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

5.1 PRODUCTION

According to the 1990 amendments to the Clean Air Act and the Montreal Protocol, U.S. production of 1,1,1-trichloroethane was to be cut incrementally, eventually being completely phased out by January 2002. However, during the period beginning on January 1, 2002 and ending on January 1, 2005, production of limited amounts of 1,1,1-trichloroethane may be authorized by the Administrator for use in essential applications, or for the export to developing countries (EPA 2004m). The total production volumes of 1,1,1-trichloroethane fell from 720 million pounds in 1992 to 450 million pounds in 1993 (CMR 1995). Despite the proposed phase-out, 1,1,1-trichloroethane was still being manufactured in the United States in 2002 in a production volume range of 100–500 million pounds (EPA 2002). Today, the only significant use of 1,1,1 trichloroethane is in the production of CFC-142. Since these laws have been passed, the projected amount of 1,1,1 trichloroethane has decreased from 300 million pounds in 2000 to a projected 125 million pounds in 2005 (HSIA 2004). Two chemical companies are listed as domestic manufacturers in 2005 (SRI 2005): Vulcan Materials Co. Chemicals Division in Geismer, Louisiana and PPG Industries in Lake Charles, Louisiana. The estimated total production capacity at each of the facilities in 2005 (in millions of pounds) is 350 for PPG's plant in Lake Charles, Louisiana and 160 for Vulcan's plant in Geismar, Louisiana (estimated total capacity of 510 million pounds as of February 1, 2005) (SRI 2005).

Besides the above producers of 1,1,1-trichloroethane, Table 5-1 reports the number of facilities in each state that manufacture and process 1,1,1-trichloroethane, the intended use of the product, and the range of maximum amounts of 1,1,1-trichloroethane stored on site. The data reported in Table 5-1 are derived from the Toxics Release Inventory (TRI) (TRI03 2005). Only certain types of facilities were required to report to the TRI databank of EPA. Hence, this is not an exhaustive list.

The most common method for industrial preparation of 1,1,1-trichloroethane is the reaction of hydrochloric acid with vinyl chloride (obtained from 1,2-dichloroethane) to obtain 1,1-dichloroethane, followed by either thermal or photochemical chlorination. Other methods include the catalyzed addition of hydrogen chloride to 1,1-dichloroethylene, and the direct chlorination of ethane itself, followed by separation from the other products produced (Archer 1979). Commercial grades of 1,1,1-trichloroethane

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AK	1	10,000	99,999	12
AL	48	0	9,999,999	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12
AR	42	0	999,999	2, 3, 7, 8, 9, 10, 11, 12
AZ	43	0	999,999	2, 3, 6, 7, 8, 9, 10, 11, 12
CA	224	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
CO	40	0	999,999	1, 2, 3, 7, 8, 9, 10, 11, 12
CT	61	0	49,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
DE	17	100	99,999	2, 3, 4, 7, 8, 9, 11, 12
FL	56	0	49,999,999	1, 2, 3, 4, 7, 8, 9, 10, 11, 12
GA	64	0	99,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
HI	2	1,000	99,999	12
IA	46	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
ID	12	100	99,999	2, 3, 6, 10, 11, 12
IL	130	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
IN	85	0	99,999,999	1, 2, 3, 5, 7, 8, 9, 10, 11, 12
KS	54	0	9,999,999	2, 3, 4, 7, 8, 9, 10, 11, 12
KY	47	0	9,999,999	2, 3, 4, 6, 7, 8, 9, 10, 11, 12
LA	48	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
MA	69	0	999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12
MD	40	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
ME	24	0	999,999	2, 3, 6, 7, 8, 10, 11, 12
MI	91	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
MN	64	0	9,999,999	1, 2, 3, 6, 7, 8, 9, 10, 11, 12
MO	67	0	499,999,999	2, 3, 4, 6, 7, 8, 9, 10, 11, 12
MS	46	100	999,999	1, 2, 3, 4, 7, 8, 9, 10, 11, 12
MT	1	1,000	9,999	10
NC	76	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
ND	10	0	99,999	10, 11, 12
NE	26	100	999,999	2, 3, 7, 10, 11, 12
NH	28	0	99,999	2, 3, 6, 7, 9, 10, 11, 12
NJ	92	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
NM	16	100	99,999	2, 3, 7, 8, 9, 11, 12
NV	7	100	99,999	7, 11, 12
NY	77	0	49,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
OH	110	0	49,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12
OK	34	100	49,999,999	2, 3, 4, 5, 7, 8, 9, 10, 11, 12
OR	29	100	99,999	1, 2, 3, 5, 7, 8, 9, 10, 11, 12
PA	89	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
PR	28	0	49,999,999	2, 3, 4, 7, 8, 9, 10, 11, 12, 13

