

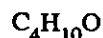
OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR tert-BUTYL ALCOHOL

INTRODUCTION

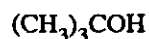
This guideline summarizes pertinent information about tert-butyl alcohol for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

• Formula



• Structure



• Synonyms

tert-Butanol; 2-methyl-2-propanol; TBA; t-butyl hydroxide; 1,1-dimethylethanol; trimethylmethanol; trimethylcarbinol

• Identifiers

1. CAS No.: 75-65-0
2. RTECS No.: EO1925000
3. DOT UN: 1120 26
4. DOT label: Flammable Liquid

• Appearance and odor

tert-Butyl alcohol is a colorless, crystalline solid or a volatile liquid (above 77°F) that has a camphorlike odor. The odor threshold is reported to be below 0.8 part per million (ppm) parts of air.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 74.1
2. Boiling point (760 mm Hg): 82.4°C (180°F)
3. Specific gravity (water = 1): 0.79 at 20°C (68°F)
4. Vapor density (air = 1 at boiling point of tert-butyl alcohol): 2.55
5. Melting point: 25.6°C (78.1°F)
6. Vapor pressure at 20°C (68°F): 31 mm Hg
7. Solubility: Soluble in water; miscible with alcohol and ether
8. Evaporation rate (butyl acetate = 1): 1.05

• Reactivity

1. Conditions contributing to instability: Heat, sparks, and open flame
2. Incompatibilities: Fires and explosions may result from contact with oxidizing agents, strong mineral acids, or strong hydrochloric acid.
3. Hazardous decomposition products: Toxic gases (such as carbon monoxide or isobutylene) may be released when tert-butyl alcohol decomposes in contact with strong mineral acids.
4. Special precautions: None

• Flammability

The National Fire Protection Association has assigned a flammability rating of 3 (dangerous fire hazard) to tert-butyl alcohol.

1. Flash point: 11°C (52°F) (closed cup)
2. Autoignition temperature: 478°C (892°F)

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3. Flammable limits in air (% by volume): Lower, 2.4; upper, 8.0

4. Extinguishant: Use dry chemical, carbon dioxide, alcohol foam, or water fog to fight fires involving tert-butyl alcohol. Blanket the fire to smother it. Water may be ineffective in extinguishing the fire, but a water spray may be used to cool fire-exposed containers. If a leak or spill has not ignited, water spray may be used to disperse vapors and to dilute spills to a nonflammable mixture.

Fires involving tert-butyl alcohol should be fought upwind and from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Emergency personnel should stay out of low areas and ventilate closed spaces before entering. Vapors may travel to a source of ignition and then flash back. Vapor explosions may occur indoors, outdoors, or in sewers. Containers of tert-butyl alcohol may explode in the heat of the fire and should be moved from the fire area if it is possible to do so safely. If this is not possible, cool containers from the sides with water until well after the fire is out. Stay away from the ends of containers. Personnel should withdraw immediately if they hear a rising sound from a venting safety device or if a container becomes discolored as a result of fire. Dikes should be used to contain fire-control water for later disposal. If a tank car or truck is involved in a fire, personnel should isolate an area of a half mile in all directions. Firefighters should wear a full set of protective clothing (including a self-contained breathing apparatus) when fighting fires involving tert-butyl alcohol. Firefighters' protective clothing may not provide protection against permeation by tert-butyl alcohol.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for tert-butyl alcohol is 100 ppm (300 mg/m³) as an 8-hr time-weighted average (TWA) concentration and 150 ppm (450 mg/m³) as a 15-min short-term exposure limit (STEL). A STEL is a 15-min TWA concentration that should not be exceeded at any time during a workday [29 CFR 1910.1000, Table Z-1-A].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 100 ppm (300 mg/m³) as an 8-hr TWA and 150 ppm (450 mg/m³) as a STEL [NIOSH 1992].

• ACGIH TLV®

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned tert-butyl alcohol a

threshold limit value (TLV) of 100 ppm (303 mg/m³) as a TWA for a normal 8-hr workday and a 40-hr workweek with a STEL of 150 ppm (455 mg/m³) for periods not to exceed 15 min [ACGIH 1991b].

