Unit 5 Other Radiological Hazards

In this unit you will learn:

- Sources of non-life threatening radiation that people are exposed to daily.
- Hazards associated with these sources.
- Measures used to protect against the hazards.

INTRODUCTION

Many people are unaware that they are exposed to radiation on a continuing basis. By far, the greatest amount of radiation received by the world's population comes from natural sources. There are also man-made sources of radiation that people are exposed to periodically that contribute to their overall dose. This unit introduces you to some of these other radiation sources that people are exposed to and the radiological hazards associated with some of them.

This unit provides an introduction to the major sources of radiological hazards that are non-life threatening and are not associated with any type of emergency situation. This unit provides basic information on the measures that are taken on your behalf or which you can take to protect against some of these hazards. Upon completion of this unit you should be aware of the amount of radiation that you are exposed to on a continuing basis, and the sources of radiation that contribute to this. You should also be aware of man-made sources that contribute to your overall radiation dose on a periodic basis.

This unit is divided into three sections: Other Radiation Sources, Natural Sources, and Man-made Sources.

The **Other Radiation Sources** section describes the every day exposure of people to radiation from many sources. These sources are both natural and artificial and originate from many different places.

The **Natural Sources** section describes the natural sources of radiation that contribute to a person's every day exposure to radiation. The measures that can be taken to provide protection from some of these hazards are explained.

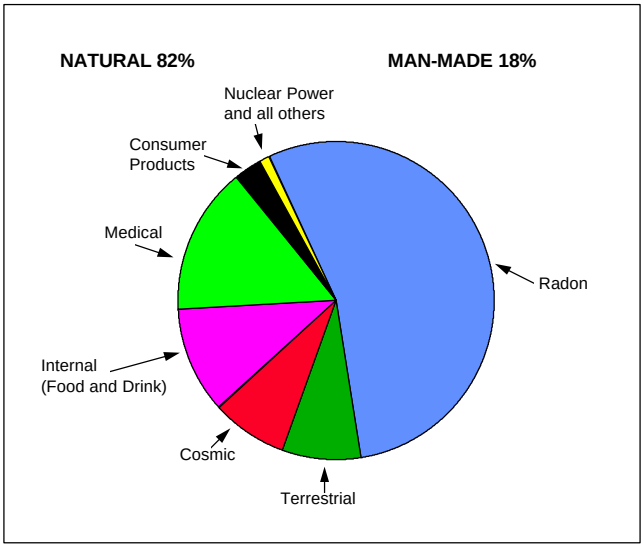
The **Man-made Sources** section describes the man-made sources of radiation that contribute to the every day exposure to radiation and the measures that can be taken to provide protection from some of these hazards.

OTHER RADIATION SOURCES

The attention that large radioactive sources such as nuclear power plants and nuclear devices has received recently has led to a greater understanding of the hazards from these sources of radiation and the need for emergency plans to respond to situations involving an accident or threat associated with them. However, radiation and radioactivity is present all the time, and has existed on the earth long before life emerged. Indeed, they were present in the universe long before the earth itself existed.

Radiation contributed to the formation of the universe, as far as we can tell, and has pervaded the cosmos ever since. Radioactive materials became part of the earth at its very conception. Even man himself is slightly radioactive. However, it has only been a little over one century since man discovered this phenomenon and began to use it for beneficial reasons. Radioactive materials are utilized in a broad array of activities which contribute to the total amount of radiation exposure a typical person receives.

Thus, the presence of radiation in our everyday lives comes from natural process, such as cosmic rays, and decay of uranium in the earth, and from man-made sources such as medical x-rays, industrial gamma rays, and air travel.



Sources of Radiation

Until very recently, radiation from natural sources was regarded as unremarkable and unalterable, a background phenomenon. It is now recognized that one of the largest sources of natural radiation, radon decay products in the home, can be high and it is fairly easy to reduce their levels in existing homes.

For all intents and purposes, exposure to the other natural sources cannot be controlled, and comprises a basic “background” dose from radiation. Some dose from radon decay products is unavoidable, but extreme exposures can be eliminated. Man-made sources, on the other hand, are more susceptible to control than natural sources, and the potential doses from them are often prevented or easily remedied through controls on their manufacture and distribution.

