Staff George F. Mantella MD

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

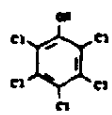
NO. 517

PENTACHLOROPHENOL

DATE October 1983

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: PENTACHLOROPHENOL
DESCRIPTION: Wood preservative and fungicide, algacide in cooling towers.
OTHER DESIGNATIONS: PCP, Phenchlorol, Penta, CAS #000 087 865, C_6Cl_5OH
MANUFACTURER: Available from several suppliers.



SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Pentachlorophenol (Purified)*		8-hr TWA 0.5 mg/m^3 (skin)**
Composition varies with each industrial batch. PCP is about 90% for commercial material with major impurities tetrachlorophenol and hydroxychlorodiphenyl ethers. Low level contamination by certain chlorinated dioxins and dibenzofurans may be responsible for some toxic effects of commercial PCP, such as chloroacne.		Human, Oral LDLo 29 mg/kg
*Current OSHA PEL and ACGIH (1983) TLV. The ACGIH STEL is 1.5 mg/m^3. *2,3,7,8-TCDD is not a contaminate.		Rat, Oral LD_{50} 50 mg/kg
		Rat, Inhalation LD_{50} 1170 ug/kg
		Rat, Oral, 9D preg. TDLo 60 mg/kg TFX:TER

SECTION III. PHYSICAL DATA

Boiling point, 1 atm deg C (decomposes)	310	Specific gravity, 22/4C	1.978*
Vapor pressure, mm Hg @ 20C	0.0001	Melting point, deg C	191*
@ 100C	0.12	Molecular weight	266.35
Vapor density (Air=1)	9.2	Log octanol/water partition coeff.	5.01
Solubility in water, ppm @ 20C	14		

Appearance and Odor: White flake, needle-like crystals or block form; pungent odor only when hot. (Technical grades dark grey to brown). Good warning properties (irritation of eyes and nose) at 1 mg/m^3.
*Purified PCP. Values for typical commercial products can be SG1.85 and m.p. 188-189C

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
None*		Not combustible*		

Extinguishing media: Use that appropriate for surrounding fire: Dry chemical, carbon dioxide, foam, water spray. Use water spray to cool fire-exposed containers. When involved in a fire, it emits toxic fumes.
Firefighters should wear self-contained breathing apparatus and full protective clothing.

*The neat material is not combustible. However, wood treating is preformed using 5% PCP soln. in petroleum solvents (mineral spirits, kerosine) which are combustible.

SECTION V. REACTIVITY DATA

This is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not polymerize.
A weak acid which forms salts in alkaline solutions.
Solutions subjected to sunlight or ultraviolet light undergo photochemical degradation.
Thermal-oxidative degradation products include vapors of hydrogen chloride and chlorine-containing compounds.

GENIUM PUBLISHING

NO. 517

SECTION VI. HEALTH HAZARD INFORMATION

TLV 0.5 mg/m^3 (skin) (See Sect II)

Unacclimated individuals exposed to dust or sprays (conc. >1.0 mg/m^3) can experience irritation to the upper respiratory tract (coughing & sneezing), eyes (tearing) and skin. Readily absorbed through the skin causing systemic injury. The risk of serious intoxication is increased in hot weather. Skin contact causes irritation, dermatitis, and acneform (believed mainly from impurities in PCP). Solutions as dilute as 1% can cause skin irritation upon prolonged or repeated contact. Symptoms from excessive exposure include anorexia, fever, profuse sweating, increased respiration, muscular weakness, hyperglycemia, weight loss and heart failure.

FIRST AID:

Eye Contact: Flush thoroughly with running water for 15 min. including under eyelids.

Skin Contact: Remove contaminated clothing! Wash affected area with soap and water.

Inhalation: Remove to fresh air.

Ingestion: Give several glasses of water to drink. Induce vomiting. Control rising body temp. with ice-cold towels or cold water bath.

Get prompt medical help for further treatment, observation and support after first aid.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel. Provide ventilation. Clean-up workers need full protection against inhalation of vapors and contact with solid or solution. Collect solution spill with absorbent solid and place in metal container for disposal. Wash residue with soap and water. Prevent spills from entering sewers, streams, and open waters.

DISPOSAL: Waste material can be buried in an approved landfill or dissolved in a flammable solvent, and burned in an approved, high temperature (>600C) incinerator using an afterburner and scrubber for HCl abatement. Follow Federal, State, and Local regulations.

EPA(CWA) RQ is 10 lbs (40 CFR 117); EPA(RCRA) HW No. U242 (40CFR261).

AQUATIC TOXICITY TLm 24 (fathead minnow): 0.33 mg/L

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. When needed a chemical cartridge respirator with a dust, mist and fume filter and organic vapor cartridge can be used to 25 mg/m^3; a full facepiece is needed >2.5 mg/m^3. Approved, self-contained, positive pressure, breathing apparatus can be used to 150 mg/m^3.

Use impervious gloves, boots, protective clothing, etc. to avoid skin contact with liquid. Use chemical safety goggles with a faceshield if splashing is possible. Contaminated clothing to be removed and laundered before reuse. Showering after workshift with a complete change to street clothes is desirable. Use separated lockers for street clothes.

Eyewash stations and washing facilities should be available near use areas.

Preplacement and periodic physical exams should emphasize cardiovasular system, eyes, upper respiratory tract, liver, kidneys and skin. Provide training to those working with PCP.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated, low fire hazard area away from sources of heat and combustible materials. Protect containers from physical damage. Outside or detached storage preferred. Accumulated sludge at the bottom of dipping tanks may concentrate toxic impurities at much higher levels than original product.

Avoid inhalation of vapors, dust or fumes. Avoid eye or skin contact. Do not ingest.

Wash thoroughly after handling and follow good personal hygiene practices.

PCP can be embryotoxic and teratogenic in test animals. No safe exposure level for pregnant women is established at this time. (See AIHA Journal 43, pp 799-810, 1982).

DOT Classification: ORM-E I.D. No. NA2020 Label: POISON

DATA SOURCE(S) CODE: 2-14,16,20,23,27,31,34,37,38,46-49; DHHS(NIOSH) Publ. #83-106.

APPROVALS: MIS/CRD J. M. Nielsen

INDUST. HYGIENE/SAFETY [signature] 9-8-83

MEDICAL REVIEW: 17 September 1983

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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From Genium's MSDS Collection, to be used as a reference.

MSDS # G 365
PHENOL (Revision B)

Issued: September, 1980
Revised: September, 1985

SECTION 1. MATERIAL IDENTIFICATION

17

MATERIAL NAME: PHENOL

OTHER DESIGNATIONS: Carbolic Acid, Hydrobenzene, Oxybenzene, Phenic acid, Phenyl Hydrate, Phenyl hydroxide, Phenylic acid, Phenyl alcohol, CAS #000 108 952, C_6H_5OH

MANUFACTURER/SUPPLIER: Available from many suppliers, including:

Dow Chemical USA
2020 Dow Center
Midland MI 48640 (517) 636-1000

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
PHENOL 	ca 100	8 hr TWA: 5 ppm, 19 mg/m^3 (Skin) STEL: 10 ppm, 38 mg/m^3* Human, Oral LDLo: 140 mg/kg Rat, oral LDLo: 414 mg/kg Rat, skin LD50: 669 mg/kg

* Current OSHA PEL and ACGIH TLV/STEL (1984-85) (Skin) notation indicates a potential contribution to overall exposure via absorption through the skin.

NIOSH recommends a 10 hr. TWA of 20 mg/m^3 with a ceiling of 60 mg/m^3 for any 15 minute period.

SECTION 3. PHYSICAL DATA

Boiling Point @ 1 atm ..... 359.4°F (181.9°C)
Vapor pressure @ 25°C 0.35
Vapor density (Air=1) 3.24
Solubility in water (% by wt.) ... 8.4 @ 20°C
(Sol. in all proportion @ temp. >66°C)

Specific Gravity (H_2O=1):
Solid: 1.017 @ 25/4°C
Liquid: 1.0576 @ 41/4°C
Melting point ..... 109.4°F (43°C)
Volatiles, % by vol @ 20°C .. ca 100
Evaporation rate (BuAc=1) ... <0.03
Viscosity, CPS, @ 80°C 1.51
Molecular weight 94.12

APPEARANCE & ODOR: White crystalline solid with a characteristic sharp medicinal sweet, tangy odor which is detectable above 0.05 ppm. Phenol turns pink or red if it contains impurities or if it is exposed to heat or light.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
175°F (79°C) C.C.	1319°F (715°C)	% by volume	1.5	8.6

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, or alcohol type foam. Do not use a solid stream of water since the stream will scatter and spread the fire. Use water spray to cool fire-exposed tanks/containers. Phenol presents a moderate fire hazard when exposed to heat, flame, or oxidizers. When heated, it remits toxic fumes and vapors which will form explosive mixtures with air. Solid phenol burns with difficulty, giving off a heavy smoke.