• Rationale for limits

The limits are based on the risk of narcotic effects associated with exposure to tert-butyl alcohol.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to tert-butyl alcohol can occur through inhalation, ingestion, and eye or skin contact.

• Summary of toxicology

1. *Effects on Animals:* tert-Butyl alcohol causes narcosis in animals exposed to high concentrations. The oral LD₅₀ in rats is 3,500 mg/kg [NIOSH 1991]. Prolonged contact of tert-butyl alcohol with the skin of rabbits caused no irritation [Clayton and Clayton 1981]. When six female rats were exposed to 10,000 ppm for 7 hr, all developed severe narcosis and five died. Female rats in another group that inhaled 5,000 ppm for 7 hr also developed ataxia and narcosis but did not die. A 2,000-ppm exposure resulted in ataxia alone [Nelson et al. 1989]. Compared with other butyl alcohols, tert-butyl alcohol is reported to have a stronger narcotic effect on mice and rats [ACGIH 1991a; Nelson et al. 1989]. Rats given nontoxic oral doses of tert-butyl alcohol (0.0163 mol/kg) showed a marked decline in motor performance test scores; tert-butyl alcohol caused a narcotic effect estimated to be 4.8 times greater than that of ethanol [Clayton and Clayton 1981]. In a teratology study, groups of pregnant rats were exposed to 5,000, 3,500, 2,000, or 0 ppm tert-butyl alcohol for 7 hr/day during gestation days 1 through 19. Absorbed daily doses for each of these respective exposure levels were theorized to be 500, 350, 200, or 0 mg/kg. Depressed maternal weight gain and food consumption were induced only at 5,000 ppm. Fetal weights were statistically depressed in a dose-related fashion for all three alcohol exposures, and skeletal variations were statistically increased only at 5,000 and 3,500 ppm [Nelson et al. 1989]. The effect of prenatal ethanol or tert-butyl alcohol exposure on postnatal development was studied in mice. Daily ingestion of a diet deriving 1% of its calories from tert-butyl alcohol reduced maternal weight gain and food consumption and increased the number of stillborn pups. The authors concluded that this compound was five times more potent than ethanol in producing developmental delay in postnatal physiologic and psychomotor performance [Daniel and Evans 1982]. Ethanol and tert-butyl alcohol exposures were also compared for their potential to induce microcephaly in neonatal rats. Using an artificial rearing technique and exposures during developmental

days 4 through 7, microcephaly was induced by both of these alcohols [Grant and Sampson 1982]. This compound has been tested in a wide variety of mutagenicity assays, all of which confirm it to be a nonmutagen [IPCS 1987]. The National Toxicology Program (NTP) has completed one carcinogenicity study in mice and rats administered tert-butyl alcohol in drinking water. However, they judged this study to be inadequate for publication. The NTP has also completed subchronic tert-butyl alcohol inhalation studies in mice and rats and intends to conduct a set of inhalation carcinogenicity studies in these species [NTP 1992].

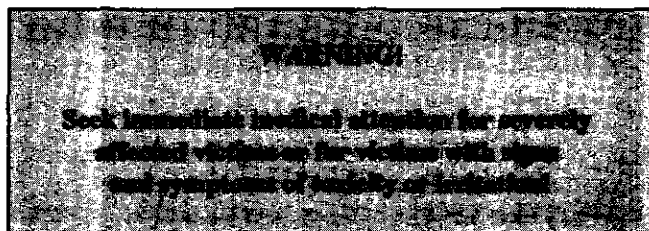
2. *Effects on Humans:* tert-Butyl alcohol causes eye and mucous membrane irritation. In contact with the skin of humans, tert-butyl alcohol caused slight redness, hyperemia, and irritation; prolonged skin contact may cause contact dermatitis [Clayton and Clayton 1981; NLM 1991]. A positive patch test was found in an individual who had an allergic skin reaction to a skin screen that contained tert-butyl alcohol [ACGIH 1991a]. Exposure to excessive (not further specified) concentrations caused eye, nose, and throat irritation, headache, nausea, fatigue, dizziness, and narcosis in humans [Clayton and Clayton 1981].

• Signs and symptoms of exposure

1. *Acute exposure:* Acute exposure to tert-butyl alcohol can cause irritation and redness of the eyes, runny nose, scratchy throat, headache, nausea, fatigue, dizziness, and redness and drying of the skin.

