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

## 4.1 PRODUCTION

RDX has been produced several ways, but the most common method of manufacture used in the United States is the continuous Bachmann process (Army 1986a; Merck 1989). The Bachmann process involves reacting hexamine with nitric acid, ammonium nitrate, glacial acetic acid, and acetic anhydride (Army 1978c, 1986e). The crude product is filtered and recrystallized to form RDX (Army 1986a). A second process that has been used to manufacture RDX, the direct nitration of octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), has not yielded a percentage of RDX as high as the percentage produced in the Bachmann process (Army 1978; Merck 1989).

Production of RDX peaked in the 1960s when it was ranked third in explosive production by volume in the United States (Army 1986e). The average volume of RDX produced from 1969 to 1971 was 15 million pounds per month. However, production of RDX decreased to a yearly total of 16 million pounds for 1984.

RDX is not produced commercially in the United States (HSDB 1994). Production in the United States is limited to Army ammunition plants such as Holston Army ammunition plant in Kingsport, Tennessee, which has been operating at lo-20% capacity (Army 1986e). Several Army ammunition plants, such as Louisiana (Shreveport, Louisiana), Lone Star (Texarkana, Texas), Iowa (Middletown, Iowa), and Milan (Milan, Tennessee), also handle and package RDX.

Since the release of RDX is not required to be reported under SARA Section 313, there are no data on RDX in the Toxics Release Inventory (TRI 1993).

## 4.2 IMPORT/EXPORT

No information is available regarding the import or export of RDX.

## 4.3 USE

RDX is a nitrate explosive compound (Turley and Brewster 1987). RDX has both military and civilian applications. As a military explosive, RDX can be used alone as a base charge for detonators or mixed with another explosive such as TNT to form cyclotols, which produce a bursting charge for aerial bombs, mines, and torpedoes (Sax and Lewis 1989; Stokinger 1982). Common military uses of RDX have been as an ingredient in plastic bonded explosives, or plastic explosives which have been used as explosive fill in almost all types of munition compounds (Gibbs and Popolato 1980). The plasticized form of RDX, composition C-4, contains 91% RDX, 2.1% polyisobutylene, 1.6% motor oil, and 5.3% 2-ethylhexyl sebacate (Turley and Brewster 1987). Civilian applications of RDX include use in fireworks, in demolition blocks, as a heating fuel for food rations (Turley and Brewster 1987), and as an occasional rodenticide (HSDB 1994). Combinations of RDX and HMX, another explosive, have been the chief ingredients in approximately 75 products (Army 1978c).

## 4.4 DISPOSAL

Waste-water treatment sludges resulting from the manufacture of RDX are classified as hazardous wastes and are subject to EPA regulations (EPA 1990a). For more information on regulations that apply to RDX, see Chapter 7.

Munitions such as RDX have been disposed of in the past by dumping in deep sea water (Hoffsommer and Rosen 1972). By-products of military explosives such as RDX have also been openly burned in many Army ammunition plants in the past. There are indications that in recent years as much as 80% of waste munitions and propellants have been disposed of by incineration (Army 1986a). Wastes containing RDX have been incinerated by grinding the explosive wastes with a flying knife cutter and spraying the ground material with water to form a slurry. The types of incineration used to dispose of waste munitions containing RDX include rotary kiln incineration, fluidized bed incineration, and pyrolitic incineration (Army 1986a). The primary disadvantage of open burning or incineration is that explosive contaminants are often released into the air, water, and soils (Army 1986c).

RDX wastes found in soils and sediments have been degraded in composts using substances such as hay, horse feed, sewage sludge, wood shavings, animal manure, and fruit and vegetable wastes (Army 1986b; Greist et al. 1993; Williams et a1.1992). In a mechanically stirred amended compost, the concentration of RDX in soil was reduced from <800 mg/kg to 39 mg/kg after 44 days (Griest et al. 1993). RDX has been removed from munitions waste waters and contaminated groundwater by activated carbon columns (Army 1987c; Bricka and Sharp 1992; Wujcik et al. 1992). No RDX was detected when a contaminated groundwater containing 487 μg/L of RDX was passed through granular activated carbon (GAC) columns at a loading rate of 7.11 gpm/ft, flow rate of 0.7 gpm and an empty-bed contact time of 4.2 minutes (Wujcik et al. 1992). Once carbon columns were saturated with explosive, they were traditionally destroyed by open burning. Since this practice is no longer allowed in many areas, other disposal alternatives for spent carbons, such as thermal reactivation for reuse, oxidative incineration with ash burial, and thermal deactivation with carbon burial, have been investigated (Army 1987c). In a feasibility study, UV irradiation was found to provide effective treatment of RDX-contaminated groundwater (Bricka and Sharp 1992).