Nuclear Training Department

COURSE 410.3

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RADIATION AND THE PUBLIC

OBJECTIVES

On completing this module, with reference to the lesson material, you will be able to:

1. State the major constituents which make up the background radiation in which we live.

2. State three types of radioactive waste that result from the operation of a Nuclear Generating Station.

3. State the two control authorities involved in the setting of discharge limits of radioactivity from our nuclear stations.

4. State what is meant by ALARA.

The following is an introduction to the concepts of radiation in our environment. You will cover some aspects of this area in more detail during training. The intent here is to introduce you to the overall concepts so that you are able to see radiation in perspective and discuss it rationally with your families and friends.

WHERE DOES THIS RADIATION COME FROM?

Natural Radiation

Naturally radioactive elements have existed in the earth since its creation. All elements having an atomic number greater than 80, and some below, possess radioactive isotopes. In addition, the earth is subject to constant bombardment by cosmic radiation and certain radionuclides are formed in the atmosphere by neutron capture, notably Tritium, a form of Hydrogen, and Carbon 14. These are the major natural sources.

Manmade Radiation

To this background must be added the effects of fallout resulting from various nuclear weapons testing programs, the use of medical techniques which involve ionizing radiation and certain consumer items like luminous watches, television receivers and video display terminals.

Over and above all these contributions we must also consider the effect which nuclear power programs have on the environment.

RADIATION RESULTING FROM NUCLEAR GENERATION

Production of electricity by means of nuclear generating stations results in large quantities of radioactivity from the fission process. Fortunately, more than 99.99% of this activity remains locked up in the spent fuel, and is known as "high" level waste.

The day to day operation of the station results in relatively large volumes of low and medium radioactivity level plant wastes. These wastes consist of items such as purification resins, personal protective gear and clean-up materials.

A third type is low level radioactive emissions, mostly tritium in the case of CANDU stations, that escape from the plant on a more or less continuous basis.

The following table gives the expected dose levels from the various types noted to this point in the text.

ANNUAL PUBLIC BACKGROUND RADIATION
DOSES IN ONTARIO (Average for the Ontario Population)

	*Millirems
Natural Radiation (cosmic rays, potassium-40, concrete buildings, etc.)	220
Medical Exposures	100
Nuclear Weapons Test Fallout	2
Consumer Products	2
Technological Processes (including nuclear power)	0.1

* The rem is the unit commonly used to measure the relative biological effects of radiation on the human body. One millirem equals one thousandth of a rem.

