4. PRODUCTION, IMPORT, USE, AND DISPOSAL

4.1 PRODUCTION

2,4,6-Trinitrotoluene is prepared by the nitration of toluene with a mixture of nitric acid and sulfuric acid (Fisher and Taylor 1983; Sax and Lewis 1987). Toluene is nitrated in a three-step operation by using increasing temperatures and mixed-acid concentrations to successively introduce nitro groups to form mononitrotoluene (MNT), dinitrotoluene (DNT), and trinitrotoluene (Mark et al. 1980). The nitration can be accomplished in three separate steps or by continuous flow (Budavari et al. 1989). Numerous other compounds are also formed during the nitration of toluene including unsymmetrical isomers of 2,4,6-trinitrotoluene, and oxidation products such as tetranitromethane, nitrobenzoic acid, nitrocresol, and partially nitrated toluenes (Hamilton and Hardy 1974; Mark et al. 1980). The unsymmetrical 2,4,6-trinitrotoluene isomers are removed by washing with aqueous sodium sulfite solution (Fisher and Taylor 1983; Mark et al. 1980; Sax and Lewis 1987).

2,4,6-Trinitrotoluene is not produced commercially in the United States; production is limited to military arsenals (HSDB 1994). Data on production volumes for 2,4,6-trinitrotoluene are not available. 2,4,6-Trinitrotoluene is purchased from the U.S. Army Armament Material Command (Gibbs and Popolato 1980). Army ammunition plants that have been involved in the production and storage of 2,4,6-trinitrotoluene include Shreveport (Louisiana), Anniston (Alabama), Crane (Indiana), Fort Wingate (New Mexico), Hawthorne (Nevada), Letterkenny (Pennsylvania), Lexington (Kentucky), McAlester (Oklahoma), Navajo (Arizona), Pine Bluff (Arkansas), Pueblo (Colorado), Red River and Lone Star (Texas), Savanna and Joliet (Illinois), Seneca (New York), Sierra (California), Tooele (Utah), and Umatilla (Oregon) Weldon Spring (Missouri), West Virginia Ordnance Works (West Virginia), Radford (Virginia), and Volunteer (Tennessee) (Army 1986a, 1986d; Haroun et al. 1990; Kraus et al. 1985; Phung and Bulff 1981).

Since 2,4,6-trinitrotoluene releases are not required to be reported under SARA Section 313, there are no data on 2,4,6-trinitrotoluene in the 1988 Toxics Release Inventory (TRI88 1990).

4.2 IMPORT/EXPORT

In 1985, an estimated 9.2 million pounds of 2,4,6-trinitrotoluene were imported into the United States (USDOC 1986). However, current import and export data for 2,4,6-trinitrotoluene are not available.

4.3 USE

2,4,6-Trinitrotoluene has been classified as a high explosive (Eveleth and Kollonitsch 1990). The compound is used as a military explosive in bombs and grenades (HSDB 1994; OHM/TADS 1985). It has been widely used for filling shells and airborne demolition bombs since it is sufficiently insensitive to the shock of ejection from a gun barrel but can be exploded on impact by a detonator mechanism (Eveleth and Kollonitsch 1990). 2,4,6-Trinitrotoluene has been used either as the pure explosive or in binary mixtures (Gibbs and Popolato 1980). The most common binary mixtures of 2,4,6-trinitrotoluene are cyclotols (mixtures with RDX), octols (mixtures with HMX), amatols (mixtures with ammonium nitrate), and tritonals (mixtures with aluminum) (Eveleth and Kollonitsch 1990; Gibbs and Popolato 1980). In addition to military use, small amounts of 2,4,6-trinitrotoluene may be used for industrial explosive applications, such as deep well and underwater blasting (HSDB 1994).

Other industrial uses of 2,4,6-trinitrotoluene include use as a chemical intermediate in the manufacture of dyestuffs and photographic chemicals (Sax and Lewis 1987).

4.4 DISPOSAL

Wastes generated in the manufacture of 2,4,6-trinitrotoluene are characterized as hazardous wastes by EPA, and EPA regulations for disposal must be followed (EPA 1990). For more information on the regulations that apply to 2,4,6-trinitrotoluene, see Chapter 7.

Disposal of 2,4,6-trinitrotoluene has been accomplished effectively by burning in an incinerator equipped with an afterburner and a scrubber (OHM/TADS 1985). 2,4,6-Trinitrotoluene has been pretreated before incineration by pouring or sifting onto sodium bicarbonate or a sand-soda ash

mixture. The resulting combination is mixed and packaged in heavy paper cartons with plenty of paper packaging to serve as fuel (OHM/TADS 1985). 2,4,6-Trinitrotoluene has also been prepared for incineration by mixing with a flammable solvent, such as alcohol or benzene, and spraying the resulting mixture into the fire chamber of an incinerator (OHM/TADS 1985).

Demilitarization is the use of various technologies to process munitions so they are no longer suitable for military applications. Demilitarization of munitions involves a number of techniques. Both destructive and nondestructive methods are used. Destructive methods include incineration, open detonation, and open burning. Nondestructive methods are aimed at recovering various components for reuse or sale. Destructive methods are the most predominant type used at the various depots and ammunition plants across the country (Army 1986). Munitions are demilitarized because of obsolescence of weapons, deterioration of chemical components, and poor serviceability. 2,4,6-Trinitrotoluene is the primary explosive filler in the demilitarization inventory.

Bench-scale cornposting of up to 10% 2,4,6-trinitrotoluene showed that almost complete removal of 2,4,6-trinitrotoluene occurred in 55 days, and many of the toxic transformation products formed in activated sludge and soil were not found in the composted 2,4,6-trinitrotoluene (Fisher and Taylor 1983). Field studies have demonstrated composting is effective in removing 2,4,6-trinitrotoluene from contaminated lagoon sediments under both thermophilic and mesophilic conditions (Williams et al. 1992). The mutagenicity of the metabolites of 2,4,6-trinitrotoluene formed by cornposting was found to be less than the parent compound (Tan et al. 1992). Waste water contaminated with 2,4,6-trinitrotoluene and various concentrations of nitrobodies, such as RDX, was successfully oxidized electrochemically from a range of 60-105 ppm 2,4,6-trinitrotoluene to below acceptable disposal concentrations (0.5 ppm); the oxidation process did not produce any toxic by-products (HSDB 1994). Other methods of treating waste waters contaminated with 2,4,6-trinitrotoluene and related products that have been investigated include ultrafiltration, activated carbon, and resin adsorption (EPA 1982).