Firefighters should wear self-contained breathing apparatus and full protective clothing when fighting fires involving phenol. NOTE: Water containing phenol can cause severe chemical burns.

SECTION 5. REACTIVITY DATA

This material is stable at room temperature under normal handling and storage conditions. It does not undergo hazardous polymerization. Phenol is incompatible with strong oxidizing agents and halogens. Reaction with calcium hypochlorite is exothermic and produces toxic fumes which may ignite. Hot phenol is corrosive to many metals, including aluminum, lead, magnesium, and zinc. Reaction with these materials causes phenol to become discolored. Do not heat phenol above 122°F (90°C).

Thermal decomposition or burning produces oxides of carbon and water.

Revised 9/85

MSDS # G 355 Issued 9/80 PHENOL (Rev. B)

SECTION 6. HEALTH HAZARD INFORMATION

TLV 5 ppm or 19 mg/m^3 (Skin)

Phenol is a general protoplasmic poison which is corrosive to body tissue. Poisoning can occur via skin absorption, vapor inhalation, or ingestion. Vapors of phenol are irritating to the eyes, nose, and throat. The liquid is rapidly absorbed through the skin. Contact with the skin causes a white wrinkled discoloration followed by a severe burn or systemic poisoning if not properly removed. Intense burning and pain from skin contact may be delayed. Absorption of phenol through skin may cause sudden collapse, or death. Symptoms develop rapidly. When ingested, phenol causes burning of the gastrointestinal tract, and blotches on the lips and in the mouth. Headache, nausea, dizziness, dyspnea, shock, convulsions, and death may follow exposures by any route. Chronic exposure to low concentrations of phenol may cause digestive disturbances, nervous disorders, skin eruptions, and death due to liver and kidney damage. The TLV is set to prevent systemic poisoning.

FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with copious amounts of running water for at least 30 minutes. Get medical attention! (Inplant, community, paramedic). SKIN CONTACT: Immediately flush skin for at least 30 minutes while removing contaminated clothing and shoes. Get medical attention! INHALATION: Remove victim to fresh air. Restore and/or support breathing as necessary. Keep person warm and quiet. Transport to a medical facility. INGESTION: Give victim large quantities of milk or water as quickly as possible. Induce vomiting by touching back of throat with finger. Do not give fluids or induce vomiting if victim is unconscious or is having convulsions. Contact a physician or Poison Control Center and transport to a medical facility.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate all personnel from area, except for those involved in clean-up. Close the leak immediately, if possible. Absorb small spills on paper, vermiculite or other absorbent and place in a closed metal container for disposal. Dike large spills and allow material to cool and solidify. Shovel solid into steel containers for disposal. Flush spill area thoroughly with water and collect flushings and wash water for disposal. Do not allow phenol to enter sewer, watersheds, or waterways! Notify proper authorities including the National Response Center (800-424-8802). Clean-up personnel must wear a self-contained breathing apparatus and full personal protective clothing and equipment. DISPOSAL: Burn contaminated waste in an approved incinerator. Phenol may be recovered by charcoal absorption, solvent extraction or steam stripping. A concentration of 1% by weight is required for economical recovery. Phenol is water soluble and is amenable to biological or chemical oxidation. Solutions can be chemically oxidized by chlorine, chlorine dioxide, or other oxidants. Phenol content of water supply not to exceed 0.001 mg/L. (DO NOT flush phenol down drains.) RCRA Hazardous Waste # U188 Reportable Spill Quantity ... 1000 lbs.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion-proof) to meet TLV requirements. When phenol is heated, vapor inhalation can be a serious hazard without proper precaution. For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH-approved full face respirator. Fume hoods should maintain a minimum face velocity of 100 lfm. All electrical service in use or storage areas should have an explosion-proof design.

DANGER! Avoid any contact with this material. Full protective equipment, including splash goggles, faceshield, impervious gloves, apron, boots, impervious shirt and trousers, hard hat with brim, acid suit and respirator should be available and worn as appropriate. Remove contaminated clothing immediately and do not reuse until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from heated surfaces, open flame and ignition sources. Outside or detached storage is preferred. Protect containers from physical damage.

Phenol is a very dangerous compound. Do not breathe vapor or allow liquid to come in contact with the skin. Wear appropriate protective equipment and remove contaminated clothing immediately. Use extreme caution when transporting phenol to prevent leaks. Vent containers before heating and do not heat above 140°F (60°C). Do not eat or smoke in areas where this material is being used or handled. Do not allow employees who have diseases of the central nervous system, liver, kidney, or lungs to work in area of phenol exposure. Provide preplacement and periodic medical exams to employees working with phenol. Do not allow untrained workers to handle this material (see also ASTM D2286-Sampling and Handling Phenol).

ICC & DOT - Class B Poison. LABEL: POISON

DATA SOURCE(S) CODE (See Glossary) 2-12, 15, 19, 23-24, 31, 34, 37, 38, 59, 79, R.

APPROVALS

INDUST. HYGIENE/SAFETY 11-85

MEDICAL REVIEW: Dec 85

GENIUM PUBLISHING

Material Safety Data Sheet

Genium Publishing Corporation
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No. 168

POTASSIUM DICHROMATE

Issued: January 1986

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: POTASSIUM DICHROMATE

Salt;

POTASSIUM DICHROMATE, $K_2Cr_2O_7$ NIOSH recommends a TWA of 0.025 mg/m^3 and a ceiling of 0.050 mg/m^3, as Cr (VI). Note: Purity level may vary with grade. Check supplier's specifications for exact composition information.	>99	ACGIH TLV (1985-86) 8-hr TWA: 0.05 mg/m^3 as Cr (VI) --- OSHA PEL Ceiling 0.1 mg/m^3 --- Oral, Dog, LDLo: 2829 mg/kg --- Oral, Guinea Pig, LDLo: 163 mg/k --- Oral, Child, LDLo: 26 mg/kg

SECTION 3. PHYSICAL DATA

Melting Point ... 748.4°F (398°C)
Specific Gravity @ 25°C ... 2.676
Solubility in Water, @ 0°C ... 4.9 g/100c
@ 100°C ... 102 g/100cc

pH of Aqueous Solution, 1% ... 4.0
10% ... 3.6
Boiling Point ... 932°F (500°C) (Decomposes)
Vapor Pressure @ 25°C ... Negligible

Appearance and odor: Bright orange-red crystals. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Applicable	Not Applicable	Not Applicable		

Potassium Dichromate is an oxidizing agent and can promote and intensify combustion, particularly when heated. Flood fires with water (if water is a suitable extinguisher for burning material). Prevent runoff to sewers and waterways.

Fire fighters should wear self-contained breathing apparatus and full protective gear.

SECTION 5. REACTIVITY DATA

Potassium dichromate is stable at room temperature. It does not polymerize. It decomposes at 932°F (500°C) with the evolution of oxygen and formation of chromium oxide and potassium chromate.

This material is a strong oxidizing agent. Contact with reducing agents and flammable and combustible materials (paper, wood, organics, metals) can cause ignition, particularly when heated. It reacts explosively with hydrazine and hydroxylamine.

No. 168 1/86 POTASSIUM DICHROMATE

SECTION 6. HEALTH HAZARD INFORMATION TLV

Inhaling dichromate dust and mist can irritate the nose, throat, bronchial tubes, and lungs. Prolonged or repeated exposure may result in ulceration and perforation of the nasal septum. Kidney and liver damage have also been reported. Skin contact is associated with both contact dermatitis and allergic skin rashes. Ulceration of the skin ("Chrome ulcers") may also occur, especially if the skin is broken. Increased incidence of respiratory cancer have been reported in the chromate-producing industry. The IARC has classified "chromium and certain chromium compounds" as being carcinogenic to humans. The specific chromium compounds responsible for the carcinogenic effects are not identified. In its 1975 criteria document on chromium (VI), NIOSH identified potassium dichromate as a "non-carcinogenic chromium (VI)."

