

## 5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

### 5.1 PRODUCTION

Bromoform may be prepared from acetone and sodium hypobromite, by treating chloroform with aluminum bromide, or by electrolysis of potassium bromide in ethyl alcohol (HSDB 2004a; Stenger 1978).

Bromoform is currently produced by Geoliquids, Inc., Prospect Heights, Illinois and Sigma-Aldrich Fine Chemicals (SRI 2004). Bromoform was produced formerly by Dow Chemical Company, Midland, Michigan. In 1975, production of bromoform in the United States was estimated to be <500 metric tons (<1 million pounds) and the 1977 production was estimated at 50–500 metric tons (100,000–1 million pounds) (NTP 1989a; Orrell and Mackie 1988; Perwak et al. 1980). The production volume of bromoform reported by manufacturers in 1990, 1994, and 1998 was within the range of 10,000–500,000 pounds (5–230 metric tons) (IUR 2002). Production volume data were not listed for reporting year 2002.

Dibromochloromethane can be prepared by the addition of dibromochloroacetone to 5N sodium hydroxide (IARC 1991b). It can also be prepared by reaction of a mixture of chloroform and bromoform with triethylbenzylammonium chloride and sodium hydroxide (IARC 1991a). Available information indicates that dibromochloromethane is no longer produced commercially in the United States (SRI 2004).

Both bromoform and dibromochloromethane are inadvertently generated during water chlorination when chlorine reacts with endogenous organic materials such as humic and fulvic acid (Rook 1977). When chlorine is added to water, hypochlorous acid is formed (Wallace 1997). Hypochlorous acid reacts with humic or fulvic acids in the water to produce chloroform or it can oxidize any bromide ion that is present to form hypobromous acid, which leads to the formation of bromoform, dibromochloromethane, or bromodichloromethane. It is estimated that 17 kkg of bromoform and 204 kkg of dibromochloromethane were generated in this way in 1978 (Perwak et al. 1980). According to a model generated by Clark et al. (1996), higher bromide to chloride ratios promote the bromine substitution reaction over the chlorine substitution reaction with organic matter in chlorinated water. At higher bromide concentrations, levels of chloroform decreased, while levels of bromoform increased. Dibromochloromethane was found to

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increase to a maximum level for bromide concentrations of 2.5 mg/L and then decline with increasing bromide concentration (Clark et al. 1996).

Table 5-1 summarizes information on companies that reported the production, import, or use of bromoform for the Toxics Release Inventory in 2002 (TRI02 2004). The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list.

## 5.2 IMPORT/EXPORT

Orrell and Mackie (1988) estimated that 6–9 kkg of bromoform were imported by Freeman Industries in the late 1980s. No current information was located on the import of bromoform and dibromochloromethane, but it is likely that little, if any, is imported.

## 5.3 USE

Bromoform is used in geological assaying as a heavy liquid for mineral ore separations based on differences in specific gravity (Verschuere 2001). It is used in the electronics industry in quality assurance programs (Orrell and Mackie 1988). Bromoform has been used as a catalyst, initiator, or sensitizer in polymer reactions and in the vulcanization of rubber (HSDB 2004a). As a solvent, bromoform has been used for waxes, greases, and oils as well as for liquid-solvent extractions and nuclear magnetic resonance (NMR) studies (Lewis 1997; NTP 1989a). Former uses of bromoform include a fire-resistant chemical ingredient, a gauge fluid ingredient, an intermediate in chemical syntheses, and a sedative and antitussive agent (HSDB 2004a; Perwak et al. 1980).

Dibromochloromethane is used in laboratory quantities only and there is no current commercial use for this compound (Perwak et al. 1980). Dibromochloromethane was used formerly as a chemical intermediate in the production of fire extinguishing agents, aerosol propellants, refrigerants, and pesticides (IARC 1991b).

## 5.4 DISPOSAL

Because bromoform and dibromochloromethane are listed as hazardous substances, land disposal of wastes containing these compounds is controlled by a number of federal regulations (see Chapter 8).

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**Table 5-1. Facilities that Produce, Process, or Use Bromoform**

State <sup>a</sup>	Number of facilities	Minimum amount on site in pounds <sup>b</sup>	Maximum amount on site in pounds <sup>b</sup>	Activities and uses <sup>c</sup>
AR	5	0	999,999	1, 2, 4, 9, 12, 13
CA	1	100	999	12
LA	2	0	999	1, 5, 13
MS	1	0	99	12
NE	1	10,000	99,999	12
OH	1	1,000	9,999	12
TX	2	1,000	999,999	12

Source: TRI02 2004 (Data are from 2002)

<sup>a</sup>Post office state abbreviations used

<sup>b</sup>Amounts on site reported by facilities in each state

<sup>c</sup>Activities/Uses:

- |                          |                          |                             |
|--------------------------|--------------------------|-----------------------------|
| 1. Produce               | 6. Impurity              | 11. Chemical Processing Aid |
| 2. Import                | 7. Reactant              | 12. Manufacturing Aid       |
| 3. Onsite use/processing | 8. Formulation Component | 13. Ancillary/Other Uses    |
| 4. Sale/Distribution     | 9. Article Component     | 14. Process Impurity        |
| 5. Byproduct             | 10. Repackaging          |                             |

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Wastes containing dibromochloromethane or bromoform may be incinerated by rotary kiln, liquid injection, or fluidized bed methods. CERCLA reportable quantities for bromoform and dibromochloromethane released to the environment are those quantities  $\geq 100$  pounds or 45.4 kg.

The amount of bromoform and dibromochloromethane released or disposed of through industrial and/or laboratory use of these chemicals is not known, but is considered to be insignificant compared to the amount inadvertently generated by water chlorination processes (EPA 1987c; HSDB 2004a; Perwak et al. 1980).