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

4.1 PRODUCTION

Initially synthesized in the late 1940s, dichlorvos was not registered for insecticidal use in the United States under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) until 1948 (EPA 1987b). Until large scale production of dichlorvos began in the late 1950s, the compound was chiefly encountered as an impurity in the pesticide trichlorfon (IARC 1979). One method of production is the dehydrochlorination of trichlorfon in aqueous alkali at 40-50°C (WHO 1989). Dichlorvos is also produced commercially by a reaction of trimethyl phosphite and chloral (Cremlyn 1978; Sittig 1980; WHO 1989).

As a pesticide, dichlorvos is commonly referred to as DDVP, which is an abbreviation for 2,2-dichlorovinyl dimethyl phosphate (Farm Chemical Handbook 1984). Commercially available formulations include aerosols and soluble concentrates. Historically, product formulations have also included dusts, granules, emulsifiable concentrates, wettable powders, flea collars, baits, and impregnated resin strips, and pellets/tablets (EPA 1990b; Farm Chemical Handbook 1984; IARC 1991; PIP-Dichlorvos 1993; The Agrochemicals Handbook 1991). Dichlorvos is also formulated in combination with a variety of other pesticides including dimethoate, dinocap, fenchlorphos, fenitrothion, iodofenphos, lindane, malathion, methoxychlor, phosalone, piperonyl, pirimiphos-methyl, propoxpur, tetrasul, pyrethrins, and trichlorfon (IARC 1991; The Agrochemicals Handbook 1991). By September 1987, the EPA had issued 885 end-use registrations for dichlorvos products. Of this total, 94 products were formulation intermediates, 24 were special local need registrations, 13 were technical products, and 49 were intrastate products (EPA 1987b).

In the past, basic producers of dichlorvos in the United States have included: Denka Chemia B.V., E.I. du Pont de Nemours and Company, Fermenta Animal Health, Kenco Chemical and Manufacturing Corporation, McLaughlin Cormley King Company, Prentiss Drug and Chemical Company, and SDS Biotech Corporation (EPA 1987b). Currently, only one manufacturer, AMVAC Chemical Corporation in Los Angeles, California, can be clearly documented as producing technical grade dichlorvos in the United States (Farm Chemical Handbook 1994; SRI 1994).

Information on historic production volumes of dichlorvos in the United States is limited. Production volumes based on estimates of annual use of dichlorvos in the United States for the years 1971, 1976, and 1980, suggest production levels as high as 4.6 million pounds (2.1 million kg) per year (IARC 1991; WHO 1989). In 1984, estimated production of dichlorvos in the United States was 500,000 kg (1.1 million pounds) (IARC 1991). In 1985, the estimated production of dichlorvos (active ingredient) in the United States was 2 million pounds (0.9 million kg) (EPA 1988a). Estimates of annual use of dichlorvos (active ingredient) in the United States during 1989 were less than 450,000 kg (992,000 pounds) and this use level was significantly lower than the total use in previous years (IARC 1991). It is unlikely, therefore, that production volumes for dichlorvos in the United States increased significantly between 1985 and 1989. Information on more recent production volumes was not found; however, it is likely that production volumes have decreased since the late 1980s due to changes in use patterns and registration cancellations (see Section 4.3).

Table 4-l lists the facilities in each state that manufacture or process dichlorvos, the intended use, and the range of maximum amounts of dichlorvos that are stored on site. The data listed in Table 4-l are derived from the Toxics Release Inventory (TR193 1995). Only certain types of facilities were required to report (EPA 1995a). Therefore, this is not an exhaustive list.

4.2 IMPORT/EXPORT

Official government statistics on imports and exports for chemicals such as dichlorvos are summarized under broad generic categories such as “pesticides” or “organophosphates.” No quantitative data on current or historic import volumes of dichlorvos were located in the available literature. With respect to exports, FIFRA generally prohibits the EPA from releasing complete information on pesticide production, sales, and distribution. No governmental agency maintains current records concerning what specific pesticides are exported. No quantitative data on current or historic export volumes of dichlorvos were located in the available literature.

