A. EMPLOYEE AND PUBLIC SAFETY

ENABLING OBJECTIVES:

1.1	Name the hazards unique to nuclear power and heavy water production from which both employees and the public must be protected.
1.2	Describe the makeup of background radiation, and state how much our nuclear stations contribute to it.
1.3	Explain the measures taken by Ontario Hydro to encourage a safe working environment.
1.4	Describe the limits of your responsibility for your personal safety.

This sections concentrates on the two KEAs relating to employee and public safety. It is no accident that you will find these topics reinforced continually during your career with Ontario Hydro. They are part of the foundation of our operating philosophy. This section is concerned primarily with **chronic hazards**, hazards continuously present in the workplace that we minimise through processes and procedures. An example of a chronic hazard is ice on walkways. It is difficult to prevent the ice from forming, but we can minimise the hazard by spreading sand.

Acute hazards - hazards that do not normally exist but could arise because of an abnormal event - will be dealt with in Section B. An example of an acute hazard is toxic smoke from a fire in a house. This hazard might be addressed by installing smoke alarms so that the abnormal event is detected early. If not prevented, we may at least be able to minimise its impact by having a prearranged plan for evacuating our family.

MAJOR HAZARDS ASSOCIATED WITH OUR NUCLEAR FACILITIES

RADIATION

The following introduces the concept of normal **background radiation** in our environment. Understanding background radiation is essential to a rational discussion of radiation hazards.

Background radiation is made up of a number of natural and manmade sources. **Naturally occurring radiation** comes from radioactive elements[2] that have existed in the earth since its creation. In addition, the earth is subject to constant bombardment by cosmic radiation which creates certain radionuclides in the atmosphere, such as tritium (hydrogen 3) and carbon 14[3]. **Manmade radiation** results from nuclear weapons testing programmes, the use of medical techniques which involve ionizing radiation, certain consumer items like luminous watches, television receivers, and video display terminals, and, of particular interest to us, nuclear power generation.

A byproduct of the nuclear generation of electricity is large quantities of radioactivity contained within the reactors. Problems can occur if this radiation escapes into the environment. The largest source of the radioactivity and hence the greatest potential acute hazard is **irradiated fuel**[4] (also known as high level waste). How we prevent this acute hazard from becoming chronic is dealt with in the next section. Some chronic hazards we face are:

- the relatively large volume of low and medium level radioactive plant wastes such as process equipment, personal protective equipment, and clean-up materials,
- and low level radioactivity (mostly tritium) emitted from the plant on a more or less continuous basis as a normal consequence of operation.

Figure 1.1 gives the expected annual radiation dose to a member of the public from each of the sources listed above.

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2 All naturally occurring elements with an atomic number greater than 83, and some below, possess radioactive forms.

3 Alternate forms of these naturally occurring elements.

4 Fuel which has become radioactive in the reactor in the process of producing heat through fission.

Sources of Radiation	Millirem/Year[5]
Natural Radiation (Cosmic Rays, Potassium-40, Building Materials, etc.)	220
Medical Exposures	100
Nuclear Weapons Test Fallout	2
Consumer Products	2
Nuclear Power	0.1

Figure 1.1
Annual Individual Exposure to Background Radiation in Ontario
(Average for the Ontario Population)

As can be seen, the contribution of nuclear power to the radiation exposure of members of the public is insignificant. Exposure of Atomic Radiation Workers within Ontario Hydro is more significant. The exposure limit set by the Atomic Energy Control Board (AECB) for Atomic Radiation Workers is 5000 millirem/year. (For non-radiation workers, the limit is 500 millirem/year.) This figure represents the amount of exposure a person can sustain year after year with no measurable effect. For comparison with actual exposures in and around our nuclear plants, see Figure 1.2.

[5] 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.

Proximity to Station	Annual Radiation Dose above Background	Relative Value
Station Operating Staff	400 millirem/year	5000 millirem/year AECB limit
Station Office Staff	20 millirem/year	The same as spending 4 months in Denver, Colorado.[6]
Person at Station Exclusion Fence	5 millirem/year	The same as a roundtrip by air between Toronto and Vancouver.
Residential Area 1 kilometre from Station	3 millirem/year	The same as radon exposure from living 2 months in a brick building.

Figure 1.2
Typical Radiation Exposures in and Around Our Plants

Note that the typical dose for operating staff (including maintenance staff) in our stations is 400 millirem/year, considerably less than the legal limit. As the distance from the reactor increases, radiation normally falls off dramatically until at the Station Exclusion Fence, the typical potential exposure is 5 millirem/year.

In conclusion, the incremental increase from nuclear power over background radiation likely to be received by members of the public is very low. Medical risks at these low dosages cannot be accurately determined. In the worst case it is believed that the effect of radiation is directly proportional to the dose (eg. half the dose, half the effect). But there is evidence that this assumption overstates the actual risk. For example, people living in Denver, Colorado, where natural levels of radiation are higher, actually exhibit a lower incidence of cancer than those in other areas of the United States. This is not to suggest that low levels of radiation are beneficial, but merely to illustrate that the effects of low level radiation are far from clear.

[6] Background radiation increases at higher altitudes due to reduced shielding from the atmosphere against cosmic radiation.