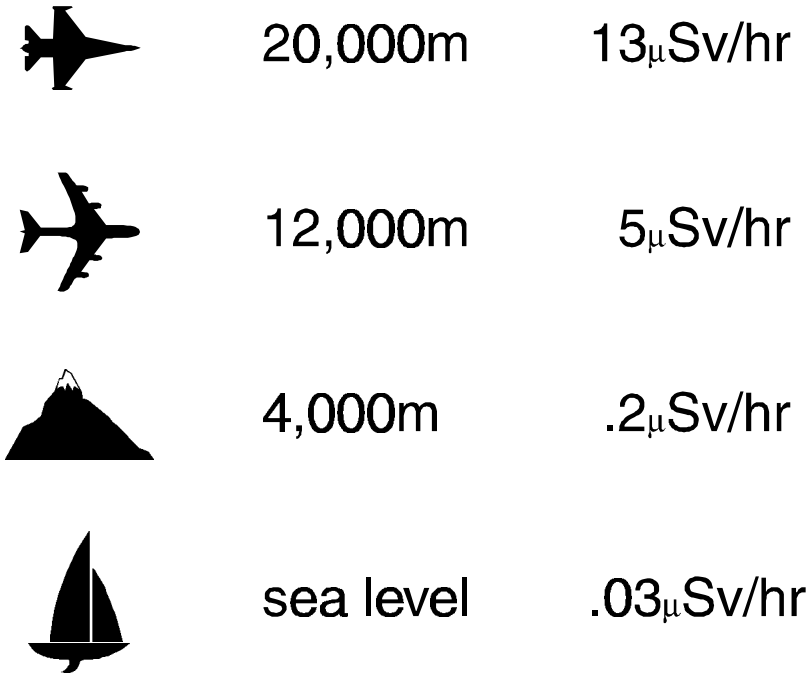
NATURAL SOURCES

Natural sources of radiation that individuals are exposed to routinely come from either **cosmic radiation or terrestrial radiation**.

Cosmic Radiation

Just under half of man's exposure to external natural radiation comes from cosmic rays. Most of these originate deep in interstellar space, however, some are released from the sun during solar flares. They irradiate the earth and interact with the atmosphere to produce further types of radiation and radioactive materials.

This source of radiation is always present. However, it affects some parts of the earth more than others. The poles receive more than the areas or the earth near the equator because the earth's magnetic field diverts the radiation. More importantly, however, the level of exposure to cosmic radiation increases with altitude, since there is less air as altitude increases to act as a shield. Someone living at sea level will, on average, receive a dose or about 300 microsievert of cosmic radiation every year, while an individual living above 2,000 meters will receive several times as much.



Cosmic Radiation Increases with Altitude

A trip from New York to Paris would expose a passenger to about 50 microsievert in addition to whatever cosmic radiation he would be exposed to at home or work. The more frequently an individual flies, especially over long distances, the more additional dose from cosmic radiation he or she is exposed to. For this reason, there are requirements limiting the number of long flights that airline personnel can fly in any year to control the total additional dose these individuals receive from cosmic radiation.

Terrestrial Radiation

Terrestrial radiation accounts for over three-quarters of the overall dose from natural sources of radiation. Three main types of terrestrial radiation account for most of this:

1. Rocks and minerals.

2. Radon and its decay products.

3. Activity in food.

Rocks and Minerals

The main sources of radiation in **rocks** are Potassium-40 and the two series of radioactive elements that come from the decay of Uranium-238 and Thorium-232. Uranium-238 is dispersed throughout the soil at various low levels of concentration. Where the concentration exceeds 1,000 ppm, it may be economic to mine the ore to make fuel for nuclear reactors. Thorium-232 is similarly dispersed in soil. Potassium-40 constitutes a significant part of elemental potassium which makes up 2.4 percent of the earth's crust.

Concentrations of minerals that collect in ash from the burning of coal for energy are sometimes quite high in radioactivity. The vast majority of ash from burning coal remains behind in the furnace, but the lighter portions that "fly" up the stack contribute to the terrestrial portion of an individuals dose. Modern pollution technology has done much to remedy this situation, and the dose contribution is much lower than at times in the past.

Phosphate, when used in fertilizer or in supplements for livestock feed can also contribute a small amount to an individual's dose from natural sources.

