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NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Health Effects of Radiation and Radioactivity

Radiation and Radioactivity

"Radiation" is simply energy moving through space. It can take the form of electromagnetic waves such as microwaves used to cook food, X-rays for diagnostic medical purposes, and gamma rays for therapeutic medical purposes. Or it can be in the form of highspeed alpha particles and beta particles emitted by heavy metals such as uranium and radium, and neutrons produced at fission.

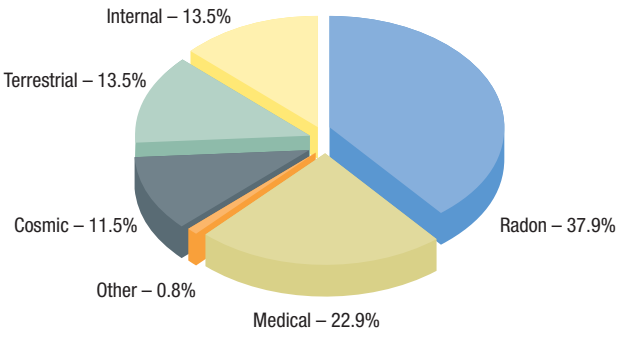

Figure 1: Sources of average annual radiation exposure in Canada

Substances are said to be "radioactive" when they emit radiation, either naturally or as a man-made condition. In Canada, on average, 76 per cent of human exposure to radiation is from natural sources. These include radon gas from the earth's crust that is present in the air we breathe, terrestrial radiation from mineral soils, and cosmic radiation from space. Our bodies are also a source of radiation from potassium and carbon in the food we eat. The remaining sources of radiation exposure are man-made. Twenty-three per cent comes from medical technologies including X-rays and gamma-rays. And one per cent can be categorized as "other" – created by things like the nuclear generation of electricity.

Health Effects of Radiation

Radiation can be either "ionizing" or "non-ionizing." Ionizing radiation has enough energy to change the make-up of materials at their most basic level, the atom. The forms of ionizing radiation are alpha particles, beta particles and neutrons, as well as X-rays and gamma-rays. Non-ionizing radiation does not have enough energy to cause atomic changes.

The form and amount of ionizing radiation determine how far it can penetrate human tissue and how much damage it can cause. Skin can stop alpha particles and low energy beta particles, while a thin aluminum sheet will stop all beta particles. Higher energy radiation – including neutrons, gamma rays and X-rays – can penetrate the human body if it is not properly shielded. That is why we wear a protective lead covering when we have our teeth X-rayed by the dentist.

Normally, the human body withstands the radioactivity encountered in our daily lives because natural processes allow us to repair damaged tissue. However, if living tissue absorbs ionizing radiation, changes can occur at the atomic level. Exposure over the long term can disrupt the body's natural repair processes, permitting the uncontrolled growth of cells.

1. Alpha
2. Beta
3. Gamma rays and X-rays
4. Neutrons
5. Aluminum
6. Lead
7. Concrete

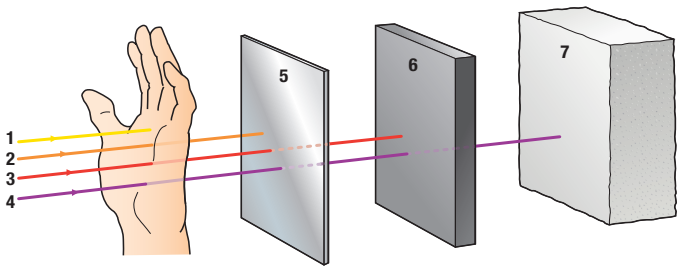

Figure 2: Types of radiation

Radiation Protection Principles

There are two important principles designed to ensure safety in the Canadian nuclear industry:

- ALARA – maintaining radiation exposure As Low As Reasonably Achievable, and
- Defence-in-Depth – creating multiple protective barriers between radiation sources and people and the environment.

ALARA is achieved by:

- Minimizing radiation and radioactive waste through efficient station operations,
- Minimizing the release of radioactive material to the environment through effective storage and ventilation systems, and
- Minimizing exposure to people and the environment by requiring workers to wear protective clothing and controlling emissions.

Figure 3: Radiometers can detect even the most minute amounts of radiation

Defense-in-Depth requires each barrier to offer a unique and stand-alone level of protection, so that if one level fails, the next will come into play. The principle is applied in the storage of nuclear fuel waste. The first barrier consists of the ceramic material that makes up the fuel pellet. A second is the special alloy tubing in which the fuel pellets are encased. And a third is the concrete canister which houses the fuel bundles in dry storage facilities. The storage building and its ventilation systems provide additional protective barriers.

Canadian nuclear facilities implement the ALARA and Defense-In-Depth principles through radiation protection programs that include:

- Systems to monitor the radiation levels in each facility.
- Classification of work areas, as well as access control and restriction of activities to these areas based on present and anticipated radiological conditions.
- Work planning, work permit, and supervisory requirements for activities in work areas.
- Monitoring of all workers and visitors to ensure their exposure to radiation does not exceed regulatory limits. All personnel in a nuclear facility must wear a device that provides a reading of the external dose of radiation while working on site. In addition, internal dose from ingestion or inhalation is assessed through bioassay samples.
- Protective clothing and equipment requirements for areas with a high probability of contamination.
- Control of surface and airborne contamination through ventilation systems.
- Systems to measure and control facility emissions, as well as environmental monitoring programs.
- Employee training programs on radiological hazards within each facility.
- Emergency response plans.
- Packaging and transportation requirements for radioactive substances.

Radiation protection programs are part of the license requirements for nuclear facilities. Operating licenses are granted only if such programs are shown to be in place. For additional information, visit our website at www.nwmo.ca.

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