2. *Chronic exposure:* Chronic exposure to tert-butyl alcohol can cause defatting of the skin and dermatitis.

• Emergency procedures



Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Tissue irritation may result from exposure to concentrated solutions, vapors, mists, or aerosols of tert-butyl alcohol. *Immediately and thoroughly* flush eyes with large amounts of water, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Skin irritation may result. *Immediately* remove contaminated clothing and *thoroughly* wash contaminated skin with soap and water.

3. *Inhalation exposure:* If vapors, mists, or aerosols of tert-butyl alcohol are inhaled, move the victim to fresh air *immediately*.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if tert-butyl alcohol or a solution containing it is ingested:

—Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

—Have the victim drink a glass (8 oz) of fluid such as water.

—Induce vomiting by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases.

—Do *not* force an unconscious or convulsing person to drink fluid or to vomit.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve tert-butyl alcohol and may result in worker exposures to this substance:

—Use of tert-butyl alcohol as a solvent for paints, lacquers, varnishes, natural and synthetic resins, gums, vegetable oils, dyes, camphor, and alkaloids, and as an octane booster in unleaded gasoline

—Manufacture of artificial leather, safety glass, rubber and plastic cements, shellac, raincoats, photographic films, flotation agents, fruit essences, perfumes, cellulose esters, lacquers, paint removers, and plastics

—Use of tert-butyl alcohol as a denaturant for alcohol and as a chemical intermediate in the manufacture of methyl methacrylate and pharmaceuticals

The following methods are effective in controlling worker exposures to tert-butyl alcohol, depending on the feasibility of implementation:

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.
4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.
5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

• Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to tert-butyl alcohol, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, and respiratory tract. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to assess an individual's suitability for employment at a specific

job and to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to tert-butyl alcohol at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with eye, skin, or respiratory tract diseases.

• Periodic medical examinations and biological monitoring

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to tert-butyl alcohol exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of tert-butyl alcohol on the eyes, skin, and respiratory system. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for tert-butyl alcohol.

• Medical examinations recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of job placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne tert-butyl alcohol is determined by using charcoal tubes (100/50-mg sections, 20/40 mesh). Samples are collected at a maximum flow rate of 0.2 liter/min until a maximum air volume of 10 liters is collected (for TWA monitoring) or a maximum air volume

of 3 liters is collected (for STEL monitoring). The sample is then desorbed with carbon disulfide/2-butanol (99:1) or with carbon disulfide/dimethylformamide (99:1) to extract the tert-butyl alcohol. Analysis is conducted by gas chromatography using a flame ionization detector. The limit of detection for this procedure is 0.01 mg per sample. This method is described in the OSHA Computerized Information System [OSHA 1990] and in Method 1400 of the *NIOSH Manual of Analytical Methods* [NIOSH 1984].

PERSONAL HYGIENE

If tert-butyl alcohol contacts the skin, workers should flush the affected areas immediately with plenty of water for 15 min and then wash with soap and water.

Clothing and shoes contaminated with tert-butyl alcohol should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering contaminated clothing should be informed of the hazardous properties of tert-butyl alcohol, particularly its potential for irritating the skin.

A worker who handles tert-butyl alcohol should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, or using toilet facilities.

Workers should not eat, drink, or use tobacco products in areas where tert-butyl alcohol is handled, processed, or stored.

STORAGE

tert-Butyl alcohol should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of tert-butyl alcohol should be protected from physical damage and should be stored separately from strong oxidizers, strong mineral acids, strong hydrochloric acid, heat, sparks, and open flame. Drums must be equipped with self-closing valves, pressure-vacuum bungs, and flame arrestors. Only nonsparking tools and equipment may be used to handle tert-butyl alcohol. To prevent static sparks, containers of tert-butyl alcohol should be grounded and bonded for transfers. Because containers that formerly contained tert-butyl alcohol may still hold product residues, they should be handled appropriately.