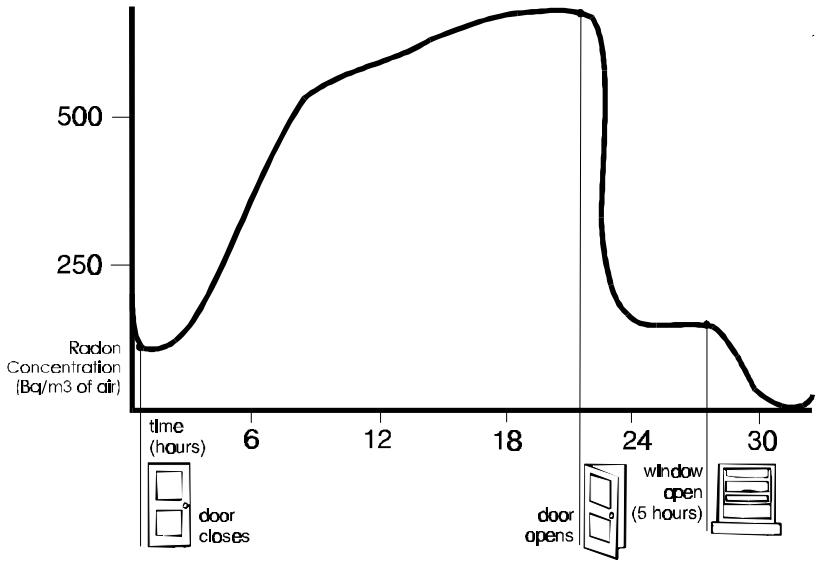
The series of radioactive elements, or daughters, that come from the decay of Uranium and Thorium include radon-222 and radon-220, which contribute significantly to man's exposure to radiation from natural sources.

Radon Decay Products

Radon-222 and Radon-220, referred to collectively as radon, seeps out of the earth all over the world. The doses from radon, however, are contributed to by the **radon decay products** (daughters) rather than by the gas itself. The levels of radon in outside air varies markedly from place to place, however, people are mainly exposed to the dose from radon decay products indoors. Radon contributes, on average, about one-half of the dose received by individuals from all natural sources.

Radon concentrates in indoor air when buildings are, by and large, closed spaces. Once the gas gets in, by filtering up through floorboards from the ground or, to a much lesser extent, seeping out of the materials used to construct the building, it cannot get out. Modern construction techniques known for good air-tightness and insulation, make it especially hard for radon to get out. The decay products of the gas are solid, and they attach themselves to dust particles in the air which when inhaled, irradiate the lung.

Radon concentrations in indoor air can be easily controlled using two main methods. Covering walls with plastic materials or thick coats of paint and filling gaps in floors combined with diverting the gas to the open air is an effective control method. Ventilating crawl spaces with fans to remove the radon concentrated air before it gets into living or working spaces in structures is also an effective control method.



Radon and Ventilation

Activity in Food

Other daughter products from the decay of Uranium and Thorium contribute to an individual's radiation dose from natural sources in **food** that is eaten. Lead-210 and Polonium-210, for example, are concentrated in fish and shellfish. Persons who eat a large amount of seafood are getting a higher dose from this source of natural radiation than those who don't.

Like many of the other situations discussed in this section, some areas of the world have certain foods higher in some radionuclides due to the particular rocks and minerals prevalent in the soil where the crops or livestock are grown.

MAN-MADE SOURCES

Man-made sources of radiation that individuals are routinely exposed to include **medical sources, nuclear fallout, and consumer products**.

Medical Sources

Medical sources of radiation are the greatest source of man-made radiation exposure. Radiation is used both in diagnosing and treating disease.

There are three uses of radiation in the practice of medicine:

