5. How Do Radioactive Materials Move Through the Environment to People?

Naturally occurring radioactive materials are present in our environment and in our bodies. We are, therefore, continuously exposed to radiation from radioactive atoms (radionuclides). Radionuclides released to the environment as a result of human activities add to that exposure.

Radiation is energy emitted when a radionuclide decays. It can affect living tissue only when the energy is absorbed in that tissue. Radionuclides can be hazardous to living tissue when they are inside an organism where radiation released can be immediately absorbed. They may also be hazardous when they are outside of the organism but close enough for some radiation to be absorbed by the tissue.

Radionuclides move through the environment and into the body through many different pathways. Understanding these pathways makes it possible to take actions to block or avoid exposure to radiation. This can minimize peoples' exposure to additional radiation resulting from human activities.

Radionuclides travel through the environment along the same pathways as other materials. They travel through the air, in water (both groundwater and surface water), and through the food chain. Radionuclides may enter the human body by eating or drinking, by inhalation, or by absorption through the skin. This fact sheet describes the pathways radioactive materials follow through the environment and into the body.

Pathways Through the Environment

➤ Atmosphere

Radionuclides can be released into the air by human activities. They can also be created in the atmosphere by natural processes such as the interaction of cosmic radiation with nitrogen to produce radioactive Carbon-14.

Radionuclides can be removed from the air in several ways. Particles settle out of the atmosphere if air currents cannot keep them suspended. Rain or snow can also remove them.

When these particles are removed from the atmosphere, they may land in water, on soil, or on the surfaces of living and non-living things. The particles may return to the atmosphere by resuspension, which occurs when wind or some other natural or human activity generates clouds of dust containing radionuclides.

➤ Water

Radionuclides can come into contact with water in several ways. They may be deposited from the air (as described above). They may also be released to the water from the ground through erosion, seepage, or human activities such as mining or release of radioactive liquids into sanitary sewers or rivers, lakes, streams or ground water.

Some radionuclides that reach either groundwater or surface water will move with the water. Others will be deposited on the surrounding soil or rocks. One important factor affecting their movement is how thoroughly they dissolve in water (solubility). Another factor affecting movement is the ability of the radionuclide to adhere to the surfaces of rocks or soil through which the water flows.

➤ Food Chain

Radionuclides in water or air may enter the food chain. For example, plants are capable of absorbing radionuclides from water in the same way as other minerals are absorbed. When animals drink water some of the radionuclides in the water will remain in their bodies.

Radionuclides from the air may settle on

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the surface of plants. When animals eat the plants, they ingest the radionuclides that have settled from the air or have been absorbed from the water. Plants and animals that will eventually become food for people thus provide a pathway for radionuclides to move through the environment to people.

Pathways into the Human Body

➤ Ingestion

Anything that people eat can contain radionuclides. The water that people drink can also contain radionuclides. Some radionuclides are intentionally ingested as part of a medical therapy or diagnostic procedure.

Some of the radionuclides people ingest can remain in the body for long periods of time while others are quickly eliminated, often within hours.

➤ Inhalation

Radionuclides suspended in the atmosphere can enter our lungs. Some radioactive particles are exhaled, and some remain in the lungs where the radiation they release strikes the lung tissue. An important natural source of radiation exposure is the radioactive gas radon. Decay of radon atoms in the air gives rise to other radioactive atoms that are much more likely than radon to be retained in the lungs. These "radon decay products" are estimated by the United States Environmental Protection Agency to be responsible for several thousand lung cancer deaths each year in the United States.

➤ Through the Skin

Radionuclides can be absorbed through the skin's surface, or can enter the body through a break in the skin. Another pathway is through the injection of radionuclides as part of medical therapy or diagnosis.

Pathways and Low-level Radioactive Waste

Packaging and disposal facilities for low-level radioactive waste are designed to minimize the amount of radioactive material entering any of these pathways. Low-level waste is placed in containers to prevent release of radionuclides to the air during transportation and handling, and to hold external radiation levels below regulated limits. Low-level radioactive waste disposal facilities must be located away from water. They are also designed to divert water away from the waste and/or to collect and remove radionuclides from any water that might come in contact with the waste. This minimizes the amount of radioactive material that might inadvertantly be released into water. Radioactive material from low-level waste that is not released into air or water cannot enter the food chain or reach people.

➤ For More Information

If you want to read more about pathways radiation can follow through the environment, the reference listed below may be helpful.

- Raymond L. Murray, "Understanding Radioactive Waste", Battelle Press, Columbus, Ohio, Fourth Edition, 1994.

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