FIRST AID: EYE CONTACT: Immediately flush eyes with plenty of water, including under the eyelids, for at least 15 minutes. Seek medical attention immediately. SKIN CONTACT: Remove contaminated clothing. Immediately wash contaminated skin with soap and water. If irritation persists after washing, prevent further contact and seek medical attention.* INHALATION: Remove victim to fresh air. If necessary, aid breathing and get medical help. INGESTION: If victim is conscious, give large quantities of water to drink. Induce vomiting. Never give victim anything by mouth if he/she is unconscious or in convulsions. Get medical assistance immediately.*

* GET MEDICAL ATTENTION = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety/environmental personnel of large spills. Carefully scoop up spilled powder into a metal drum with cover. Avoid generating dust. Mop up residue with water, recovering the resulting solution for treatment and disposal. Absorb small solution spills on inert absorbent and place in a suitable container for disposal. Those involved in cleanup work should use personal protective equipment to prevent contact with skin, eyes, and clothing, and inhalation of dust and mist. Reporting of spills may be required. Reportable spill quantity = 1000 lbs. (40 CFR 117).
DISPOSAL: Waste containing this material may require disposal as a hazardous waste in an approved chemical landfill. Contact supplier or a licensed chemical waste disposal contractor for treatment and disposal instructions. Follow Federal, state, and local regulations.
Applicable EPA Hazardous Waste Numbers: D001 (Ignitable, 40 CFR 261.21); D007 (EP Toxic, 40 CFR 261.24).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet the TLV and PEL requirements. NIOSH-approved full-facepiece respirators with high-efficiency dust/mist filters should be used at operations where the TLV may be exceeded. Self-contained breathing apparatus or supplied-air respirators should be worn under severe exposure conditions. Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134). Wear rubber gloves, boots, apron, and chemical goggles or face shield when handling this material and its solutions. Leather gloves and shoes should be avoided because they may become impregnated with bichromate. If clothing becomes contaminated, fresh clothing should be obtained promptly. Launder contaminated clothing before reuse.

Safety showers and eyewash stations should be provided in work areas where this material is handled.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry location on noncombustible surface. Store away from flammable and combustible materials and easily oxidizable substances. Protect containers from physical damage. Maintain good housekeeping procedures. Clean up spills promptly. Use with adequate ventilation.

Follow good personal hygiene practices. Wash hands thoroughly after handling and before eating and smoking. Wash all areas of the body that may have come in contact with the material at the end of each work shift. Eating and smoking should not be permitted in areas where solids or liquids containing chromates are handled. Avoid inhalation of dust/mist and contact with skin and eyes. Do not ingest.

DOT Classification: ORM-A Label: None (49 CFR 172.101) DOT ID No.: NA1479

Data Source(s) Code: 2, 4, 5, 8, 9, 12, 19, 25, 27, 57, 58, 61, 82. CV

Approvals Racanoco 6/86
Indust. Hygiene/Safety 6/86
Medical Review

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NO. 2

POTASSIUM HYDROXIDE
Revision B

DATE February 1984

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: POTASSIUM HYDROXIDE
OTHER DESIGNATIONS: Caustic Potash, Potash Lye, KOH, GE Material D4811, CAS #001 310 583
MANUFACTURER: Available from many suppliers, including:

Hooker Chemicals & Plastics Corp.
Industrial Chemicals Group
Niagara Falls, NY 14303
Tel: (716) 278-7777

Allied Chemical
P.O. Box 1139R
Morristown, NJ 07960 Tel: (201) 455-4157
Emerg Tel: (201) 455-2000

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Typical content:		Ceiling Level
Potassium Hydroxide (KOH)	>83	2 mg/m^3 (KOH)*
Water	<13	
Potassium Carbonate (K_2CO_3)	<3.5	Human, Skin 50 mg/24H Severe Irritation
*ACGIH (1983) TLV.		Rat, Oral LD_{50} 365 mg/kg

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F ---- 2400
Vapor pressure, 719 C, mm Hg --- 1.0
Volatility @ R.T. ---------- Negligible
Solubility in water, %, at 0 C - 49
20 C - 52
100 C - 64

Specific gravity, 20/4C ---------- 2.044
Melting point, deg C ---------- ~360
(if anhydrous - 380C)
pH (0.1 M solution) ---------- 13.5
Molecular weight ---------- 56.1

Appearance & Odor: Off-white, hygroscopic solid; no odor. (Irritancy of KOH dust may become noticeable at 2 mg/m^3.)

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
None-Not combustible	N/A	N/A	N/A	N/A

Although it is not combustible and does not support combustion, it can be hazardous if present in a fire area. The following should be known for fire fighting: (1) It can melt and flow when heated (m.p. about 360 C). (2) Hot or molten material can react violently with small amounts of water (splattering, misting). (3) Can react with certain metals, such as aluminum, to generate flammable hydrogen gas. (4) Reacts with CO_2.
Firefighters should use self-contained respirator and full protective clothing.

SECTION V. REACTIVITY DATA

It is a stable material in closed containers under normal conditions of storage and handling. It does not polymerize. It is hygroscopic. It reacts with carbon dioxide from the air to form potassium carbonate.
Potassium hydroxide can react violently with strong acids and with many organic chemicals especially with nitrocarbons and chlorocarbons. (Reacts with trichloroethylene to form spontaneously flammable dichloroacetylene.) It generates much heat when it dissolves in water.
Avoid contact with leather and wool (hydrolysis). It is corrosive to aluminum, tin, zinc, and alloys which contain these metals (liberates hydrogen).

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NO. 2

SECTION VI. HEALTH HAZARD INFORMATION

TLV (Ceiling) 2 mg/m3

Strongly alkaline! Solid or its Conc. solutions can be rapidly corrosive to human tissue, producing severe burns and severe to permanent eye injury. Dust/mist inhalation can injure the entire respiratory tract. Ingestion causes burns, extreme pain and esophageal stricture. Estimated adult LD_{50} is 5g.

FIRST AID:

Eye Contact: Immediately flush with running water for 15 min., including under eyelids. (Speed in rinsing may save eyesight!) Contact physician! Continue gentle flushing 30 minutes or more or until medical help obtained.

Skin Contact: Flush with running water, under safety shower while removing clothing for gross contact. Continue flushing up to an hour for serious cases until medical help obtained.

Inhalation: Safely remove to fresh air. Contact physician. Have trained person administer oxygen for respiratory distress.

Ingestion: Immediately give 2-3 glasses of milk or water to drink; then citrus juice or diluted vinegar to neturalize. Contact physician. Vomiting may occur spontaneously, but do not induce it. Repeat giving liquid if vomiting occurs.

Get medical help for treatment, observation and support after first aid.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of large spills. Institute prior plan. Provide ventilation (explosion-proof where H_2 can be generated). Clean-up personnel need protection against inhalation of mists or dusts and skin or eye contact.

Promptly shovel or sweep up dry material and place in appropriate container for use or disposal. (Delayed clean-up will allow pick up of moisture, increasing clean-up task.) CAUTION! Avoid dusting conditions. Wet trace residues with water and neutralize with dilute acetic acid. (Sodium bicarbonate may be used to partially neutralize.) Flush with much water. Do not flush waste caustic directly to sewer or surface waters.

DISPOSAL: Carefully dissolve in water and neutralize with dilute acetic acid. Flush to sewer with lots of water, regulations permitting. Or dispose of through a licensed contractor. Consider use of waste caustic for neutralizing plant acid wastes. Follow Federal, State and Local regulations.

AQUATIC TOXICITY TLm 96: 100-10ppm EPA (CWA) RQ is 1000 lbs. (40CFR 117)

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation, and also local exhaust ventilation (with filtration to remove KOH from exhausted air) to meet TLV requirements, especially where dusting or misting occurs. For exposures to 100 mg/m3 use high efficiency particulate respirator or a self-contained respirator; full facepiece. Wear chemical safety goggles and/or full faceshield where dusting or splashing is possible. Use neoprene or rubber gloves and appropriate protective clothing (apron, boots, etc.) where needed to prevent contact, especially when solutions are prepared. Soiled clothing to be removed promptly and laundered before reuse.

Eyewash fountains, washing facilities and safety showers should be immediately accessible in areas of use and handling.

Provide employee training for those working with KOH; until trained, workers should not work with this material.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a dry, well-ventilated area separate from acids, peroxides, easily ignitible materials and other incompatibles. Protect containers from physical damage. Have abundant water supply available where stored or used. Drainage systems for storage or use areas need retention basins for pH adjustment and dilution of spills prior to discharge.

