

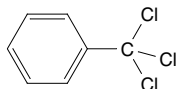
## Benzotrichloride

### CAS No. 98-07-7

Reasonably anticipated to be a human carcinogen

First listed in the *Fourth Annual Report on Carcinogens* (1985)

Also known as 1-(trichloromethyl)benzene,  $\alpha,\alpha,\alpha$ -trichlorotoluene, or benzoic trichloride



### Carcinogenicity

Benzotrichloride is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

#### Cancer Studies in Experimental Animals

Exposure to benzotrichloride by two routes of administration caused tumors at several different tissue sites in mice. When administered to female mice by stomach tube, benzotrichloride caused cancer of the forestomach (squamous-cell carcinoma) and of the lining of the lung (adenocarcinoma). Benzotrichloride applied to the skin of female mice caused lymphoma, cancer of the skin and lung (squamous-cell carcinoma), and cancer of the upper digestive tract (carcinoma of the lips, tongue, esophagus, and stomach) (IARC 1982a,b).

Since benzotrichloride was listed in the *Fourth Annual Report on Carcinogens*, additional studies in mice have been identified. Inhalation exposure of female mice to benzotrichloride caused benign and malignant lung and skin tumors (Yoshimura *et al.* 1986). In male and female strain A/J mice (a strain with a high spontaneous incidence of lung tumors), benzotrichloride given by intraperitoneal injection caused benign lung tumors (adenoma) (Stoner *et al.* 1986).

#### Cancer Studies in Humans

The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to benzotrichloride. However, epidemiological data provide limited evidence that employment in the production of chlorinated toluenes, which involves potential exposure to benzotrichloride and other  $\alpha$ -chlorinated toluenes, may increase the risk of cancer (IARC 1982a,b). The evidence includes (1) six case reports of respiratory-tract cancer in young benzoyl chloride production workers, including three nonsmokers, who potentially were exposed to benzotrichloride and (2) excess deaths from lung cancer in two cohorts of workers potentially exposed to benzotrichloride and other chlorinated toluenes (IARC 1982a,b). Subsequent studies reviewed by the International Agency for Research on Cancer (IARC 1999) have also reported excesses of respiratory-system cancer in workers with mixed exposure to benzotrichloride and other chlorinated toluenes (Sorahan *et al.* 1983, Wong *et al.* 1988, Sorahan and Cathcart 1989).

### Properties

Benzotrichloride is a chlorinated aromatic hydrocarbon. At room temperature, it is a clear, colorless to yellow, oily liquid with a penetrating odor. It is practically insoluble in water, but it is soluble in diethyl ether, benzene, and ethanol (HSDB 2009). It is unstable and hydrolyzes in the presence of moisture (IARC 1982b). Physical and chemical properties of benzotrichloride are listed in the following table.

Property	Information
Molecular weight	195.5 <sup>a</sup>
Specific gravity	1.38 at 20°C/4°C <sup>a</sup>
Melting point	-5°C <sup>a</sup>
Boiling point	221°C at 760 mm Hg <sup>a</sup>
Log $K_{ow}$	2.92 <sup>a</sup>
Water solubility	53 mg/L at 5°C <sup>b</sup>
Vapor pressure	0.414 mm Hg at 25°C <sup>a</sup>
Vapor density relative to air	6.77 <sup>a</sup>

Sources: <sup>a</sup>HSDB 2009, <sup>b</sup>ChemIDplus 2009.

### Use

Benzotrichloride is used extensively as a chemical intermediate in manufacturing processes. Its most important derivative is benzoyl chloride (IARC 1999). It has also been used as a dye intermediate in the preparation of eight dyes and pigments, including five that have been produced in commercial quantities in the United States. In addition, benzotrichloride has been used to make benzotrifluoride and hydroxybenzophenone ultraviolet-light stabilizers for plastics and in the production of ion-exchange resins, pharmaceuticals, and antimicrobial agents (IARC 1982b).

### Production

In 2009, benzotrichloride was produced by 16 manufacturers worldwide (7 in India, 4 in Europe, 3 in China, 2 in East Asia, and none in the United States) (SRI 2009) and was available from 251 suppliers, including 14 U.S. suppliers (ChemSources 2009). U.S. imports of benzotrichloride were reported in a combined category with benzyl chloride. Imports in this category were between 562,000 and 1.2 million kilograms (1.2 million and 2.7 million pounds) from 1989 to 1997, increasing to a peak of 6.2 million kilograms (13.7 million pounds) in 2001 and declining to 3.2 million kilograms (7.1 million pounds) in 2004. During this period, U.S. exports of benzotrichloride were reported in the large category of "halogenated derivatives of aromatic hydrocarbons, not elsewhere specified or included" and ranged from a high of 65 million kilograms (144 million pounds) in 1996 to a low of 20 million kilograms (44 million pounds) in 2001 (USITC 2009). Reports filed under the U.S. Environmental Protection Agency's Toxic Substances Control Act Inventory Update Rule indicated that U.S. production plus imports of benzotrichloride between 1986 and 2006 ranged from 10 million to 50 million pounds (EPA 2004, 2009).

### Exposure

The routes of potential human exposure to benzotrichloride are inhalation, ingestion, and dermal contact. The potential for exposure of the general population to benzotrichloride from industrial releases is expected to be low, because the chemical hydrolyzes rapidly in the presence of moisture and is degraded in the vapor phase in the atmosphere by reaction with photochemically produced hydroxyl radicals (IARC 1982b, HSDB 2009). According to EPA's Toxics Release Inventory, environmental releases of benzotrichloride in 1988 totaled 35,000 lb, of which 25,000 lb was released to air and 10,000 lb to off-site nonhazardous-waste landfills. Releases have since declined steadily and significantly. Since 2002, the small quantity of benzotrichloride not emitted to air (< 20 lb) has been sent to hazardous-waste landfills. In 2003, six facilities released 1,200 lb of benzotrichloride to air (TRI 2009). Benzotrichloride has been identified in surface waters at unreported concentrations (IARC 1982b).