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
RI	31	0	999,999	2, 3, 7, 8, 9, 10, 11, 12
SC	52	0	9,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12
SD	9	1,000	99,999	10, 11, 12
TN	67	0	999,999	2, 3, 4, 5, 7, 8, 9, 10, 11, 12
TX	131	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
UT	34	0	9,999,999	2, 3, 6, 7, 8, 10, 11, 12
VA	41	0	99,999,999	2, 3, 5, 6, 7, 8, 9, 10, 11, 12
VI	3	10,000	999,999	10, 11
VT	11	1,000	99,999	2, 3, 8, 10, 11, 12
WA	36	0	999,999	1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 13, 14
WI	65	0	9,999,999	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13
WV	10	1,000	999,999	9, 11, 12
WY	5	0	9,999	2, 3, 10, 11, 12

[a]Post office state abbreviations used
[b]Amounts on site reported by facilities in each state
[c]Activities/Uses:

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

Source: TRI03 2005 (Data are from 2003)

usually contain some inhibitor, such as nitromethane, methyl ethyl ketone, toluene, 1,4-dioxane, butylene oxide, 1,3-dioxolane, or secondary butyl alcohols (Archer 1979; OHM/TADS 1992).

5.2 IMPORT/EXPORT

According to the Commerce Department's National Trade Data Bank (NTDB 1994), the following amounts of 1,1,1-trichloroethane (in pounds with kg in parentheses) were exported from the United States during the period 1989–1993: 124.3 million (56.4 million) in 1989; 114.6 million (52.0 million) in 1990; 162.4 million (73.7 million) in 1991; 139.7 million (63.4 million) in 1992; and 75.8 million (34.4 million) in 1993. The amount of 1,1,1-trichloroethane exported has declined since 1991. Because 1,1,1-trichloroethane has been classified as an ozone-depleting chemical, its export and import is regulated by Sections 601–607 of the Clean Air Act. 1,1,1-Trichloroethane may not be imported into the United States; however, under section 604(e) of the Clean Air Act, 1,1,1-trichloroethane may be produced domestically for export to developing countries that are parties to the Montreal Protocol and are operating under article 5 of such Protocol until January 1, 2012 (EPA 2004m). No recent data were found regarding amounts of 1,1,1-trichloroethane exported from the United States.

5.3 USE

1,1,1-Trichloroethane was developed initially as a safer solvent to replace other chlorinated and flammable solvents. Currently 1,1,1, trichloroethane is almost entirely used as a precursor for hydrofluorocarbons (HSIA 2004). In 1995, 1,1,1,trichloroethane was used for: hydrochlorofluorocarbon (HCFC) intermediate (60%), vapor degreasing and cold cleaning 25% (through 1995), adhesives 5%, coatings and inks 3%, textiles 2%, and electronics and miscellaneous 5% (CMR 1995). During the period beginning on January 1, 2002 and ending on January 1, 2005, the Administrator may authorize the use of limited amounts of 1,1,1-trichloroethane for essential applications such as medical devices and aviation safety. An example is its use for nondestructive testing for metal fatigue and corrosion of existing airplane engines and airplane parts susceptible to metal fatigue. These applications have no safe and effective substitute available.

1,1,1-Trichloroethane was used as a solvent for adhesives (including food packaging adhesives) and in metal degreasing, pesticides, textile processing, cutting fluids, aerosols, lubricants, cutting oil formulations, drain cleaners, shoe polishes, spot cleaners, printing inks, and stain repellents, among other

uses. It was used in industry primarily for cold-cleaning, dip cleaning, bucket cleaning, and vapor degreasing operations of items such as precision instruments, molds, electrical equipment, motors, electronic components and instruments, missile hardware, paint masks, photographic film, printed circuit boards, generators, switchgears, semiconductors, high vacuum equipment, fabrics, and wigs. It was also used for on-site cleaning of printing presses, food packaging machinery, and molds. 1,1,1-Trichloroethane was also used as a chemical intermediate in the production of hydrochlorofluorocarbons and vinyl chloride. It was formerly used as a food and grain fumigant (Archer 1979; Aviado et al. 1976, 1980; Budavari 1989; Sax and Lewis 1987; Stewart 1983; WHO 1992).