To prepare solutions add caustic potash slowly to water while stirring to avoid rapid heat build up. Avoid breathing dusts or mists. Avoid contact with skin, eyes and clothing. Wash thoroughly after handling. Wear protective clothing when handling material.

DOT Classification: CORROSIVE MATERIAL I.D. No. UN1813 (Dry Solid) Label: CORROSIVE

DATA SOURCE(S) CODE: 1-11,14,25,26,37,39,43,47-49

APPROVALS: MIS/CRD J. M. Nies

INDUST. HYGIENE/SAFETY 2-6-84

MEDICAL REVIEW: FEB 13 1984

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 351

STYRENE MONOMER
Revision B

Date August 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: STYRENE MONOMER
OTHER DESIGNATIONS: Vinylbenzene, Phenylethylene, Ethenylbenzene, Stryol, $C_6H_5CH{=}CH_2$, GE Material D5D50, ASTM D2826 & 2827, CAS# 000 100 425
MANUFACTURER: This material is available from many suppliers, including:
Dow Chemical Company

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Styrene Monomer	>99.2	8-hr TWA 100 ppm*
Typical inhibitor level (4-t-Butylcatechol) (See MSDS #421)	10-15 ppm	8-hr TWA 5 ppm**(skin)
*Current OSHA level with a ceiling concentration of 200 ppm and a maximum peak of 600 ppm (less than 5 minutes in a 3 hour period) permitted. ACGIH (1979 Intended Changes List) has recommended 50 ppm 8-hr TWA.		Rat, oral LD_{50} 5000 mg/kg
**TLV suggested by Manufacturer.		

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C	145	Specific gravity (20/4 C)	0.907
Vapor pressure at 30 C, mm Hg	9.5	Melting point, deg C	-31
Vapor density (Air=1)	3.6	Volatiles, %	ca 100
Solubility in H_2O at 25 C, Wt.%	0.02	Evaporation rate (BuAc=1)	0.5
		Molecular weight	104.16

Appearance & Odor: Colorless to yellow, oily liquid with a sweet, pleasant odor when pure at low concentrations (unpleasant at higher concentrations). Recognition threshold (100% test panel, unfatigued) is 0.15 ppm in air.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air % by volume	LOWER	UPPER
88 F (31 C) (TCC)	914 F (490 C)		1.1	6.1

Extinguishing Media: Dry chemical, foam, or CO_2 (water may be ineffective).
Use water to cool fire-exposed containers. (Sprinkler system desirable for storage area.)
In large fires, the fire-fighting should be done at a distance or from a protected location, since heated containers of styrene can explode.
Vapors can flow along surfaces, reach distant ignition sources and flash back.
Firefighters should use self-contained breathing equipment with full face and eye protection.

SECTION V. REACTIVITY DATA

The inhibited monomer is stable in storage below 90 F for a limited period of time. (The lower the temperature, the longer the storage stability.) The polymerization rate becomes significant when heated to 150 F or when the inhibitor content drops to 3 ppm. Hazardous polymerization can occur with this material, especially when it is exposed to heat, light, or catalytic materials (such as peroxides and strong acids), or if the inhibitor is exhausted or removed.
Styrene is a flammable liquid, OSHA Class IC. It will readily react with oxidizing agents. Toxic gases and vapors, such as CO, are formed on partial oxidation.
Styrene can corrode copper & copper alloys & become inhibited for normal polymerization by copper content.

GENIUM PUBLISHING

RSV 0021496

SECTION VI. HEALTH HAZARD INFORMATION

TLV (See Sect. II)

Exposure to styrene vapors at 200-400 ppm may be irritating to the eyes and nasal passages, above 800 ppm is immediately irritating. Eye damage can occur. High concentrations can have a toxic and anesthestic effect (one hour at 1000 ppm severely toxic; one hour at 5000 ppm produces unconsciousness; 10,000 ppm for 30 minutes has caused death). Repeated and prolonged contact of the liquid with the skin can cause defatting and dermatitis.

FIRST AID:

Skin Contact: Wash exposed areas well with soap and water. Remove contaminated clothing promptly. Get medical help if irritation persists or if contact has been extensive.

Eye Contact: Flush with running water, promptly and thoroughly, for 15 minutes. Get medical attention immediately!

Inhalation: Remove to fresh air. Keep warm and at rest. Restore breathing if needed. Get medical help immediately!

Ingestion: Do not induce vomiting! Get medical help immediately!

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel. Eliminate sources of ignition and provide explosion-proof ventilation. Clean-up personnel should use protective equipment to avoid contact with the liquid or breathing of the vapors. Use nonsparking tools. Absorb on inert solid, such as sand or vermiculite, for disposal. (Attempted reclaim of styrene spills is not usually recommended.) Water can be used to flush spills away from sensitive areas to open ground (not to sewer!).

DISPOSAL: Burn in a suitable incinerator or deposit mixture of styrene and absorbent in a sanitary landfill. Dispose of contaminated styrene promptly; do not store contaminated liquid styrene. Follow Federal, State and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide adequate local exhaust and general ventilation to meet the TLV requirements. Approved organic vapor cartridge respirator can be used for short periods up to 1000 ppm vapor. Use self-contained or air-supplied breathing equipment for higher or unknown concentrations or oxygen deficient atmospheres. A full facepiece is required above 400 ppm.

Use impervious gloves and chemical safety goggles for personal protection. Boots, face shield, impervious clothing etc. may also be needed to avoid contact with the liquid, depending on working conditions.

An eyewash station and safety shower should be readily accessible.

Preplacement and periodic medical exams recommended for those exposed to styrene.

Avoid breathing vapors. Avoid contact with liquid. Do no ingest. Follow good persons hygiene.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in tightly closed, mild steel containers in a well-ventilated area away from heat and ignition sources, direct sunlight, oxidizing agents, and polymerization catalysts. Store in the original container to avoid contamination. Control inventory! Monitor inhibitor content and polymer formation in stored styrene. (See ASTM D2120 and D2121.) Large tankage should be inerted with nitrogen. Carry out transfers with grounded and bonded containers. No smoking in areas of storage, handling or use.

Inhibited styrene can polymerize from frictional heat in a running centrifugal pump if flow is stopped. Condensed styrene vapors (no inhibition) can polymerize.

DATA SOURCE(S) CODE: 1-9,12,21,23,24, 31

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

No. 56

SULFUR

Date October 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: SULFUR
DESCRIPTION: Pure sulfur exists in several solid forms. The common forms (S_8 ring) of molecular weight 256.512 are alpha and beta crystalline forms and an amorphous form.
OTHER DESIGNATIONS: Sulphur, Flowers of Sulfur, Sulfur Flour, Sublimed Sulfur, Brimstone, CAS #007 704 349, GE Material D4F11
MANUFACTURER: Available from many sources, including Stauffer Chemical Co., Specialty Chemicals Division, Westport, CT 06880

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Sulfur	ca 100	No TLV Established*

*The Nuisance Dust TLV should govern exposure to solid sulfur in the absence of other standards. ACGIH (1979) is 10 mg/m^3 (total dust) or 5 mg/m^3 (respirable dust).

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C ——— 444.6 Melting point, deg C —— 112.8-119.0*
Vapor pressure at 20 C, mm Hg ——— <0.0001 Specific gravity, 20/4C - 1.92-2.07*
Water solubility ——————— Insoluble

Appearance & Odor: Yellow rhombic or monoclinic crystals, powder, granular, lump, stick, etc. Pure sulfur has no odor or taste.

*Property depends on allotropic form(s) present and the measurement technique. The transition temperature is about 95 C (slow conversion) between α- and β-crystalline forms.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
>335 F (CC)	Dust Cloud 374 F Undispersed >428 F	Dust, g/m^3	35	1400

Extinguishing Media: Water spray or fog is the most satisfactory. Steam and carbon dioxide may be useful in special cases. Streams of water from a nozzle can scatter molten sulfur and disperse sulfur dust into the air.
Sulfur dust is a moderate explosion hazard when dispersed in air. It is a greater explosion hazard when it is in contact with oxidizing agents. Bulk sulfur is a slight fire hazard when exposed to heat or flame.
Firefighters may need self-contained breathing apparatus for SO_2 protection. Eye protection and full protective clothing may also be indicated in large fires.