1. X-ray examinations.

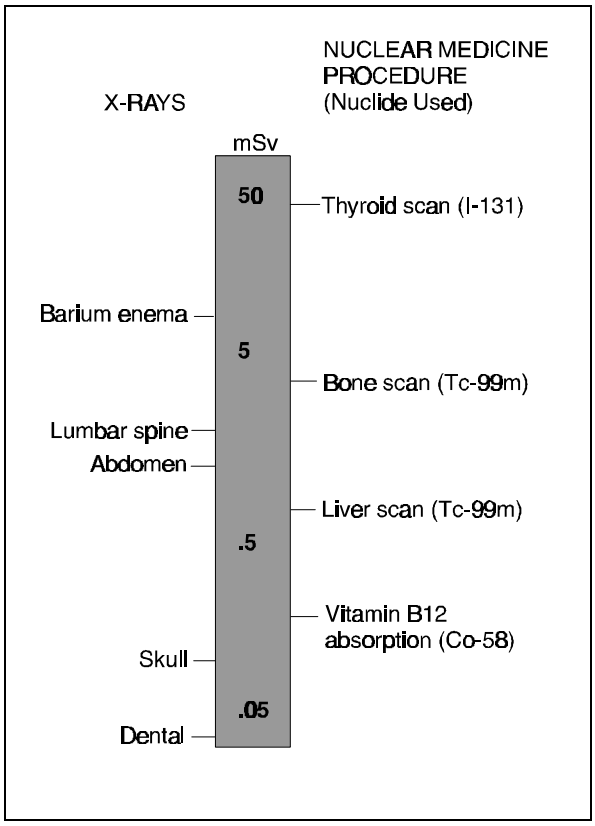
2. Nuclear medicine.

3. Radiotherapy.

X-ray Examinations

X-ray examinations and nuclear medicine are both techniques used in diagnosing injuries and illnesses. X-rays from an x-ray machine pass through the area of the patients body being examined and are then detected with film. X-rays by far account for most of the exposures from medical uses of radiation. The parts of the body most often x-rayed are the teeth, chest, and limbs, each accounting for about a quarter of the total number of examinations.

Because they are used so frequently and account for most of the man-made radiation exposure, great improvements have been made in x-ray machines and methodologies to try to keep doses at a minimum. Doses from dental x-rays have come down as a result of limiting the x-ray beam more tightly, filtering it further to remove unnecessary radiation, using faster films to capture the beams, and better shielding of patients.



Dose From Typical Diagnostic Procedure

Nuclear Medicine

Nuclear Medicine refers to diagnostic techniques that use the gamma rays from a radioactive substance that is introduced into the patient to allow medical professionals to diagnose certain functions of critical organs. The radioactive material is administered with a drug that is chosen carefully because it is preferentially absorbed by the organ that needs to be diagnosed. The distribution of the drug with the gamma-emitting radioactive material is watched in the organ using a gamma-scanning camera.

The use of nuclear medicine has increased dramatically over the past two decades, but is still used much less frequently than x-rays. The radionuclide used in over 75 percent of nuclear medicine procedures is Technetium-99m because it can be easily obtained, has a convenient half-life of six hours, and it is suitable for incorporating into a wide variety of drugs allowing for examinations of the brain, liver, and kidneys.

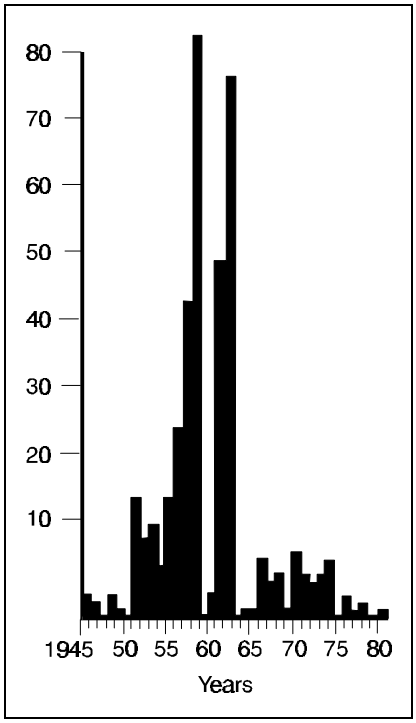
Radiotherapy

Radiotherapy is confined almost exclusively to the treatment of malignant cancers with the intention of either curing the disease or alleviating the more distressing symptoms. Beams of high energy X-rays or gamma rays from Cobalt-60 are most commonly used for radiotherapy. High doses are given to the target tissue while the surrounding healthy tissues is spared exposure.

Cancerous tumors require a dose on the order of tens of grays to kill or inactivate the malignant cells. This is a very high dose and thus, radiotherapy is regarded as a severe measure which is used only on those conditions which are extremely serious or which other forms of treatment are not available or have been ineffective. It is important that considerable care is taken to deliver these doses as accurately as possible to avoid ineffective treatment or unacceptable complications.

Nuclear Fallout

For the last 50 years, the world's population has been exposed to radiation from fallout from atmospheric explosions carried out to test nuclear weapons. This testing reached two peaks, the first between 1954 and 1959 and the second in 1961 and 1962.



