North American Water office

AT RISK POPULATIONS

There are critical at risk subgroups in the population that needs special attention when examining health risks of exposure to gaseous and liquid radioactive wastes that nuclear power plants routinely discharge into our environment. In order to meaningfully address questions of public health arising from these discharges, it is particularly important to determine the risks of the maximally exposed individuals, and those most susceptible to radiation damage. Understanding the risks to the most exposed and most susceptible members of society will make it easier to establish radiation monitoring objectives that are useful and relevant from a public health perspective.

Actual dose equivalents received by members of the public will vary widely depending on such factors as age, metabolism, dietary and other habits, as well as variations in their environment. This variability can be accounted for by identifying an appropriate group that is representative of those individuals in the population expected to receive the highest dose equivalents from the source of radiation under consideration. The group must be small enough to be relatively homogeneous with respect to age, diet and those aspects of behavior that affect the doses received.

Are There Safe Levels of Exposure to Ionizing Radiation?

There is no safe level of exposure to ionizing radiation. Generally, as

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INSIDE FEATURES

exposure to ionizing radiation increases, the risk of harm increases. The "acceptable" radiation dose or the one inducing the least radiation damage will not be the same for all members of the population. There are individuals who, due to age or different physiology, either receive a relatively higher radiation dose, or suffer greater radiation damage from an average dose, than the average population.

Who Are The Susceptible Groups

Susceptible individuals include embryos, fetuses, infants, children, the aged, sick people, and people with physiological abnormalities, such as DNA repair defects or immune deficiencies. Chemical and radiation workers also belong to the group of people at risk because they may experience higher radiation dosages.

The dose a person receives from a given radioisotope can vary depending on the age of the person. The most sensitive populations are embryos and fetuses and children, because cells in their bodies are rapidly growing and multiplying. In addition to variations in the doses received at different ages, the radiation dose depends on parameters such as uptake rates of the radionuclides from the gastrointestinal tract to the blood, uptake rates from the blood to the body organs, biological half-lives of the radionuclides, and the size of critical organs. These parameters have an individual variation depending on, for example, body size, weight, health condition, and age.

Embryo and Fetus

The developing embryo and fetus are stages of life most susceptible to damage from ionizing radiation. Radionuclides inhaled or ingested by the mother can pass through the placental barrier (which is a membraneous organ that develops during pregnancy, lining the uterine wall and partially enveloping the fetus), and can be absorbed by embryos and fetuses. The extent of damage in utero depends upon the level of radiation dose absorbed. The amount of radiation delivered to the unborn depends upon the distribution and biological half-lives of radionuclides in the embryo and fetus.

Most radionuclides pass through the placenta by passive diffusion. For certain radionuclides, for example those of calcium, iron, strontium, plutonium and iodine, an active transport mechanism is assumed. Where active transport occurs, the fetal organism shows significantly higher concentrations of radionuclides than the mother.

Experiments have shown that some radionuclides that are emitted into the atmosphere by nuclear facilities, can accumulate in fetal organs. For example, it has been observed that strontium is incorporated in the fetal skeleton throughout its formation. Similarly, cobalt in vitamin B_{12} is accumulated in the fetus. By the time of birth, concentrations of radionuclides in fetal serum exceed concentrations in the mother. In regard to cesium, zinc, zirconium, and iron, the passage of these nuclides through the placenta has been proven by experiments. The iodine concentration of the fetal thyroid may exceed the concentration of the mother's thyroid by 12 times. Finally, animal studies indicate that, after application of plutonium citrate to the mother, the plutonium concentration in the fetal bone of rats was three times as high as in the bone of the mother. Newborn rats and dogs had a 100-fold higher plutonium absorption than the adult rats and dogs.

Infants

The radiation dose derived from the uptake of a certain amount of radioactivity is dependent upon age, and various parameters for the calculation of the radiation dose are also age dependent. For example, ingestion of Iodine-131 and Strontium-90 provides the highest radiation doses to infants. In contrast, fetuses are the most endangered group when the iodine pathway under consideration is inhalation.

Persons With DNA Repair Defects

Mutagenesis, carcinogenesis, and teratogenesis, are the three toxic health effects of primary concern with exposure to radionuclides or ionizing radiation. Mutagenesis refers to changes in the germinal tissue. Carcinogenesis refers to cellular damage in the somatic tissue, whereas teratogenesis occurs in developing fetal tissue. There are four heritable diseases known to entail both deficiency in DNA repair enzymes and predisposition to radiation carcinogenesis. A John Hopkins University study of cancer frequencies among relatives of persons with these four DNA repair deficiency syndromes concluded that as many as 15 percent of all cancer patients in the U.S. were predisposed to their disease and hence, fall into a radiosensitive subgroup of the population in the U.S.

Other Subgroups

Other categories of critical groups who are more susceptible to damage from ionizing radiation include:

-persons with immunodeficiency: for example, organ transplant recipients, cancer patients undergoing chemotherapy, cancer patients undergoing radiotherapy, persons with heritable immunodeficiency syndromes, and persons with chronic stress;

-chemical and radiation workers;

-sensitized subgroup of the public: for example, citizens who reside near hazardous waste dumps.

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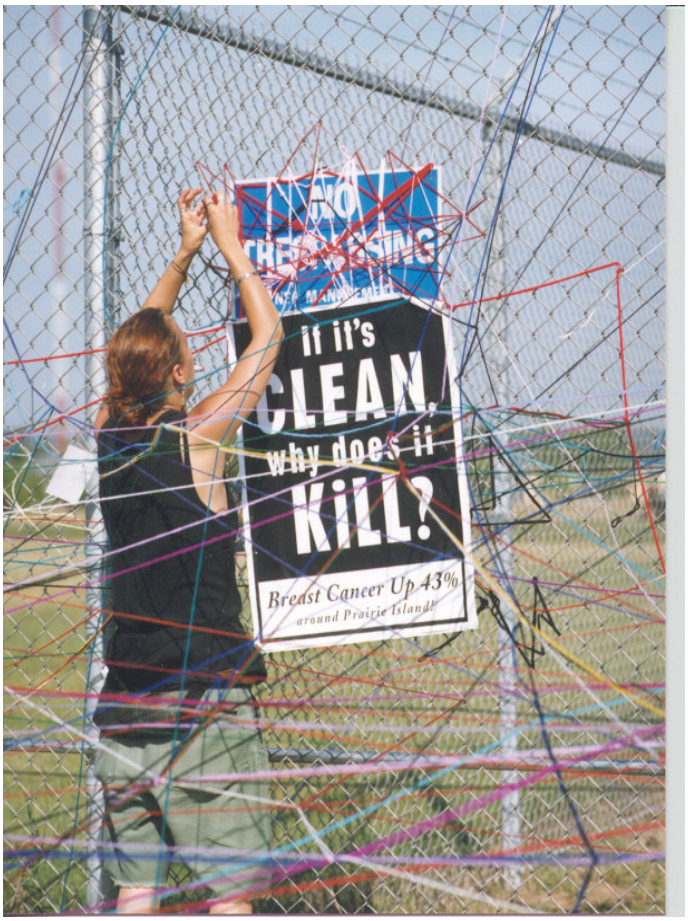

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