SPILLS AND LEAKS

In the event of a spill or leak involving tert-butyl alcohol, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill or leak:

1. Do not touch the spilled material; stop the leak if it is possible to do so without risk.
2. Notify safety personnel.
3. Remove all sources of heat and ignition.
4. Ventilate potentially explosive atmospheres.
5. Use water spray to reduce vapors, but be aware that the spray may not prevent ignition in closed spaces.
6. Absorb small liquid spills with sand or other noncombustible absorbent material and place the material in a covered container for later disposal.
7. For large liquid spills, build dikes far ahead of the spill to contain the tert-butyl alcohol for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

• Emergency planning requirements

tert-Butyl alcohol is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

• Reportable quantity requirements for hazardous releases

Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of tert-butyl alcohol; there is no reportable quantity for this substance.

• Community right-to-know requirements

Employers who own or operate facilities in SIC codes 20 to 39, who employ 10 or more workers, and who manufacture 25,000 lb or more or otherwise use 10,000 lb or more of tert-butyl alcohol per calendar year are required by EPA [40 CFR 372.30] to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of tert-butyl alcohol emitted or released from their facility annually.

• Hazardous waste management requirements

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although tert-butyl alcohol is not specifically listed as a hazardous waste under the Resource Conservation and

Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

• Conditions for respirator use

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of tert-butyl alcohol exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

• Respiratory protection program

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent skin contact with tert-butyl alcohol. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. Butyl rubber has been tested against permeation by tert-butyl alcohol and has demonstrated good-to-excellent resistance for periods greater than 8 hr. Polyethylene ethylene/vinyl alcohol may withstand permeation for more than 4 but fewer than 8 hr.

If tert-butyl alcohol is dissolved in water or an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which tert-butyl alcohol might contact the eyes (e.g., through splashes of solution). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with tert-butyl alcohol. Contact lenses should not be worn if the potential exists for tert-butyl alcohol exposure.

REFERENCES CITED

ACGIH [1991a]. Documentation of the threshold limit values and biological exposure indices. 6th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ACGIH [1991b]. 1991-1992 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ATS [1987]. Standardization of spirometry—1987 update. American Thoracic Society. *Am Rev Respir Dis* 136:1285-1296.

CFR. Code of Federal regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Clayton G, Clayton F, eds. [1981]. *Patty's industrial hygiene and toxicology*. 3rd rev. ed. New York, NY: John Wiley & Sons.

Daniel MA, Evans MA [1982]. Quantitative comparison of maternal ethanol and maternal t-butanol diet on postnatal development. *J Pharmacol Exp Ther* 222(2):294-300.

Grant KA, Sampson HH [1982]. Ethanol and tertiary butanol induced microcephaly in the neonatal rat: comparison of grain growth parameters. *Neurobehav Toxicol Teratol* 4:315-321.

IPCS [1987]. Butanols—four isomers: 1-butanol, 2-butanol, tert-butanol, isobutanol. *Environmental Health Criteria* 65. Geneva, Switzerland: World Health Organization, International Programme on Chemical Safety, pp. 67-92.

Nelson BK, Brightwell WS, Khan A, Burg JR, Goad PT [1989]. Lack of selective developmental toxicity of three butanol isomers administered by inhalation to rats. *Fundam Appl Toxicol* 12:469-479.

NIOSH [1984]. Alcohols I: Method 1400. In: Eller PM, ed. *NIOSH manual of analytical methods*. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

NIOSH [1987a]. *NIOSH guide to industrial respiratory protection*. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-116.

NIOSH [1987b]. *Respirator decision logic*. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-108.

NIOSH [1991]. *Registry of toxic effects of chemical substances database: tert-butyl alcohol*. Cincinnati, OH: U.S.

Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Standards Development and Technology Transfer, Technical Information Branch.

NIOSH [1992]. *NIOSH recommendations for occupational safety and health: compendium of policy documents and statements*. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

NLM [1991]. *The hazardous substances data bank: tert-butyl alcohol*. Bethesda, MD: National Library of Medicine.

NTP [1992]. *NTP chemtrack system. Management status report: chemicals considered or being evaluated for short term toxicity and for long term toxicity and carcinogenesis effects*. Research Triangle Park, NC: National Toxicology Program.

OSHA [1990]. *Computerized information system*. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration.

Proctor NH, Hughes JP, Fischman ML [1988]. *Chemical hazards of the workplace*. 2nd ed. Philadelphia, PA: J.B. Lippincott Company.