Occupational exposure can occur if benzotrichloride is released in the work environment in liquid or vapor form during its manufacture or use as a chemical intermediate. Workers could potentially

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be exposed during the production, formulation, packaging, or application of products made with benzotrichloride or benzoyl chloride. The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 171 male workers potentially were exposed to benzotrichloride (NIOSH 1990).

### Regulations

#### Department of Transportation (DOT)

Benzotrichloride is considered a hazardous material and special requirements have been set for marking, labeling, and transporting this material.

#### Environmental Protection Agency (EPA)

##### Clean Air Act

*National Emissions Standards for Hazardous Air Pollutants:* Listed as a hazardous air pollutant.

*New Source Performance Standards:* Manufacture of substance is subject to certain provisions for the control of volatile organic compound emissions.

##### Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 10 lb.

##### Emergency Planning and Community Right-To-Know Act

*Toxics Release Inventory:* Listed substance subject to reporting requirements.

Threshold planning quantity (TPQ) = 100 lb.

Reportable quantity (RQ) = 10 lb.

##### Resource Conservation and Recovery Act

*Listed Hazardous Waste:* Waste codes for which the listing is based wholly or partly on the presence of benzotrichloride = U023, K015, K149.

Listed as a hazardous constituent of waste.

### Guidelines

#### American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – ceiling (TLV-C) = 0.1 ppm.

### References

- ChemIDplus. 2009. *ChemIDplus Advanced*. National Library of Medicine. <http://chem.sis.nlm.nih.gov/chemidplus/> and select Registry Number and search on CAS number. Last accessed: 3/22/09.
- ChemSources. 2009. *Chem Sources - Chemical Search*. Chemical Sources International, Inc. <http://www.chemsources.com/chemonline.html> and search on benzotrichloride. Last accessed: 3/22/09.
- EPA. 2004. *Non-confidential IUR Production Volume Information*. U.S. Environmental Protection Agency. <http://www.epa.gov/oppt/iur/tools/data/2002-vol.html> and search on CAS number.
- EPA. 2009. *Non-confidential 2006 IUR Records by Chemical, Including Manufacturing, Processing and Use Information*. U.S. Environmental Protection Agency. [http://cfpub.epa.gov/iursearch/2006\\_iur\\_natlcheminfo.cfm?id=6711](http://cfpub.epa.gov/iursearch/2006_iur_natlcheminfo.cfm?id=6711).
- HSDB. 2009. *Hazardous Substances Data Bank*. National Library of Medicine. <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB> and search on CAS number. Last accessed: 3/22/09.
- IARC. 1982a. Benzotrichloride. In *Some Industrial Chemicals and Dyestuffs*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 29. Lyon, France: International Agency for Research on Cancer. pp. 73-82.
- IARC. 1982b. Chlorinated toluenes, production of: benzal chloride (Group 3), benzotrichloride (Group 2A), benzoyl chloride (Group 3), benzyl chloride (Group 3). In *Chemicals, Industrial Processes and Industries Associated with Cancer in Humans*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, suppl. 4. Lyon, France: International Agency for Research on Cancer. pp. 84-86.
- IARC. 1999.  $\alpha$ -Chlorinated toluenes and benzoyl chloride. In *Re-evaluation of Some Organic Chemicals, Hydrazine, and Hydrogen Peroxide*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 71. Lyon, France: International Agency for Research on Cancer. pp. 453-477.
- NIOSH. 1990. *National Occupational Exposure Survey (1981-83)*. National Institute for Occupational Safety and Health. Last updated: 7/1/90. <http://www.cdc.gov/noes/noes1/x7402sic.html>.
- Sorahan T, Waterhouse JA, Cooke MA, Smith EM, Jackson JR, Temkin L. 1983. A mortality study of workers in a factory manufacturing chlorinated toluenes. *Ann Occup Hyg* 27(2): 173-182.
- Sorahan T, Cathcart M. 1989. Lung cancer mortality among workers in a factory manufacturing chlorinated toluenes: 1961-84. *Br J Ind Med* 46(6): 425-427.
- SRI. 2009. *Directory of Chemical Producers*. Menlo Park, CA: SRI Consulting. Database edition. Last accessed: 3/22/09.
- Stoner GD, You M, Morgan MA, Superczynski MJ. 1986. Lung tumor induction in strain A mice with benzotrichloride. *Cancer Lett* 33(2): 167-173.
- TRI. 2009. *TRI Explorer Chemical Report*. U.S. Environmental Protection Agency. Last updated: 3/19/09. <http://www.epa.gov/triexplorer> and select Benzoic Trichloride.
- USITC. 2009. *USITC Interactive Tariff and Trade DataWeb*. United States International Trade Commission. [http://dataweb.usitc.gov/scripts/user\\_set.asp](http://dataweb.usitc.gov/scripts/user_set.asp) and search on HTS no. 32041915. Last accessed: 3/22/09.

Wong O. 1988. A cohort mortality study of employees exposed to chlorinated chemicals. *Am J Ind Med* 14(4): 417-431.

Yoshimura H, Takemoto K, Fukuda K, Matsushita H. 1986. [Carcinogenicity in mice by inhalation of benzotrichloride and benzoyl chloride] [In Japanese; English abstract]. *Sangyo Igaku* 28(5): 352-359.