CONTROLLING SOURCES OF RADIOACTIVITY FROM NUCLEAR GENERATION

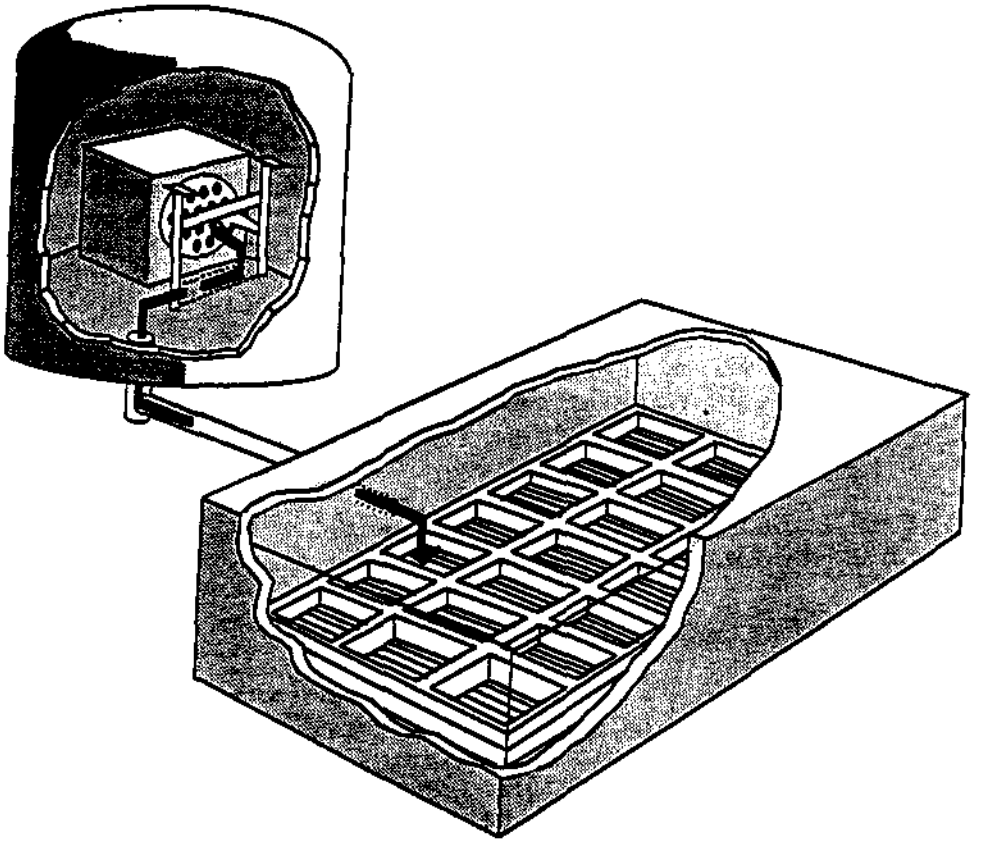
Storage and Disposal of "High" Level Waste

The irradiated fuel is remotely handled by the fuelling machines and stored in the irradiated fuel bays where it is kept both cool and shielded by several metres of water. In time, much of the radiation will decay away although it will be many years before radiation levels have dropped sufficiently to allow casual handling. At the present time, all the irradiated fuel produced by Ontario Hydro reactors is stored in fuel bays located at the generating stations.

In 1988, approximately 4 boxcars would contain all the fuel used in Ontario Hydro's nuclear power production since 1960. This is true despite the fact that more electrical power has been produced in the last decade by nuclear methods than by water power or coal.

Figure 1

REMOTE HANDLING AND STORAGE OF IRRADIATED FUEL IN CANDU STATIONS



Two possibilities exist regarding the long term future of irradiated fuel:

1) Remove it to a custom built, long term depository - possibly located within the Canadian Shield.

2) Subject the fuel, at some time in the future, to reprocessing. This would separate the useful fissile material (notably uranium and plutonium) from the highly radioactive waste products. This high level waste would then have to be safely stored for an extended period of time - again, possibly in some underground depository.

Either solution is technically possibly but at the moment it remains a contentious socio-political issue.