SECTION V. REACTIVITY DATA

This combustible material is stable under normal storage and handling conditions. It does not undergo hazardous polymerization.
It ignites and burns readily to form SO_2. It can be dangerously explosive when intimately mixed with oxidizing agents: for example, nitrates, chlorates, chromic anhydride, potassium permanganate, lead dioxide, calcium hypochlorite, etc. Sulfur can react as an oxidizing agent to give highly exothermic reactions, for example with P_2O_3 or phosphorus, with carbides, and with metals. It can react with hydrocarbons and other other organic material when molten to produce H_2S and CS_2.
Dry sulfur is not corrosive to steel or aluminum; moist sulfur is corrosive to steel.

GENIUM PUBLISHING

RSV 0021498

SECTION VI. HEALTH HAZARD INFORMATION

TLV 5-10 mg/m^3 (See Sect. II)

Sulfur is very low in vapor pressure and very low in toxicity. It should be considered in the nuisance dust category.

Health hazards can arise from reaction products of sulfur, such as SO_2, H_2S, and CS_2 (see MSDS #50, #52, and #350, respectively).

Sulfur dust can irritate the mucous membranes of the respiratory tract and the inner surface of the eyelid. Sensitive persons can experience skin irritation from repeated exposure to sulfur dust. Allergenic responses can occur.

FIRST AID:

Eye Contact: Flush eyes with plenty of running water for at least 15 minutes, including under the eyelids.

Skin Contact: Remove sulfur dust by washing with soap and water. Remove clothing that becomes contaminated with sulfur dust.

Inhalation: Remove from exposure to fresh air.

Remove any worker from exposure to sulfur who shows allergic reactions; such individuals should not be assigned further work where exposed to sulfur without a physician's approval.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Provide ventilation in spill area (but do not stir up dust). Pick up spilled material for recovery or disposal in a manner that will not produce dusting conditions. (Powdered sulfur should not be scattered nor allowed to accumulate on surfaces from spills or plant operations.)

DISPOSAL: Small amounts of scrap can be disposed of by burning (SO_2 emission). Larger amounts can be buried in a landfill, mixed with 3 parts by weight of calcium carbonate to neutralize the slow generation of sulfuric acid. Contact supplier for further disposal options. Follow Federal, State and local regulations in disposing of this material.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical services must meet requirements for sulfur dust exposure. (Electrical equipment suitable for Class I, Group D locations has been suggested as satisfactory.) Approved dust respirators should be provided for worker comfort and for protection against any dust exposure above the TLV. Self-contained breathing equipment should be available for fire situations, where SO_2 is generated.

To reduce body contact with sulfur dust workers should use gloves and dust-tight safety goggles. Workers with sensitive skin might further protect themselves with body-covering clothing and by the use of approved protective creams on the hands and face.

Use clean work clothing. Do not use clothing which is impregnated with sulfur dust.

An eyewash station and washing facilities should be readily available where workers are exposed to sulfur dust. Follow good hygienic practice in working with this material. Wash exposed skin with mild soap and water after work periods and before breaks.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a cool, ventilated area away from sources of heat and ignition and away from oxidizing agents and reactive chemicals (see Sect.V). (Sprinkler protection needed for large amounts of storage.) Guard against conditions or actions that could disperse sulfur dust in air. Provide grounding, humidification, etc. in transferring powdered sulfur to prevent static sparks from electrical charges which are readily developed in this material. Use nonsparking tools.

Follow good design and good housekeeping practices to prevent uncontrolled accumulations of sulfur dust. General dust containing 25% or more sulfur may be almost as explosive in air as 100% sulfur dust.

Avoid dust inhalation.

DATA SOURCE(S) CODE: 1-10,24,25

APPROVALS: MIS, CRD J. M. Nixon

Industrial Hygiene and Safety [illegible] White

MEDICAL REVIEW: 12/79

Material Safety Data Sheet

Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 9
SULFURIC ACID, CONCENTRATED
Revision C
Issued: October 1980
Revised: February 1986

SECTION 1. MATERIAL IDENTIFICATION

19

MATERIAL NAME: SULFURIC ACID, CONCENTRATED

OTHER DESIGNATIONS: Oil of Vitriol, Hydrogen Sulfate; H_2SO_4; CAS #7664-93-9

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corporation, PO Box 2064R, Morristown, NJ 07960; Telephone: 800 631-8050

HMIS
H:3
F: 0
R: 2
PPE: *
* See Sect. 8

R 1
I 3
S 4
K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Hydrogen Sulfate (H_2SO_4) Water * Material is obtained by the reaction of SO_3 and water. Can contain low impurity levels, such as 0.02% max of iron as Fe. Properties vary with H_2SO_4 content. Current OSHA standard and ACGIH (1985-86) TLV. NIOSH has a 10-hr TWA, 40-hr. work week, of 1 mg/m^3.	93-98 Balance*	8-hr TWA: 1 mg/m^3 Human, Mist Inhalation, TCLo: 3 mg/m^3, 24 wk. (Toxic Mouth Effects) Rat, Oral, LD_{50}: 2140 mg/kg

SECTION 3. PHYSICAL DATA

	93.19% H_2SO_4	98.33% H_2SO_4	100% H_2SO_4
Boiling Point, 1 atm, deg C	ca 281	ca 338	ca 330 (dc)
Specific Gravity (60/60°F)	1.8354	1.84	1.84
Volatiles, % @ 340°C	ca 100	ca 100	ca 100
Melting Point, deg C	ca -34	ca 3	10.4

Water Solubility ... Complete Miscible
Vapor Pressure, mm Hg @ 100°F ... <1 (93.19% H_2SO_4); Deg. Baume ... 66 (93.19% H_2SO_4) - Density of H_2SO_4 is often reported in degrees Baume Be). Formula is Be=145 [145/sp gr for liquids heavier than water].

Appearance and odor: Clear, colorless, hygroscopic, oily liquid with no odor. Mists greater than 1 mg/m^3 are easily recognizable. Those at 5 mg/m^3 are distinctly objectionable.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None - Nonflammable	NA	NA	NA	NA

Sulfuric acid is nonflammable; however, it is a strong oxidizing agent and may cause ignition by contact with combustible materials. Small fires may be smothered with suitable dry chemical. Cool exterior of storage tanks of H_2SO_4 with water to avoid rupture if exposed to fire. Do not add water or other liquid to the acid! The acid, especially when diluted with water, can react with metals to liberate flammable hydrogen gas.
Sulfuric acid mists and vapors from a fire area are corrosive (see sect. 5).
Fire fighters must wear self-contained breathing equipment and fully protective clothing.

SECTION 5. REACTIVITY DATA

Sulfuric acid is stable under normal conditions of use and storage. It does not undergo hazardous polymerization. It is a strong mineral acid reacting with bases and metals. The concentrated acid is also a dehydrating agent, picking up moisture readily from the air or other materials. Hydrogen gas may be generated within a H_2SO_4 container. Vent drums cautiously.

This material reacts exothermically with water. (Acid should always be added slowly to water. Water added to acid can cause boiling and uncontrolled splashing of the acid.) Sulfur oxides can result from decomposition and from oxidizing reactions of sulfuric acid.

SECTION 6. HEALTH HAZARD INFORMATION TLV

Concentrated sulfuric acid is a strong mineral acid, an oxidizing agent, and a dehydrating agent that is rapidly damaging to all human tissue with which it comes in contact. Ingestion may cause severe injury or death. Eye contact produces severe or permanent injury. Inhalation of mists can damage both the upper respiratory tract and the lungs. Sulfuric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.

FIRST AID: EYE CONTACT: Immediately flush eyes (including under eyelids) with plenty of running water for at least 15 minutes. Speed in diluting and rinsing out acid with water is extremely important if permanent eye damage is to be avoided. Obtain medical help as soon as possible.* SKIN CONTACT: Immediately flush affected areas with water, removing contaminated clothing while under the safety shower. Continue washing with water and get medical attention.* INHALATION: Remove to fresh air. Restore breathing. Call a physician immediately. INGESTION: Dilute acid immediately with large amounts of milk or water, then give milk of magnesia to neutralize. Never give anything by mouth to an unconscious person. Do not induce vomiting; if it occurs spontaneously, continue to administer fluid. Obtain medical attention as soon as possible.*

Maintain observation of patient for possible delayed onset of pulmonary edema.

* GET MEDICAL HELP = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Handle major spills by a predetermined plan. Contact supplier for assistance in this planning, in meeting local regulations, and for disposing of large amounts. Notify safety personnel. Provide optimum ventilation; vapors are extremely irritating. Stop leak if you can do so without risk.

Cleanup personnel need protection against inhalation or contact. Keep upwind. Contain spill. Minor leaks or spills can be diluted with much water and neutralized with soda ash or lime. If water is not available, cover contaminated area with sand, ashes, or gravel and neutralize cautiously with soda ash or lime.