Numbers of Atmospheric Tests

Some of the radioactive debris from an atmospheric nuclear weapon test lands relatively close by. Some stays in the troposphere, the lowest layer of the atmosphere, and is carried by the wind around the world, remaining on average about a month in the air. Most debris is pushed into the stratosphere, the next layer of the atmosphere (from about 10 to 50 kilometers up) where it stays for many months, and whence it slowly descends all over the earth.

These various types of fallout contain several hundred different radionuclides, but only a few contribute to human exposure. Four collectively contribute about 1 percent to the world population dose from nuclear test explosions. These are Carbon-14, Cesium-137, Zirconium-95, and Strontium-90. Like some of the terrestrial sources of natural radiation, the dose from these radionuclides is generally delivered through the ingestion of the radioactivity in some food that has been exposed to the fallout.

Consumer Products

Some common consumer products contain materials or generate radiation which contributes to the dose to individuals, although in an extremely minor way. Luminous watches and clocks contain Tritium or Promethium-147, and by far contribute the most dose from consumer products.

Many smoke detectors use alpha radiation. More than 26 million of them containing Americium-241 had been installed in the United States by the end of the 1980s. X-rays are produced inside color televisions, although modern sets emit only a tiny amount if used normally and serviced appropriately.

Practice Exercise

40. Natural sources of radiation can be grouped into either _____ radiation or _____ radiation.

41. The level of exposure to cosmic radiation increases with _____.

42. Besides the contribution from the radionuclides from the Uranium and Thorium series, rocks containing _____ can contribute a significant dose to humans.

43. The dose contribution from radon actually comes from the radon _____ products.

44. _____ by far account for most of the dose from medical uses of radiation.

45. Like many natural sources of radiation, a dose from radioactive fallout is likely to be delivered through someone's _____.

UNIT 5 REVIEW

This unit reviews the fact that most of our exposure to radiation comes from everyday sources that are not considered life-threatening. This type of radiation comes from natural and artificial sources. The vast majority of this everyday radiation (over 80 percent) comes from natural sources.

Of the natural sources, cosmic radiation accounts for most of our direct exposure. Radon decay products account for most of the dose delivered through inhalation or ingestion. Most of our everyday radiation exposure from artificial sources is due to x-ray.

Mitigation measures can be used to decrease our exposure to almost all of these sources of radiation, although some exposure to background radiation is considered unavoidable.

UNIT 5 REVIEW QUESTIONS

Answer the following questions to review your knowledge of the Other Radiological Hazards unit. Read each question carefully and circle the correct answer.

1. On average, approximately 82 percent of our everyday radiation exposure comes from what sources?

   a. Uranium

   b. Radon

   c. Natural

   d. Extra-terrestrial

2. Solar flares are one source of this type of radiation.

   a. Cosmic

   b. Radon

   c. Terrestrial

   d. Artificial

3. Altitude increases exposure to cosmic radiation because there is (are) less _____ to act as a shield.

   a. Clouds

   b. Air

   c. Airplanes

   d. People

4. Radon dose comes primarily from its _____ products.

   a. Son

   b. After

   c. Follow-on

   d. Daughter

5. What radionuclide concentrates in seafood?

   a. Mercury

   b. Thorium

   c. Lead

   d. Iron

6. What two parts of the body are most often x-rayed?

   a. Limbs and chest

   b. Chest and liver

   c. Teeth and spine

   d. Spine and thyroid

7. What is radiotherapy used almost exclusively in the treatment of?

   a. Broken bones

   b. Chest pain

   c. Cancer

   d. Migraine headaches

8. Most debris from atmospheric tests of nuclear weapons _____.

   a. Fell immediately

   b. Was pushed into the troposphere

   c. Was pushed into the stratosphere

   d. Disintegrated

9. Where did most of the dose from atmospheric test of nuclear weapons come from?

   a. Direct exposure

   b. Inhalation of dust particles

   c. Radon decay products

   d. Ingestion of contaminated food

10. What radionuclide is often used in luminous watches and clocks?

    a. Tritium

    b. Carbon-14

    c. Strontium-90

    d. Iodine

UNIT 5
REVIEW ANSWER KEY

1. c
2. a
3. b
4. d
5. c
6. a
7. c
8. c
9. d
10. a