

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

### 4.1 PRODUCTION

Jet fuels are primarily derived from crude oil, the common name for liquid petroleum. These jet fuels can be referred to as petroleum-derived jet fuels. Jet fuels can also originate from an organic material found in shale, called kerogen or petroleum solids: that can be converted by heat to shale oil. Jet fuels from this source are called shale-derived jet fuels (Hoffman 1983). Jet fuels are typically made by blending and refining various crude oil petroleum distillation products such as naphtha, gasoline, or kerosene in order to meet specific military or commercial specifications (Air Force 1989b). Since there is great variability in the concentrations of major components of crude oil, there is also a great variation in the final jet fuel product (Air Force 1989b). Therefore, there are many types of each jet fuel, and each jet fuel is not specified by chemical composition (Air Force 1989b; CRC 1984). JP-4 is a naphtha-type fuel made by blending straight-run kerosene streams with lower boiling distillates to fit the specifications given in Table 3-6 (Air Force 1989b; IARC 1989). JP-4 is known as a wide-cut fuel; it is made from the distillation products obtained over a wide range of temperatures and has a broad spectrum of hydrocarbon chain lengths varying from C<sub>4</sub> to C<sub>16</sub> (Air Force 1989b; CONCAWE 1985). JP-4 is also made by blending and refining shale oil distillate streams (Stallard and Krautter 1984). JP-7 is made by blending kerosene distillates in order to achieve a product containing a maximum of 5% aromatics by volume and a maximum total weight of 0.1% sulfur (CRC 1984; IARC 1989). Once jet fuels are made, they are often transported through pipelines to terminals where additional substances such as metal deactivators, electrical conductivity additives, and fuel system icing inhibitors are added to the mixture (IARC 1989).

In 1970, total U.S. production of military and commercial jet fuels was approximately 38 million metric tons (IARC 1989). Production in the United States steadily increased over the next 15 years to about 57 million metric tons in 1985. Data on amounts of JP-4 and JP-7 produced during this 15-year period, as well as data on current production volumes of JP-4 and JP-7, are not available.

Data on specific manufacturers of JP-4 and JP-7 are not available. In 1978, the Standard Oil Company (SOHIO, Cleveland, Ohio) refined 87,000 barrels of crude shale oil to produce different fuel oils including jet fuels (Stallard and Krautter 1984). However, no report was located in the literature

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that would indicate shale has been mined or retorted on a commercial scale for the production of jet fuels in recent years.

Since JP-4 and JP-7 are not required to be reported under SARA Section 313, there are no data for JP-4 and JP-7 in the Toxics Release Inventory (TRI 1993).

##### 4.2 IMPORT/EXPORT

Import volumes of naphtha-type jet fuels such as JP-4 decreased considerably between 1981 and 1983 (ITC 1985). Total amounts of naphtha-type jet fuels imported into the United States were  $\approx$ 2.7 million barrels in 1981,  $\approx$ 1.9 million barrels in 1982, and 322,000 barrels in 1983. Current import data for JP-4 and JP-7 are not available. No export data were located for JP-4 or JP-7.

##### 4.3 USE

Aviation turbine fuels such as JP-4 and JP-7 were not used until the 1930s when the first turbojet engine was developed (IARC 1989). Jet-powered aircraft had only limited use in World War II, but further military and commercial developments brought jet engines to the forefront as power sources for aircraft in the 1960s. The Air Force has used turbine-powered aircraft, which require the use of aviation turbine fuels such as JP-4 and JP-7, for over 25 years (Gleason and Martone 1979).

Both JP-4 and JP-7 are used exclusively as military aviation fuels by the U.S. military, especially the U.S. Air Force (Air Force 1989b; IARC 1989). However, there are indications that JP-4 has been used and stored at one U.S. Coast Guard Facility (Grand Traverse County, Michigan) (Twenter et al. 1985). JP-4 is a wide-cut fuel that meets operational requirements and offers a broad availability in the event of a war (CRC 1984; Dukek 1978). JP-4 is used in military aircraft such as the F-4 (Air Force 1981h). JP-7 is a kerosene fuel used by the Air Force for specific applications that require high thermal stability. Since JP-7 has a high flashpoint, it is used in supersonic Air Force aircraft (CRC 1984; Dukek 1978).

At one time, the U.S. Department of Defense consumed approximately 2.7% of the total petroleum products made in the United States (Gleason and Martone 1979). Approximately 50%, or 250,000

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barrels per day, has been used as JP-4. JP-4 has constituted 85% of the turbine fuels used by the Department of Defense (Air Force 1989b).

#### 4.4 DISPOSAL

Since JP-4 and JP-7 have been widely used by the U.S. Air Force, disposal information for JP-4 and JP-7 involves mostly the disposal of JP-4 released into the air, water, or soil in the case of accidental spills and normal aircraft operations.

Vapors generated in tank truck loading of JP-4 can be disposed of by the installation of a vapor recovery system (NIOSH 1989). Runoff of jet fuels from loading and unloading aircraft operations can be separated by an on-site oil/water separation system.

Several methods have been investigated for the disposal of JP-4 spilled onto soil from normal aircraft operations or from accidental spills. One method, in situ soil venting, involves using vacuum blowers to pull large amounts of air through soil contaminated with JP-4 (Elliot and DePaoli 1990). The air pulls out the soil gas, and the JP-4 contaminants volatilize as a result of disrupted equilibrium. Freeproduct extraction of JP-4 from soil and subsequent off-site cement kiln incineration have also been investigated as a means of disposal of JP-4 spills in soil and groundwater (EPA 1990b). Another process called in-situ bioventing, whereby oxygen is delivered by forced air movement through the contaminated unsaturated soils to stimulate in-situ biodegradation in an otherwise oxygen-limited zone, has been successfully applied to a contaminated test site (Air Force 1992). Thermophilic composting in the presence of horse manure and chicken manure has shown considerable promise for treating JP-4 contaminated soil (McMullen and Regan 1992). Excavation of soil contaminated with JP-4 and subsequent incineration at an approved EPA hazardous waste incineration site is another means of disposal that has been investigated for JP-4 (EPA 1990b). Additional information on the EPA hazardous waste regulations that apply to JP-4, JP-7 and incineration practices is available in Chapter 7.

Biodegradation of JP-4 in groundwater has also been investigated as a means to treat contaminated groundwater (EPA 1990b). This process involves the extraction of JP-4 from contaminated groundwater, addition of nutrients for subsequent reinjection, and *in situ* biodegradation of the volatile organic compounds found in JP-4. Carbon adsorption is another suggested method of treatment of

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JP-4 in which activated carbon is injected into JP-4 contaminated groundwater. The activated carbon is later removed along with the JP-4.