1,1,1-Trichloroethane was used extensively in household products. In a "shopping basket" survey, 1,1,1-trichloroethane was found in 216 of 1,159 common household products chosen as likely to contain solvents at concentrations >0.1% by weight (Sack et al. 1992). In a similar study, 1,1,1-trichloroethane was found in 32 of 67 categories (1,026 brands sampled) of common household products at concentrations >1% by weight; trace amounts were listed in all 67 categories (EPA 1987l; Maklan et al. 1987). Some of the several commonly used household items that may contain 1,1,1-trichloroethane are shown in Table 5-2. 1,1,1-Trichloroethane is emitted during use of items prevalent in the average home (Pleil and Whiton 1990; Wallace et al. 1987b).

5.4 DISPOSAL

1,1,1-Trichloroethane 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). Specific information regarding federal regulations on 1,1,1-trichloroethane disposal on land, in municipal solid waste landfills, in incinerators, and during underground injection is available in the Code of Federal Regulations (EPA 1992b, 1992c, 1992d, 1992e). Disposal of 1,1,1-trichloroethane can be accomplished through its destruction in a high temperature incinerator equipped with a hydrochloric acid scrubber. The destruction and removal efficiency (DRE) for 1,1,1-trichloroethane in hazardous wastes must attain 99.99% (Carroll et al. 1992). Potential methods of incineration include liquid injection, rotary kiln, and fluidized bed incineration (Carroll et al. 1992; HSDB 2005). Product residues and sorbent media may be packaged in a 17H epoxy-lined drum, encapsulated in an organic polyester resin, and disposed of at an approved EPA disposal site (OHM/TADS 1992). Other methods that have shown promise for the destruction of 1,1,1-trichloroethane are homogeneous sonochemical treatment for aqueous wastes (Cheung et al. 1991) and a combination of ozonation and ultraviolet treatment for groundwater (Kusakabe et al. 1991). From a

Table 5-2. 1,1,1-Trichloroethane in Common Household Products[a]

Product	Concentration (percent w/w)[b]
Adhesive cleaners	0.1–95.0
Adhesives	0.2–121.1
Aerosol spray paint	0.2–1.0
Battery terminal protectors	37.1
Belt lubricants	11.4–72
Brake cleaners	0.4–75.6
Carburetor cleaners	0.2–0.3
Circuit board cleaners	NS
Door spray lubricants	95.6
Drain cleaner (nonacid)	97.8
Electric shaver cleaners	2.5–20.3
Engine degreasers	0.2
Fabric finishes	77.9–85.1
Gasket removers/adhesives	0.2–1.0
General purpose spray degreasers	0.1–71.4
General purpose liquid cleaners	72.7–126.7
Ignition wire driers	24.3–43.6
Lubricants	0.1–104.5
Miscellaneous nonautomotive	12.5–67.5
Miscellaneous automotive	0.3–0.4
Oven cleaners	97
Paint removers/strippers	0.1–25.7
Primers	1.2–61.8
Rust removers	0.7
Silicone lubricants	0.2–91.1
Specialized aerosol cleaners	0.2–83.8
Spot removers	10.5–110.8
Spray shoe polish	11.4–62.3
Stereo/record player cleaners	0.7
Suede protectors	4.8–118.5
Tape recorder cleaners	0.2–101.5
Tire cleaners	0.1–90.3
Transmission cleaner/lubricant	113
TV/computer screen cleaners	0.3
Typewriter correction fluid	6–110
VCR cleaners	97.8
Video disk cleaners	0.6
Water repellents	0.2–116.2
Wood cleaners	12.3–20.4
Woodstain/varnishes/finishes	0.1–21.4

[a]1,1,1-Trichloroethane is no longer used in common household products.
[b]Average recovery from spiked samples: 97±13%

w/w = weight per weight

Source: Adapted from Frankenberry et al. 1987; Maklan et al. 1987

laboratory feasibility study, it was concluded that the *in situ* biodegradation of 1,1,1-trichloroethane in soils by methane-oxidizing bacteria was not a viable bioremediation method (Broholm et al. 1991).