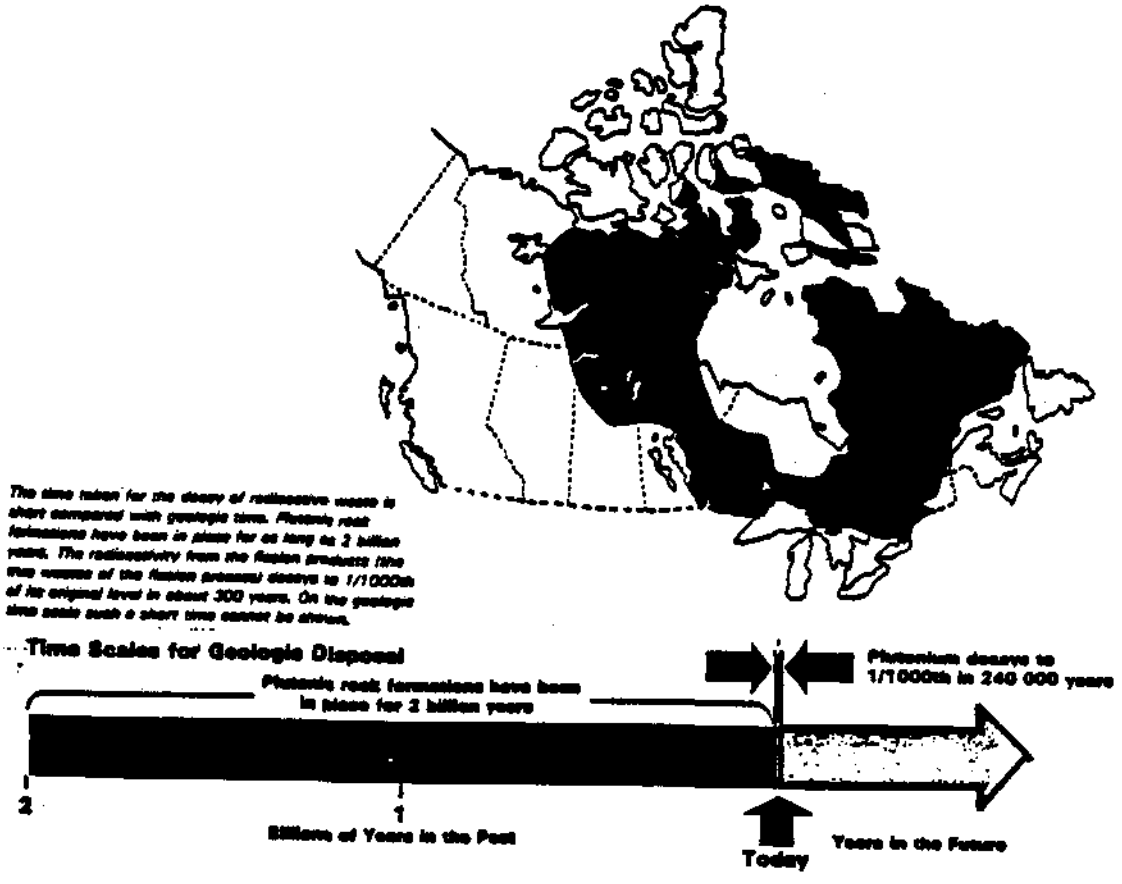


Figure 2

POSSIBLE AREAS SUITABLE FOR
LONG TERM STORAGE OF IRRADIATED FUEL

Storage of "Low" and "Intermediate" Level Wastes

Plant wastes are generally either combusted in special incinerators or are compacted and sealed in special containers which are then managed and stored at the Bruce Nuclear Power Development. Again, this storage is temporary pending the development of permanent disposal sites.

Nuclear Station Radioactive Emissions

Ontario Hydro controls discharges to less than 1% of the Regulatory limits for radioactive emissions set by the Atomic Energy Control Board of Canada (AECB) and based upon the recommendations of the International Atomic Energy Authority (IAEA).

The small amount of radioactivity that is released from the plant is either to atmosphere via a filtered exhaust stack or to the lake by means of a liquid waste disposal system. Within the plant there is immediately a significant reduction by means of dilution. For airborne releases, there is a secondary dilution determined by the minimum one kilometre radius public exclusion zone around the stations. In any event, the amount and type of radioactivity which is released is carefully controlled and monitored.

In order to ensure that operating targets are achieved and maintained, an extensive program of environmental monitoring has beer established. Samples are taken from fixed positions at regular intervals. Measurements are taken of both the air and water at all sampling sites. The significance of the distribution will be discussed at greater length during RPT Training.

In addition, samples are also taken of lake sediments, certain fish species and terrestrial biota (fruits and vegetables).

EFFECTS OF LOW DOSE RADIATION

The information presented so far in this module has described the means of producing, measuring and controlling radioactivity in the environment. The module title indicates that we are looking at the effects of radiation on the public. It is in this low level area that quantitative answers are difficult to produce, and subject to large variations in interpretation.

Most data concerning the risk of cancer due to low level radiation exposure is based on the assumption that the effect of radiation is directly proportional to the dose (i.e., half the dose, half the effect). It is interesting, therefore, that people living in Denver, Colorado, where natural background levels of radiation are higher, largely due to altitude, actually exhibit a lower incidence of cancer than those in other areas of the United States. This demonstrates that the effects of low level radiation are far from clear.