Even at the typical exposure of 400 millirem/year for operating staff, employees receive much less than the minimum dose considered to be dangerous to health. Even so, the Nuclear Business is always seeking ways of doing work so as to lower radiation exposure.

HYDROGEN SULPHIDE

CANDU reactors require **heavy water** (D_2O) for their processes. The Bruce Heavy Water Plant (BHWP) is currently our only source. The principle hazard associated with D_2O production is the use of hydrogen sulphide (H_2S) gas. In sufficient concentrations H_2S will cause respiratory failure and ultimately death. H_2S is a chronic hazard at BHWP, but it is also an acute hazard for the rest of the site. The volumes normally used in the production of heavy water are sufficient, if they escaped, to create a major hazard on the BNPD site (depending on wind direction). This gas is more of an immediate potential hazard to staff working on site than radiation. All departments at BNPD have emergency procedures in place for dealing with the potential danger associated with H_2S release. The site as a whole also has procedures designed to protect staff on site and the public in the area around BNPD.

ALARA - OUR PHILOSOPHY TOWARDS HAZARDS

The radiation and hydrogen sulphide hazards associated with our facilities are very real. Our control and containment methods are designed to prevent any harm to the public. The principle we observe is to "play it safe" by reducing hazard levels **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA). You will hear more about this principle in the safety training you will receive both at the training centre and at your work locations.

A SAFE WORKING ENVIRONMENT

Apart from the hazards that are fairly unique to the Nuclear Business, we face a host of conventional hazards that are common to most industries. Ontario Hydro places a heavy emphasis on safety in the work place. There are several reasons for this. First, none of us are prepared to accept an environment where employee injury or fatality is routine. Second, employees are our most valuable resource so it would be poor economics to tolerate an environment where employees are routinely injured. The emphasis on safety therefore pays off in terms of employee motivation and economics.

SAFETY STANDARDS

To encourage a positive attitude to safety, Ontario Hydro sets the following standards:

1) On average, employees at work should be safer than when they are not at work.

2) On average, employees at work in the nuclear business should be as safe as the average of all Ontario Hydro employees.

3) On average, employees at work in the nuclear business should be twice as safe as the average industrial employee in Ontario.

4) On average, employees at work in the nuclear business should be as safe as the average employee in all Canadian utilities and as safe as the average employee in all U.S. electrical utilities.

These standards are expressed in numerical terms and form part of the performance contract of each department. To achieve these minimum standards, we actually aim higher. Figure 1.3 shows both the standard and the target we aim for.

	Nuclear Standard (Average of 10 Years)	Nuclear Annual Target	Nuclear Goal for 2000 (Annual Target)
Employee Fatalities	≤ 2 per 100 million worker-hours	0 occurrences	0 occurrences
Employee Permanent Disabilities	≤ 2 per 10 million worker-hours	0 occurrences	0 occurrences
Employee Temporary Total Disabilities	≤ 0.4 per 200,000 hours worked	≤ 0.4 per 200,000 hours worked	≤ 0.2 per 200,000 hours worked
Employee Risk of Disabling Injury	≤ 10 days lost per 200,000 hours worked	≤ 10 days lost per 200,000 hours worked	≤ 10 days lost per 200,000 hours worked

Figure 1.3
Nuclear Business Safety Targets and Standards

Days per millions of worker hours may be a good way for the corporation to measure time lost, but how does this relate to the probability of you being injured? If we look at the category of Employee Temporary Total

Disabilities (accidents which require time off from work) the standard works out as **less than one injury in six working lifetimes.**[7] The target for the year 2000 is to reduce this to less than one injury in twelve working lifetimes.

While these are high standards, more often than not we have exceeded them. For example, to date we have not had a fatality related to operation of our nuclear facilities. Targets are continually reviewed and improved.

Ontario Hydro assists and encourages us to meet our safety targets through:

- **Corporate Safety Rules;**
- **policies and procedures** to encourage safe work practices;
- **free and subsidized personal protective equipment;**
- **intensive safety training** to develop a positive approach to safety;
- and **regular safety meetings** (you will be introduced to these as part of your initial training) to keep safety in the limelight by discussing progress towards our annual targets and topical safety issues.

When safety targets are met, recognition is provided through a safety recognition and award program.

The combination of a safe work place, protective equipment and safety training is vital. More critical, though, is your own attitude towards safety. Remember that SAFETY IS YOUR RESPONSIBILITY. **No work is so urgent, no task so important, that you cannot take the time to do the job safely.** A safe working environment is a cooperative achievement, it does not happen by accident.

ASSIGNMENT

At this point it is important to stop and review the material covered so far. The following questions are intended to focus your attention on the key safety issues defined in the enabling objectives.

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

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[7] Assuming a working lifetime of forty hours a week, fifty weeks a year for forty years.

2. Name three sources of radioactivity associated with the normal operation of a CANDU reactor.

3. Apart from radiation, what is the other major hazard that is relatively unique to Ontario Hydro's nuclear business?

4. Why is it in Ontario Hydro's interest to place a heavy emphasis on a safe working environment?

5. How does Ontario Hydro assist us in working to achieve a safe working environment?