DISPOSAL: Follow Federal, state, and local regulations. Runoff to sewer may create hydrogen gas, which is a fire or explosion hazard. EPA (CWA) RQ 1000 lbs. (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general ventilation to meet current TLV requirements in the workplace. Where mists are up to 50 mg/m^3, a high-efficiency particulate respirator with full facepiece is warranted; a type-C supplier-air respirator with full facepiece operated in pressure-demand mode is used to 100 mg/m^3.

Avoid eye contact by use of chemical safety goggles or face shield where splashing may occur. Acid-resistant protective clothing, such as rubber gloves, aprons, boots, and suits, is recommended to avoid body contact.

Eyewash fountain and safety showers with deluge type of heads should be readily available where this material is handled or stored.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

Comprehensive preplacement and annual medical examinations with emphasis on dental erosion, cardiopulmonary system, and mucous membrane irritation and cough are indicated.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Sulfuric acid in carboys or drums should be stored in clean, ventilated storage areas having acid-resistant floors with good drainage. Keep out of direct sunlight, do not store above 89.6°F (32°C). Storage facilities are to be separate from organic materials, metallic powders, chromates, chlorates, nitrates, carbides, oxidizables, etc. Soda ash, sand, or lime should be kept in general storage or work areas for emergency use. Protect containers against physical damage. Glass bottles need extra protection. Sulfuric acid is highly corrosive to most metals, especially below 77% H_2SO_4. Avoid breathing mist or vapors. Avoid contact with skin or eyes. Do not ingest. Do not add water to concentrated acid. Drums may contain hydrogen gas, so open cautiously. Use nonsparking tools free of oil, dirt, and grit and vapor-proof electrical fixtures

DOT Classification: Corrosive Material. ID No.: UN1830 Label: Corrosive

Data Source(s) Code: 1-12, 19, 20, 24, 26, 31, 37-39, 42, 82. CK

Approvals [signature], 6/86.

Indust. Hygiene/Safety [signature] 6/86

Medical Review [signature] 8/86

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 317

TOLUENE

Revision C

Date August 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: TOLUENE
OTHER DESIGNATIONS: Toluol, Methylbenzene, Phenylmethane, $CH_3C_6H_5$, GE Material D5B11, ASTM D362 and D841, CAS# 000 108 883
MANUFACTURER: Available from many suppliers, including Shell Chemical Co. and Sun Oil Co.

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Toluene	ca 100	8-hr TWA 100 ppm (skin)* or 375 mg/m^3 Human, inhalation TCLo 200 ppm (central nervous syst.) Rat, inhalation LCLo 4000 ppm/4 hr Rat, oral LD_{50} 5000 mg/kg

*ACGIH (1978); (skin) notation indicates a potential contribution to overall exposure via skin absorption. OSHA/NIOSH (1976) proposed an 8-hr TWA of 100 ppm, with a 15 minute ceiling of 200 ppm, and an action level of 50 ppm. Current OSHA TLV is 200 ppm.

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F (C)	231 (110.6)	Specific gravity (Water=1)	0.866
Vapor pressure @ 25 C, mm Hg	28	Volatiles, %	100
Vapor density (Air=1)	3.2	Evaporation rate (BuAc=1)	1.9
Solubility in water, %	0.05	Molecular weight	92.15

Appearance & Odor: Water white liquid with a characteristic aromatic odor, whose recognition threshold (unfatigued) is 2-5 ppm (100% of test panel). Odor detection is unsatisfactory for safety because of fatigue.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
40 F (4.4 C) Closed cup	(536 C) 997 F	% by volume	1.2	7

Extinguishing Media: Carbon dioxide, dry chemical, foam, and water fog. Water may be ineffective for putting out fire, but use spray to cool fire-exposed containers.
At room temperature, toluene emits vapors that can form flammable mixtures with air. It is a dangerous fire hazard and a moderate explosion hazard when exposed to heat and flame. Vapors can flow along surfaces to distant ignition sources, then flash back.
Firefighters should wear self-contained breathing apparatus and eye protection when fighting toluene fires.

SECTION V. REACTIVITY DATA

Toluene is a stable material under normal storage and handling. It does not undergo hazardous polymerization.
Since toluene is a flammable liquid, avoid contact with heat, sparks or open flames. Avoid contact with strong oxidizing agents. Nitric acid and toluene, especially in combination with sulfuric acid, will produce nitrated compounds which are dangerously explosive.
Oxidation in air can form oxides of carbon and nitrogen.

SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm (skin) (See Sect.II)

Vapor inhalation can produce headache and slight drowsiness at 100 ppm, fatigue, nausea and itching skin at 100-200 ppm, anesthetic effects and respiratory tract and eye irritation above 200 ppm. Absorption can occur through the skin, and liquid contact will cause defatting of the skin, with possible dermatitis from repeated or prolonged contact. Eye contact is irritating and can be damaging (corneal burns). Ingestion irritates the digestive tract and results in systemic effects from absorption.

FIRST AID:

Eye Contact: Immediately irrigate with water for 15 minutes. Get medical help.

Skin Contact: Wash area with soap & water; remove contaminated clothing promptly. Get medical help if irritation persists or if large areas of skin were exposed.

Inhalation: Remove to fresh air; restore breathing and give oxygen if needed. Get medical help!

Ingestion: Get medical help as soon as possible! When victim is conscious, give USP mineral oil to drink. (Aspiration is a potential hazard if vomiting occurs!)

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Report large spills to safety personnel. Remove ignition sources; provide explosion-proof ventilation. Those involved in clean-up must use protection again liquid contact and vapor inhalation. Pick as liquid when feasible, or absorb on vermiculite or sand and scoop up with nonsparking tools into a metal container with cover. Liquid can be flushed with a water spray to an open holding area for handling. Do not flush to sewer, to a confined space, or to a watercourse!

DISPOSAL: Consider reclaiming by distillation or disposal via a licensed waste disposal company. Scrap may be incinerated under properly controlled conditions. Follow Federal, State and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and exhaust ventilation to meet TLV requirements. Ventilation fans & other electrical service must be nonsparking and explosion proof. Exhaust hoods should have >100 lfm face velocity and be designed to capture heavy vapors. Exposure above the TLV for nonroutine and emergency situations requires use of an organic chemical cartridge respirator up to 200 ppm; above 200 ppm a full face piece is required with an approved canister-type gas mask or self-contained breathing equipment.

Safety goggles or glasses should be worn in areas of use. Impermeable (neoprene has been recommended) gloves and apron, face shield, and other protective clothing may be needed to prevent skin contact during use, especially where splashing may occur. An eyewash station should be available if splashing is possible. A safety shower and washing facilities should be available.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in cool, clean, well-ventilated area away from sources of heat and ignition and away from oxidizing agents. Area must meet requirements of OSHA Class IB liquid. No smoking in areas of storage or use. Nonsparking tools should be used near toluene. Use safety cans for handling small amounts. Ground and bond metal containers for liquid transfers to prevent static sparks. Protect containers from physical damage.

Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart and blood should be provided. At least an annual exam is recommended for workers exposed above the action level (50 ppm). Use of alcohol can aggravate the narcotic effect and blood effects of toluene.

DATA SOURCE(S) CODE: 1-9,12,20,21,24,26

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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SCHENECTADY, NY 12303-1836 USA
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GENIUM PUBLISHING CORP.

NO. 311
INHIBITED
1,1,1-TRICHLOROETHANE
REVISION D
DATE August 1983

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: INHIBITED 1,1,1-TRICHLOROETHANE
OTHER DESIGNATIONS: Methyl Chloroform, MC, CCl_3CH_3, GE Material D5B79, CAS# 000 071 556, α-Trichloroethane
TRADENAMES & MANUFACTURER: BLACO-THANE (Baron-Blakeslee), CHLOROTHENE NU & VG (Dow), INHIBISOL (Penetone Corp.), TRI-ETHANE (PPG Ind. Inc), TRITHENE (SRS, Inc.)

