

4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

Chloroform is used primarily in the production of chlorodifluoromethane (hydrochlorofluorocarbon-22 or HCFC-22) used as a refrigerant for home air conditioners or large supermarket freezers and in the production of fluoropolymers (CMR 1995). Chloroform has also been used as a solvent, a heat transfer medium in fire extinguishers, an intermediate in the preparation of dyes and pesticides, and other applications highlighted below. Its use as an anesthetic has been largely discontinued. It has limited medical uses in some dental procedures and in the administration of drugs for the treatment of some diseases.

4.1 PRODUCTION

The chlorination of methane and the chlorination of methyl chloride produced by the reaction of methanol and hydrogen chloride are the two common methods for commercial chloroform production (Ahlstrom and Steele 1979; Deshon 1979). The Vulcan Materials Co., Wichita, Kansas, was documented as still using the methanol production process during the late 1980s with all other facilities in the United States at that time using the methyl chloride chlorination process (SRI 1990).

One U.S. manufacturer began chloroform production in 1903, but significant commercial production was not reported until 1922 (IARC 1979). Since the early 1980s, chloroform production increased by 20-25%, due primarily to a higher demand for HCFC-22, the major chemical produced from chloroform. The Montreal Protocol established goals for phasing out the use of a variety of ozone-depleting chemicals, including most chlorofluorocarbons (CFCs). HCFC-22 was one of the few fluorocarbons not restricted by the international agreement. Chloroform is used in the manufacture of HCFC-22, and an increase in the production of this refrigerant has led to a modest increase in the demand for chloroform (CMR 1989). These increasing trends in U.S. production, based on information compiled in the trade journal *Chemical & Engineering News* for period from 1983 through 1994 (CEN 1995), are summarized in Table 4-1.

The manufacturers and sites of major chloroform production facilities identified for 1993 (SRI 1993) include the following: Dow Chemical U.S.A., Freeport, Texas, and Plaquemine, Louisiana; Occidental Petroleum Corp., Belle, West Virginia; and Vulcan Materials Co., Geismar, Louisiana, and Wichita, Kansas. Estimated annual production capacity (SRI 1993) from these facilities as of January 1, 1993,

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Table 4-1. U.S. Production of Chloroform

Year	U.S. production (in millions of pounds)	U.S. production (in millions of kg)
1983	362	164
1984	405	183
1985	275	124
1986	422	191
1987	462	209
1988	524	237
1989	588	266
1990	484	219
1991	505	229
1992	na	na
1993	476	215
1994	565	254

Taken from Chemical & Engineering News 1995

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was 460 million pounds (208 million kg). By early 1995, the Occidental Petroleum Corporation facility in West Virginia had ceased its chloroform production operations (CMR 1995; SRI 1995). While precise production figures for the 4 remaining sizable U.S.-based facilities are not available, the annual production capacity estimate for the Dow plant in Freeport, Texas, was 135 million pounds (61.8 million kg); capacity for the Dow plant at Plaquemine, Louisiana, was 150 million pounds (67.5 million kg); capacity at the Vulcan plant at Geismar, Louisiana, was 90 million pounds (40.5 million kg); and capacity at the Vulcan plant at Wichita, Kansas, was 145 million pounds (62.3 million kg); for a total United States annual production capacity of around 520 million pounds (234 million kg) from these 4 large plants (CMR 1995). An estimate of actual production (CEN 1995) in the United States during 1994 was 565 million pounds (254 million kg).

Table 4-2 lists the facilities in each state that manufacture or process chloroform, the intended use, and the range of maximum amounts of chloroform that are stored on site. The data listed in Table 4-2 are derived from the Toxics Release Inventory (TRI93 1995). Only plants from 3 states (associated with the 4 plants noted above) actually generate chloroform as an end-product for sale or distribution. In most cases, chloroform is a chemical intermediary, impurity, or waste by-product at the 172 facilities included in the TRI survey. Only certain types of facilities were required to report; therefore, this is not an exhaustive list. In some cases, facility names are not available or numeric values for amounts of chloroform produced, stored, transferred, or released are missing. This complicates making comparisons between the TRI listings and information from other information sources.