Typical radiation exposures are shown in Figure 3. Note that the typical Ontario Hydro worker dose is 0.7 rem per year compared with the legal limit for annual exposure for an Atomic Radiation Worker of 5 rem.

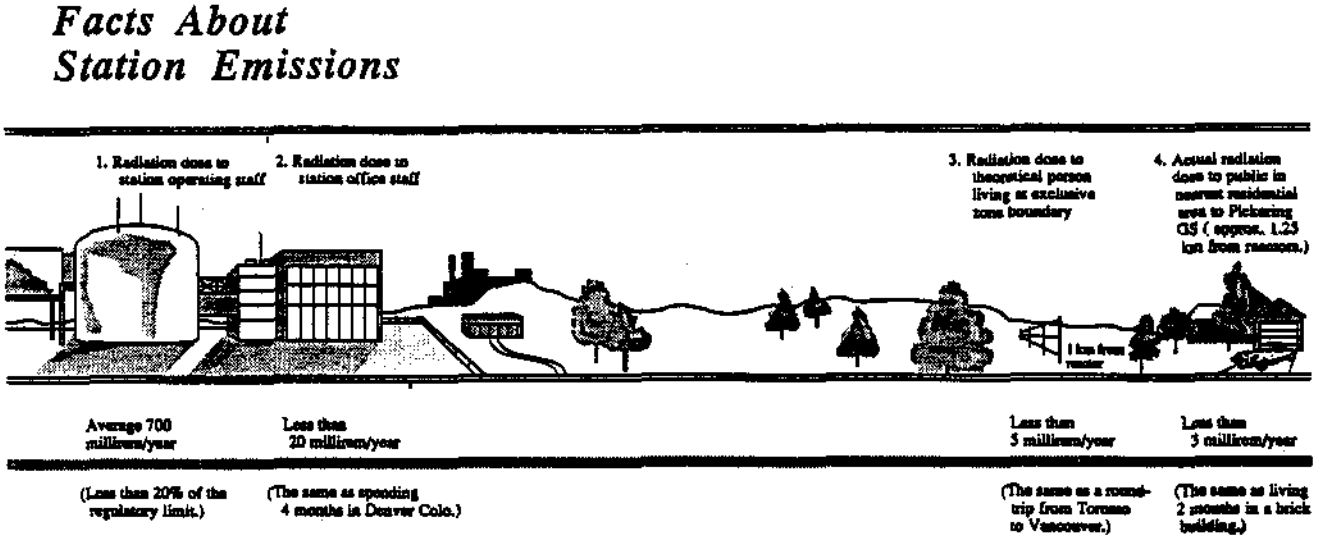


Figure 3

It is also of interest to note the increase in radiation exposure received by a theoretical person living continuously "on" the Pickering perimeter fence; 5/1000 rem (5 millirem), annually an increase of about 3%.

OUR PHILOSOPHY

The above information does not intend in any way to minimize or make light of the effects of low level radiation. Our concern must be to "play it safe" - reduce levels to both our workers and the general public to as low as reasonably achievable (ALARA). This principle will be further developed in the Radiation Protection Training you will receive. This training will then form the basis for carrying out work in radioactive work locations.

In addition we must continue to refine work procedures and operating methods to be used in our plants which ensure that these low levels of radioactive emissions are reduced even further below 1% of the regulatory limits.

Our plant design and operating policies are intended to achieve this They are based on the Defence in Depth philosophy introduced in the first section and fully explained in Course 429, Introduction to Reactor Safety, given later in your initial technical training.

ASSIGNMENT

Using the course notes and lecture materials.

1. State two natural sources and two "manmade" sources which together constitute the natural radioactive background in which we live.

2. Name three types of radioactive waste which are produced by the normal operation of a CANDU nuclear generating station.

3. Name the two control authorities involved in the setting of radioactivity discharge limits in Canada.

4. Our radioactive exposure and discharges are described by the acronym ALARA. What does ALARA stand for?