4.3 USE

Dichlorvos has been used widely as an insecticide and miticide since 1961 to control internal and external parasites in livestock and domestic animals, to control insects in houses, and for crop protection (IARC 1991). It is an organophosphorus insecticide with fumigant and penetrant action that

Table 4-1. Facilities That Manufacture or Process Dichlorvos

Facility	Location[a]	Range of maximum amounts on site in pounds	Activities and uses
AMERICAN VANGUARD CO.	LOS ANGELES, CA	10,000-99,999	Produce; For on-site use/processing; For sale/distribution; As a reactant; As a formulation component
NA	SANDERSVILLE, GA	1,000-9,999	As a formulation component
NA	PLEASANTVILLE, IA	1,000-9,999	As a formulation component
NA	ELWOOD, KS	10,000-99,999	As a formulation component; As a product component
NA	ADDISON, TX	1,000-9,999	As a product component

Source: TRI93 1995

[a] Post office state abbreviations used

NA = not available

exhibits anticholinesterase effects (EPA 1987b, 1990a; Worthing 1983). Dichlorvos is poisonous if swallowed, inhaled, or absorbed through the skin; therefore, it acts as a contact and stomach poison (WHO 1985). Because dichlorvos is one of the more volatile pesticides in this class of compounds, it has been used primarily for its fumigant action (Cremlyn 1978). It is effective in controlling nuisance pests (e.g., caterpillars, flies, mosquitoes, and cockroaches) in and around domestic dwellings, stored products, commercial transportation vehicles, and livestock buildings. In 1974, dichlorvos was ranked as one of three active ingredients most frequently used by pest control operators. The aerosol formulation of dichlorvos was viewed as the most popular (EPA 1976). In 1975, it was estimated that approximately 80% of the dichlorvos produced in the United States was formulated into polyvinylchloride resin strips containing 20% by weight of dichlorvos (EPA 1976; IARC 1979, 1991). Prior to marketing this formulation for controlling flies and mosquitoes in the home in 1967, resin strips were introduced to the dairy and poultry industries (IARC 1991). According to the National Household Pesticide Usage Study of 1976 and 1977, the most frequently observed pesticide in a sample of 8,254 households was dichlorvos (EPA 1987b). Other uses have included direct application to packaged nonperishable processed or bulk-stored raw agricultural commodities (EPA 1990b, 1993b). Dichlorvos also has therapeutic uses; it has been incorporated in animal feed as an antihelminthic to treat a variety of internal and external parasites in swine, horses, and dogs (Farm Chemical Handbook 1984; HSDB 1996; PIP-Dichlorvos 1993).

Until the early 1970s, dichlorvos or mixtures containing dichlorvos were routinely used by fisheries biologists for the control of nuisance species such as carp (Marking 1992). Dichlorvos also has been added directly to water to control parasites in intensive fish farming (WHO 1989). Concern over problems associated with toxic and environmentally persistent organochlorine and organophosphate pesticide agents has led to restrictions on the use of such agents in natural lakes or other waterbodies, but dichlorvos has continued to be used in aquaculture to control various types of fish parasites. The use of such methods is very common in some European countries; for example, in Norway it is used in the aquaculture production of Atlantic salmon and rainbow trout (Cusack and Johnson 1990; Hoey et al. 1991; Horsberg and Hoey 1990; McHenery et al. 1991). Information on the current use of dichlorvos in aquaculture in the United States was not found.

In 1971, a total of 1,116,000 kg (2.44 million pounds) of dichlorvos were used in agricultural applications with 16,000 kg (35,000 pounds) being used on crops and 1.1 million kg (2.4 million pounds) being used on livestock and livestock buildings (IARC 1979). In 1980, the total usage of