4.2 IMPORT/EXPORT

In 1985, the United States imported 27.6 million pounds (12.5 million kg) of chloroform; 24 million pounds (10.8 million kg) of chloroform were imported into the United States in 1988 (CMR 1989; HSDB 1996). More recent U.S. import figures from the National Trade Data Bank (NTDB 1995) are:

U.S. Imports for Year	Quantity (kg)
1990	10,624,006
1991	9,460,747
1992	6,038,483
1993	8,467,294
1994	2,398,668

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Table 4-2. Facilities That Manufacture or Process Chloroform

State ^a	Number of facilities	Range of maximum amounts on site in thousands of pounds ^b	Activities and uses ^c
AK	2	0-1	1, 5, 6
AL	12	0-1000	1, 5, 6, 7, 12
AR	6	0-1000	1, 5, 6, 7, 13
AZ	1	0-1	1, 5
CA	2	0-0	1, 6, 13
CO	1	10-100	2, 6, 11
CT	1	100-1000	11
FL	7	0-100	1, 5, 6, 13
GA	6	0-10	1, 5, 6
ID	1	1-10	1, 5
IL	2	10-1000	11
IN	3	1-100	11, 13
KS	2	100-10000	1, 3, 4, 7, 13
KY	7	0-10000	1, 3, 5, 6, 7, 10, 13
LA	16	0-50000	1, 2, 3, 4, 5, 6, 7, 11, 13
MA	1	10-100	12
MD	1	0-1	1, 5
ME	7	0-1	1, 5, 6
MI	5	0-10000	1, 5, 6, 7, 11, 12, 13
MN	3	0-100	1, 5, 8, 12
MO	2	10-100	8, 10, 11
MS	2	0-1	1, 6
MT	1	0-1	1, 5
NC	4	0-1000	1, 5, 6, 11
NH	1	0-1	1, 5
NJ	4	0-1000	1, 5, 7, 8, 11
NY	3	0-100	1, 5, 6, 11, 13
OH	3	0-100	1, 6, 10, 11
OK	1	0-0	1, 5
OR	3	0-10	1, 6, 11
PA	7	0-1000	1, 5, 6, 11
PR	6	0-1000	11, 12, 13
SC	5	0-10	1, 5, 6, 8, 10
TN	2	0-1	1, 5, 6
TX	17	0-50000	1, 2, 4, 5, 6, 7, 9, 12, 13
VA	4	0-1000	1, 5, 11
VT	1	10-100	8
WA	7	0-10	1, 5, 6

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Table 4-2. Facilities That Manufacture or Process Chloroform (continued)

State ^a	Number of facilities	Range of maximum amounts on site in thousands of pounds ^b	Activities and uses ^c
WI	11	0-100	1, 5, 6, 7, 11, 13
WV	3	10-10000	1, 4, 5, 9, 11, 13

Source: TRI93 1995

^a Post office state abbreviations used^b Data in TRI are maximum amounts on site at each facility^c Activities/Uses:

- | | |
|-------------------------------|----------------------------------|
| 1. Produce | 8. As a formulation component |
| 2. Import | 9. As a product component |
| 3. For on-site use/processing | 10. For repackaging only |
| 4. For sale/distribution | 11. As a chemical processing aid |
| 5. As a by-product | 12. As a manufacturing aid |
| 6. As an impurity | 13. Ancillary or other uses |
| 7. As a reactant | |

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These import statistics suggest a slight decrease in chloroform imports from the late 1980s into the 1990s. Additional data would be needed to evaluate properly the drastic decrease in imports for 1994.