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
1,1,1-Trichloroethane	>95	8-hr TWA 350 ppm**
Inhibitor, typical*	< 5	Unknown
*Inhibitors used are proprietary. Commercial materials contain up to about 5% inhibitor and are designed for cold cleaning or vapor degreasing use or both.		Human, Inhalation LCLo 27 gm/m³/10 min
**Current OSHA PEL and ACGIH (1983) TLV. ACGIH STEL 450 ppm.		TCLo 920 ppm/70 min (CNS effects)
NIOSH (1976) proposed a 10-hr TWA of 200 ppm with a 350 ppm ceiling (15 minute sample) and has recommended caution in use		Human, Oral TDLo 670 mg/kg (GI effects)

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F ----- ca 165*
Vapor pressure, 20 C, mm Hg ----- 100
Vapor density (Air=1) ---------- 4.55
Water solubility, g/100ml H_2O @20C - 0.09
Specific gravity, 25/25C --- 1.3-1.336*
Volatiles, % ---------- ca 100
Melting point, deg C ------- -32
Evaporation rate (CCl_4=1) -- 1
Molecular weight ---------- 133.41

Appearance & Odor: Colorless liquid with a mild, sweetish, pleasant, ether-like odor which may be just perceptible (unfatigued) at about 100 ppm in air.
*Properties depend on the inhibitor and inhibitor level.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
None	537 C (998 F)	(High energy ignition source at 25C), Vol. %	8.0%	10.5%

This material is nearly nonflammable. High energy, such as electric arc, is needed for ignition, and the flame tends to go out when the ignition source is removed. Material involved in a fire can emit toxic and irritating fumes. Water fog, carbon dioxide, dry chemical, or foam may be used to fight fires.
Use self-contained or air-supplied breathing apparatus for protection against suffocating vapors and toxic and corrosive decomposition products.

SECTION V. REACTIVITY DATA

This material can be hydrolyzed by water to form hydrochloric acid and acetic acid. It will react with strong caustic, such as caustic soda or caustic potash to form flammable or explosive material. Attacks natural rubber.
It requires inhibitor content to prevent corrosion of metals; and when inhibitor is depleted, it can decompose rapidly by reaction with finely divided white metals, such as aluminum, magnesium, zinc, etc. Do not use these metals for storage containers or in pressurized spraying equipment where MC is involved.
It will decompose at high temperature upon contact with hot metal, or under ultra-violet radiation to produce toxic and corrosive gases (hydrogen chloride, dichloroacetylene, chlorine and some phosgene).

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NO. 311

SECTION VI. HEALTH HAZARD INFORMATION

TLV · 350 ppm or 1900 mg/m3

Brief exposure at 900-1000 ppm causes mild eye irritation and loss of coordination due to the early effects of MC on the CNS. Excessive exposure gives headache, drowsiness, impaired judgement, unconsciousness. Defats skin on contact, can produce irritation and dermatitis; can be absorbed through the skin. Eye contact gives pain and irritation. Considered low in toxicity among the chlorinated hydrocarbons.

FIRST AID:

Eye contact: Flush eyes well with plenty of running water for 15 min, including under eyelids.

Skin contact: Remove solvent-wet clothing promptly. Wash contact area with warm water and soap. Get medical attention for irritation.

Inhalation: Remove to fresh air. Restore and/or support breathing as needed. Get medical assistance. (Note: Advise physician not to use adrenalin.)

Ingestion: Contact physician. Aspiration a hazard! Possible spontaneous vomiting. (If medical help not readily available and amount swallowed was appreciable, give milk or water to drink and induce vomiting. Repeat. Estimated lethal dose for 150 lb man is 0.5 to 1 pint.)

PHYSICIAN: Avoid using sympathomimetic amines in treatment.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

For small spills in ventilated area, mop, wipe or soak up with absorbent material avoiding inhalation and contact. Evaporate outdoors or in an exhaust hood.

For large spills, inform safety personnel and evacuate area. Use protective equipment during clean-up (see Sect. VIII). Ventilate area. Contain liquid, pick up and place in closed metal containers. Do not allow to enter drains and water ways.

DISPOSAL: Dispose of via a licensed waste solvent disposal company, or reclaim by filtration and distillation procedures. Follow Federal, State and Local regulations.

Aquatic toxicity TLm 96: 100-10 ppm.

EPA hazardous waste number under RCRA is U226 (40CFR261).

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Air-supplied or self-contained respirator should be available for non-routine or emergency use. A chemical cartridge-type respirator can be used for a limited time below 1000 ppm. A full facepiece is needed above 500 ppm.

Chemical goggles or a face shield should be worn if splashing is possible. Gloves and apron (of neoprene, polyethylene or polyvinyl alcohol) should be worn when needed to avoid skin contact. Remove solvent-wet clothing promptly. A safety shower and eyewash station should be available to use area if splashing is probable.

Preplacement and periodic medical examinations should consider cardiovascular, liver, CNS functions, and skin.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, well-ventilated area. Keep water-free. Monitor inhibitor level for vapor degreasing use. Use caution in cleaning operations involving white metal fines (see Sect. V). Trichloroethylene contamination may cause decomposition when aluminum is degreased.

Provide medical monitoring of those regularly exposed to MC in the workplace. Preclude those with CNS, liver, or heart disease from exposure. Personnel using this solvent should avoid drinking alcoholic beverages shortly before, during, or soon after exposure.

NIOSH(1976 Crit. Doc.) expressed concern because of possible birth defects from high level pregnant rat exposures. Since 1976, directed studies have been negative. At occupational physicians' seminar on "Reproductive Hazards in the Workplace," Washington, DC (4/25/83), no physician was aware of data to substantiate the NIOSH concern.

DOT Classification: ORM-A I.D. No. UN2831

DATA SOURCE(S) CODE: 1-12,14,20,23,25,26,30,31,34,37,38,45-49,53

APPROVALS: MIS/CRD J. M. Nielsen

INDUST. HYGIENE/SAFETY [signature] 7.28.83

MEDICAL REVIEW: 1 August 1983

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA

NO. 312

TRICHLOROETHYLENE

Revision D

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: TRICHLOROETHYLENE
OTHER DESIGNATIONS: TCE, Trichloroethylene, Ethylene Trichloride, Ethenyl Trichloride, $CHCl{=}CCl_2$, GE Material D5B56, CAS# 000 079 016
MANUFACTURER & TRADE NAMES: BLACO-TRI (Baron-Blakeslee); ALK-TRI, HI-TRI and NEU-TRI (Dow); KAYNIDE (Kraft); PERM-A-CLOR and TRIAD (Detrex); TRICHLOR (PPG); TRICLENE D & MD (Diamond Shamrock)

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Trichloroethylene + Stabilizer* *Stabilizers such as amines or epoxy compounds are usually added at low levels to increase resistance to oxidation and to polymerization. Vapor degreasing grades require higher stabilizer levels. **ACGIH (1979 Intended Changes List) proposes an 8-hr TWA of 50 ppm with STEL 150 ppm. NIOSH (1978) reviewed TCE as a suspected carcinogen and suggested a TWA of 25 ppm as readily attainable. Unresolved controversy on TCE carcinogenicity at present.	ca 100	TLV 100 ppm with 200 ppm Ceiling level** Human, Oral LDLo 857 mg/kg Human, Inhal. TCLo 160 ppm/83 min (central nervous system)

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F (C) ----	188 (87)	Specific gravity 20 C ----	1.45-1.47*
Vapor pressure @ 20°C, mm Hg -------	58	Volatiles % ----------	ca 100
Vapor density (Air = 1) ----------	4.54	Evaporation rate (CCl_4=1) -	0.69
Water solubility @ 25°C, % ---------	0.1	Freezing point, deg C ----	-73 to -86*
		Molecular weight ---------	131.39

Appearance & Odor: Colorless, mobile liquid with a characteristic, sweet, ether-like odor whose recognition threshold is 21.4 ppm in air (unfatigued, 100% of test panel).
*Depends on stabilizer and level used.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits		LOWER	UPPER
None	770 F (410 C)	in air, Vol %	@ 57C	15	40
			@100C	2.5	90%

Extinguishing Media: Use that which is appropriate for surrounding fire. Trichloroethylene is normally considered noncombustible. However, when 15% vapor in air at 33 C is exposed to intense heat (electric arc) or to ordinary flame at vapor-air temperatures exceeding 50 C, it can be made to burn mildly. Combustibility increases in O_2-enriched air.
Self-contained breathing apparatus should be used for protection against TCE vapors and their toxic and corrosive decomposition products in a fire situation.

SECTION V. REACTIVITY DATA

TCE is considered to be a stable compound under normal conditions of storage and handling. However, when it is heated (as in a vapor degreaser) or exposed to sunlight, it requires stabilization against oxidation, degradation and polymerization. When it is exposed to high temperatures, hydrogen chloride and phosgene (highly toxic) can be produced as decomposition products. It is slowly decomposed by light when moist.
TCE can react with NaOH, KOH, or other strong alkali to form explosive mixtures of chloroacetylenes. Soda ash does not react.
Polymerization of TCE is catalyzed by aluminum chloride. Magnesium or aluminum powder can react with TCE.