dichlorvos (active ingredient) in the United States was estimated to range from 1.58 to 2.1 million kg (3.5-4.6 million pounds) (EPA 1980 as cited in IARC 1991). This includes 0.68-1.2 million kg (1.5-2.6 million pounds) for agricultural uses, 450,000 kg (1 million pounds) for public health applications, and about 450,000 kg (1 million pounds) for household use. With respect to agricultural uses of dichlorvos during 1980, approximately 340,000 kg (748,000 pounds) were used on dairy cattle, 30,000 kg (66,000 pounds) on beef cattle, 6,000 kg (13,200 pounds) on hogs, 2,000 kg (4,400 pounds) on poultry, 14,000 kg (30,800 pounds) on other livestock, and 50,000 kg (110,000 pounds) for treatment of tobacco. The estimated annual agricultural use of dichlorvos on crops in the United States during 1982 was 112,500 kg (248,000 pounds) of active ingredient (Gianessi 1986). From the mid- to late-1980s, agricultural applications represented 60% of the total annual usage in the United States: 35% was used on beef and dairy cattle, swine, and livestock buildings; and 25% was used on sheep, poultry, other livestock, tobacco, and greenhouse-grown food crops including lettuce, mushrooms, and tomatoes. Commercial, institutional, and industrial uses accounted for 25% of the annual usage; and domestic uses, including household pesticides and pet collars, accounted for 15% of the usage. The annual usage of dichlorvos (active ingredient) for 1989 was estimated to be less than 450,000 kg (990,000 pounds) (IARC 1991). This use level was significantly lower than the total use in previous years (IARC 1991). No information on more current use levels was identified in the available literature.

Drastic changes in use patterns (EPA 1993a) and restrictions on or cancellations of some registrations (EPA 1991a) are likely to have resulted in decreasing production of dichlorvos. For example, there has been a decline in the use of dichlorvos in unique agricultural applications such as ornamental perennials (EPA 1993a), and its use on figs was canceled in October 1989 (EPA 1991a). As a result of scientific investigations initially begun in the early 1980s and determination that exposure to dichlorvos from the registered uses may pose a carcinogenic risk, the EPA announced in February 1988 that it was initiating a Special Review for products containing dichlorvos (EPA 1991a). Dichlorvos has since been classified as a probable human carcinogen based on effects observed in mice and rats. The EPA has required cautionary warning labels on products containing dichlorvos; and the FDA has required warnings for pest strip products to discourage their use around kitchens, restaurants, or other areas where food is prepared. Recently, the EPA issued a “stay” on the effective date for the revocation of the food additive regulation for residues of dichlorvos in or on certain packaged processed foods (EPA 1993b, 1994a).

As of September 28, 1995, the EPA proposed cancellation of most uses of the pesticide dichlorvos and proposed restrictions on retained uses (TOXLIST 1995). The proposed uses to be cancelled included all home uses such as hanging pest strips, room foggers, and pet flea collars. EPA also proposed that most retained uses be restricted to specially trained certified applicators. Because of dietary cancer risk, the EPA also proposed cancelling uses of dichlorvos on non-perishable raw and processed agricultural commodities which are stored in bulk, packages, or bags. The following uses are being proposed for cancellation because of unacceptable risks to persons applying dichlorvos or persons who live or work in areas where the chemical is applied: all warehouses, including tobacco warehouses; commercial, institutional, and industrial areas including food service, food manufacturing and food processing facilities; dichlorvos applied by hand to farm livestock (except poultry); all home uses (including uses by residents and commercial applicators); uses on ornamental lawns, turf and plants; and in airplanes. The EPA proposes to retain the following uses: mushroom houses and greenhouses (only automatic foggers or fogging through a port), kennels, feedlots, insect traps, garbage dumps, direct application to poultry, automated application to livestock, animal premises, manure, and in passenger buses. The uses in mushroom houses, greenhouses, and passenger buses will also be cancelled unless specified re-entry period statements (no re-entry within 48 hours after application except in emergency) are added to the product labels. Because of the uncertainty associated with continuing the registration of a number of registered uses, it is difficult to predict future production or use patterns for the United States.

4.4 DISPOSAL

Dichlorvos was designated as a hazardous substance under the Federal Resource Conservation and Recovery Act, and the clean-up of discharges of dichlorvos to the environment are further regulated by the Clean Water Act (CWA) Amendments of 1977 and 1987 and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Regulations and advisories governing the treatment and disposal of dichlorvos-containing waste are detailed in Section 7. Generally, the recommended disposal methods for dichlorvos include alkaline hydrolysis, landfilling,and incineration. Prior to disposal, the product from the alkali treatment is mixed with soil that is rich in organic matter. Another possible disposal technology is to combine residues of dichlorvos with sawdust followed by incineration at high temperature in a unit equipped with effluent gas scrubbers (IRPTC 1985).

No historic or current information was located on the volume of dichlorvos disposed of or on the specific disposal method used.