In 1985, 33.5 million pounds (15.2 million kg) of chloroform were exported (HSDB 1994); for 1988, exports of 40 million pounds (18.1 million kg) were estimated (CMR 1989). More recent export figures from the National Trade Data Bank (NTDB 1995) are:

U.S. Exports for Year	Quantity (kg)
1989	26,756,412
1990	21,897,011
1991	23,709,482
1992	20,133,535
1993	31,620,815
1994	42,320,259

These statistics suggest an overall increase in export levels from the mid-1980s through the mid-1990s.

4.3 USE

The major use for chloroform (CMR 1989) is in the manufacture of the refrigerant HCFC-22. Chloroform has been used in the past as a solvent or an extraction solvent for fats, oils, greases, resins, lacquers, rubber, alkaloids, gums, waxes, gutta-percha, penicillin, vitamins, flavors, floor polishes, and adhesives in artificial silk manufacture. It is also used as a dry cleaning spot remover, in fire extinguishers, as an intermediate in the manufacture of dyes and pesticides, and as a fumigant (Deshon 1979). Chloroform was previously used as an anesthetic, but it has been replaced by safer and more versatile materials (Deshon 1979). The U.S. Food and Drug Administration (FDA) banned chloroform use in drug, cosmetic, and food packaging products in 1976 (see Chapter 7). This ruling did not include drug products that contain chloroform in residual amounts resulting from its use as a processing solvent in manufacturing or its presence as a by-product from the synthesis of drug ingredients (IARC 1979). Chloroform can still apparently be used as a local anesthetic and solvent in certain dental endodontic (gutta-percha root canal) surgery procedures (McDonald and Vire 1992).

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Topically applied aspirin-chloroform mixtures are also used to relieve pain from severe cases of herpes zoster (shingles) or posttherapeutic neuralgia (King 1993).

A recent summary of major domestic uses for chloroform noted the following percentage breakdowns typical of the early to mid-1990s (CMR 1995): use for manufacture of HCFC-22, 98% (refrigerants, 70%; fluoropolymers, 30%); other miscellaneous uses, including laboratory reagents and 'extraction solvents for pharmaceuticals, 2%.

As discussed in Chapter 5, the most common chloroform exposure opportunities for members of the general population are related less to any commercially produced form of the chemical than to chloroform generated when organic materials come in contact with chlorinated oxidants (e.g., chlorine or hypochlorous acid) widely used to purify water or remove pathogens from waste materials.

4.4 DISPOSAL

According to the 1993 TRI, the amount of chloroform released to land is only a small fraction (less than 1%) of the total amount of chloroform released to the environment by facilities that produce and process the chemical (see Section 5.2.3) (TR193 1995). TRI also documents 2,386,285 pounds (1,073,828 kg) transferred to off-site waste handling sites in 1993, a level amounting to around 17% the total releases to environmental media and larger than any releases to environmental media other than air (TR193 1995). The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list.

Chloroform has been identified as a hazardous waste by EPA, and disposal of this waste is regulated under the Federal Resource Conservation and Recovery Act (RCRA) (EPA 1988a, 1989b). Specific information regarding federal regulations on chloroform disposal on land is available in the Code of Federal Regulations (EPA 1988a, 1989b). Ultimate disposal of chloroform, preferably mixed with another combustible fuel, can be accomplished by controlled incineration. Complete combustion must be ensured to prevent phosgene formation, and an acid scrubber should be used to remove the haloacids produced. Chloroform also is a potential candidate for liquid injection incineration. Because chloroform has been used in some pesticides, the disposal of containers for these pesticides may be relevant. Combustible containers from organic or many metallo-organic pesticides could be disposed of in pesticide incinerators or in specified landfill sites. Noncombustible containers could be disposed

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of in a designated landfill or recycled (HSDB 1996). Except for the TRI statistics, no data were located regarding the approximate amounts of chloroform disposed or released to environmental media. Chapter 7 provides more details on federal or state regulations governing the disposal of chloroform.