No. 312

SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm or 535 mg/m^3 (See Sect II)

Inhalation of TCE above the TLV can irritate nose and throat, with dizziness, drowsiness, headache, nausea, unconsciousness, and even death resulting from excessive exposure. Eye irritation and lacrymation can result from exposure to vapor or liquid. Skin contact causes irritation and, when prolonged or repeated, dermatitis. Ingestion irritates the digestive tract and may cause nausea and rapid drowsiness partial paralysis, unconsciousness and kidney failure can result in severe cases.

FIRST AID:

Eye contact: Wash immediately with plenty of running water. Continue washing to minimize discomfort. Get prompt medical attention.

Skin contact: Remove contaminated clothing. Wash with soap and warm water.

Inhalation: Remove to fresh air; restore breathing if required. Keep at rest and warm. Immediately contact physician; advise him not to give adrenalin.

Ingestion: Get immediate medical help! Do not induce vomiting unless directed by a physician. (Authorities differ; professional decision required). Physician should be warned not to use adrenalin for treatment.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Inform safety personnel and evacuate area for large spills. Clean-up personnel should use respiratory and liquid contact protection. Provide ventilation. Confine spill to as small an area as possible. Do not allow run off to the sewer. Pick up spill with vacuum or on an absorbent and store in closed container for disposal.

DISPOSAL: Waste can be processed to recover TCE, or it can be burned in an appropriately equipped, high temperature incinerator (fume scrubbing system required to remove HCl). Disposal through a licensed waste disposal company should also bo considered. Scrap solvent and distillation residues must be handled as toxic wastes. Follow Federal, State and local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general ventilation and exhaust ventilation to keep workplace vapor levels within TLV requirements

Approved respiratory equipment should be available for emergency and nonroutine use. Use self-contained breathing equipment above 1000 ppm; use full facepiece cartridge or canister respirators for limited exposures above ceiling limit or TLV. (Cartridge, 1-2 hrs max.)

Use neoprene gloves, aprons etc. to prevent liquid contact with the skin and splashproof goggles for eye protection. Gas-tight goggles should be used by maintenance and emergency personnel.

An eyewash station should be available where splashing is probable.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Avoid breathing vapors. Avoid skin contact. Store in a cool, well-ventilated area and use with adequate ventilation, including floor level ventilation. Avoid contact of vapors with high temperature (toxic and corrosive decomposition products from TCE above 700 C). No smoking in use or storage areas.

Avoid collecting aluminum fines or chips in vapor degreaser. Regularly monitor TCE stabilizer level. Only trained personnel should operate vapor degreaser.

TCE has produced liver cancer in test animals. Exercise due caution in use. Evidence of cancer hazard with TCE is greater than with perchloroethylene or 1,1,1-trichloroethane. (OSHA Reporter 1978, 1565). However, observed effects may be due to stabilizers used (not TCE itself).

DATA SOURCE(S) CODE: 1-9, 12, 14, 21

APPROVALS: MIS, CRD J. M. Nielsen

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854

From Genium's MSDS Collection, to be used as a reference.

MSDS # G 561
2,6-XYLENOL

Issued: November 1985
Revised:

SECTION 1. MATERIAL IDENTIFICATION

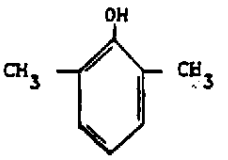
18

MATERIAL NAME: 2,6-XYLENOL
OTHER DESIGNATIONS: 2,6-Dimethylphenol, $C_8H_{10}O$; CAS # 0576 26 1.

MANUFACTURER/SUPPLIER: Aldrich Chemical Co., Inc.
PO Box 355
Milwaukee, WI 53201
(414) 273-3850

Koppers Co., Inc.
Organic Materials Group
Koppers Bldg.
Pittsburgh, PA 15219
(412) 227-2000

SECTION 2. INGREDIENTS AND HAZARDS	%	HAZARD DATA
2,6-XYLENOL	ca 100	No TLV established Rat, oral LD50: 296 mg/kg Rat, skin LD50: 1000 mg/kg



2,6-Xylenol is not listed as a carcinogen by NTP, IARC or OSHA.

SECTION 3. PHYSICAL DATA

Boiling point, 1 atm ..... 397°F (207.7°C)
Vapor pressure, 20°C, mmHg ... <1
Vapor density (Air=1) 4.2
Solubility in water ..... slightly soluble

Specific gravity (H_2O=1) ... 1.02
Melting point ..... 113-144.8°F (45-46°C)
Molecular weight 112.18

APPEARANCE & ODOR: Colorless crystalline solid or liquid with a sweet tarry odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
190°F (87.7°C) C.C.	1110°F (598.8°C)	Volume %	1.4	NA

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical or alcohol type foam. Do not use a solid stream of water since the stream will scatter and spread the fire. Use water spray to cool fire-exposed tanks/containers.

This combustible liquid is a moderate fire hazard and a slight explosion hazard when exposed to heat or flame.

Firefighters should wear self-contained breathing apparatus and full protective clothing when fighting fires involving 2,6-Xylenol.

SECTION 5. REACTIVITY DATA

This material is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

2,6-Xylenol is incompatible with strong oxidizing agents.

Thermal decomposition or burning produces toxic vapors and gases, including carbon monoxide.

RSV 0021508

SECTION 6. HEALTH HAZARD INFORMATION

TLV

Vapors of 2,6-Xylenol are irritating to the upper respiratory tract and may irritate or severely burn the eyes and skin. In solid or liquid form, 2,6-Xylenol is corrosive to all body tissue and contact causes severe burns. It is rapidly absorbed through the skin. Overexposure to 2,6-Xylenol via ingestion, inhalation or skin absorption may cause headache, dizziness, nausea, vomiting, difficult breathing, or coma. Chronic exposure to low doses of 2,6-Xylenol may result in liver and kidney damage.

FIRST AID:

EYE CONTACT: Promptly flush eyes, including under eyelids, for at least 15 minutes with running water. Get medical attention.* If eyes are burned, cover with a dry, sterile bandage.

SKIN CONTACT: Flush skin with running water for at least 5 minutes while removing contaminated clothing. Get medical attention.*

INHALATION: Remove victim to fresh air. Restore and/or support breathing as needed. Notify medical personnel.*

INGESTION: Give victim water or milk as quickly as possible. Contact a physician or Poison Control Center. Do not induce vomiting unless instructed to do so. Never give anything by mouth to a person who is unconscious or is having convulsions. Get medical attention.*

* MEDICAL ATTENTION = Inplant, Paramedic, Community.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate the area of all nonessential personnel. Clean-up personnel should wear suitable protective clothing and equipment (see Section 8).

Cover spill with sand, vermiculite or soda ash and place in closed container for disposal. Use caution to avoid generating dust. Do not flush to drain. After clean-up, wash spill area thoroughly with soap and water.

DISPOSAL: Place in suitable container for disposal by licensed contractor, landfill, or mix with solvent and burn in an approved incinerator. Follow all federal, state and local regulations.

Do not flush to surface waters.
EPA (CWA) RQ is 1000 lbs./454 kg (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion proof) to keep vapor levels in the workplace to a minimum. When 2,6-Xylenol is heated, vapor inhalation can be a serious hazard without proper precautions. For emergency or nonroutine exposures where vapor concentration in air may be excessive, use an appropriate NIOSH-approved respirator. Fume hoods should maintain a minimum face velocity of 100 lfm. All electrical service in use or storage areas should have an explosion-proof design.

2,6-Xylenol is highly toxic and corrosive. Full protective clothing, including splash goggles, face shield, impervious gloves, apron, boots, impervious shirt and trousers, hard hat with brim, acid suit and respirator should be available and worn as necessary to prevent bodily contact.

Eyewash stations and safety showers should be readily available in use and handling areas.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, and open flame. Protect container from physical damage.

Use only with adequate ventilation. Avoid contact with skin, eyes, and clothing. Do not breathe vapors. Untrained workers should not handle this material.

DOT CLASSIFICATION: ORM-A, UN2261.

RSV 0021509

DATA SOURCE(S) CODE (See Glossary) 1,2,4,6,7,23,63,75,78, 59, 79, R.

APPROVALS J.O. Accocco 1/86

INDUST. HYGIENE/SAFETY 1-86

MEDICAL REVIEW: Feb 86

GENIUM PUBLISHING