4. PRODUCTION, IMPORT, USE, AND DISPOSAL

4.1 PRODUCTION

Radon is a naturally occurring radionuclide. The largest source of radon in the environment is due to the ambient levels produced by the widespread distribution of uranium and its decay products in the soil. Radon is a decay product of radium and part of the uranium decay chain (see Figure 3-1). Every square mile of surface soil, to a depth of 6 inches, contains approximately 1 gram of radium, which releases radon in small amounts to the atmosphere (Weast 1980). The ambient outdoor radon level goes through a daily cycle of concentrations ranging from 0.03 to 3.50 pCi radon-222/L (1.11 to 130 Bq/m^3) of air with the average level in the United States being about 0.3 pCi radon-222/L (11.1 Bq/m^3) of outdoor air (Martin and Mills 1973).

The amount of naturally occurring radon released to the atmosphere is increased in areas with uranium and thorium ore deposits and granite formations, which have a high concentration of natural uranium. It is the presence of granite formations that has greatly increased radon concentrations in eastern Pennsylvania and parts of New York and New Jersey. Sources of radon in the global atmosphere include natural emanation from radium in soil and water, uranium tailings, phosphate residues, coal, and building materials (NCRP 1984a). In a few locations, tailings have been used for landfills and were subsequently built on, resulting in possible increased exposure to radon (Eichholz 1987). There is also an increased radon concentration in spring water due to the deposition of radium isotopes in the sinter areas about hot springs, where it is coprecipitated with calcium carbonate or silica (NCRP 1975).

Radon has been produced commercially for use in radiation therapy but for the most part has been replaced by radionuclides made in accelerators and nuclear reactors. Radiopharmaceutical companies and a few hospitals pump the radon from a radium source into tubes called "seeds" or "needles" which may be implanted in patients (Cohen 1979). Research laboratories and universities produce radon for experimental studies.

4.2 IMPORT

Radon is not imported into the United States.

4.3 USE

Medical uses of radon in the United States began as early as 1914. Treatments were primarily for malignant tumors. The radon was encapsulated in gold seeds and then implanted into the site of malignancy. During the period of 1930 to 1950, radon seeds were used for dermatological disorders, including acne.

Radon therapy is still being studied and applied (Morken 1980). In many places in the world, water or air containing naturally high levels of radon-222 is used for therapeutic treatment of various diseases (Pohl- Ruling et al. 1982). These diseases include obliterative arteritis and atherosclerosis of lower extremities. In a few places, “radon mines” (caves with a high radon concentration in the air) are used as a health treatment . By law , these facilities cannot advertise; therefore , the number of people involved is quite small (Cohen 1979). A few of these caves are located in old Montana mines. Thousands of people seek medical cures through exposure to radon gas for ailments ranging from arthritis, asthma, and allergies to diabetes, ulcers, and cancer (Dobbin 1987). Radon “spas” are used in Europe for the treatment of hypertension and a number of other disorders. In the U.S.S.R. , about 25,000 radon baths are prescribed daily by the National Health System, and in Badgastein, Austria, every year 1 million radon thermal baths are taken (Usunov et al. 1981).

The prediction of earthquakes is fairly new technology that uses radon (Cothern 1987b). The emanation of radon from soil and the concention measured in groundwater appear to be good indicators of crustal activity. Other uses of radon include the study of atmospheric transport, and the exploration for petroleum or uranium (Cothern 1987b).

4.4 DISPOSAL

Disposal of radon would only be applicable to those facilities producing and/or using it for medical or experimential purposes where its release may be controlled. Regulations regarding the land disposal of radionuclides are set forth in 10 CFR 61 (NRC 1988); however, there appear to be no regulations specific to radon. See Chapter 7 for a listing of regulations concerning radon. Radioactive effluents from facilities operating under a Nuclear Regulatory Commission (NRC) license are regulated by 10 CFR 20 (NRC 1988). The NRC effluent regulations and also disposal regulations regarding uranium tailings are listed in Table 7-1. Since radon is relatively short lived, it may be compressed and stored in tanks until it decays or, if the quantity is small , it may be absorbed on activated charcoal (Cember 1983). Particulate matter may be removed from the gas by a variety of different devices including detention chambers, adsorbent beds, and liquefaction columns. After filtration, the remaining radioactive particulates are discharged into the atmosphere for dispersion of the nonfilterable low levels of activity (Cember 1983).

Low-level radioactive waste produced as a result of using radon medically or experimental include paper towels, protective clothing, rags, animal excreta, and animal carcasses. This waste is often accumulated in containers. Combustible waste is incinerated and the activity is concentrated by burning away the substrate in which activity is held. The ashes are then either dispersed to the atmosphere or packaged for disposal into the sea or into the ground.