ESH738 – General Employee Radiological Training (GERT)

Welcome to ESH738

This program was designed to fulfill training requirements identified by 10CFR835 and the DOE Radiological Control Manual; and to inform the radiological workers of the radiological conditions and safety procedures specific to Argonne National Laboratory.

Upon completion of this program, you will be able to discuss the Argonne National Laboratory Radiological Control Program in regard to radiological terminology, hazards and risks, controls and identification systems, and employee responsibilities.

You will be able to:

- Identify fundamental radiological terms and concepts.
- Identify natural and man-made sources of background radiation.
- State the potential health effects of radiation exposure.
- Compare risks due to occupational radiation exposure with other common health risks.
- Identify the ALARA concept and practices.
- State the methods used to recognize and control radiological hazards.
- State management and individual responsibilities for the site radiological control program.

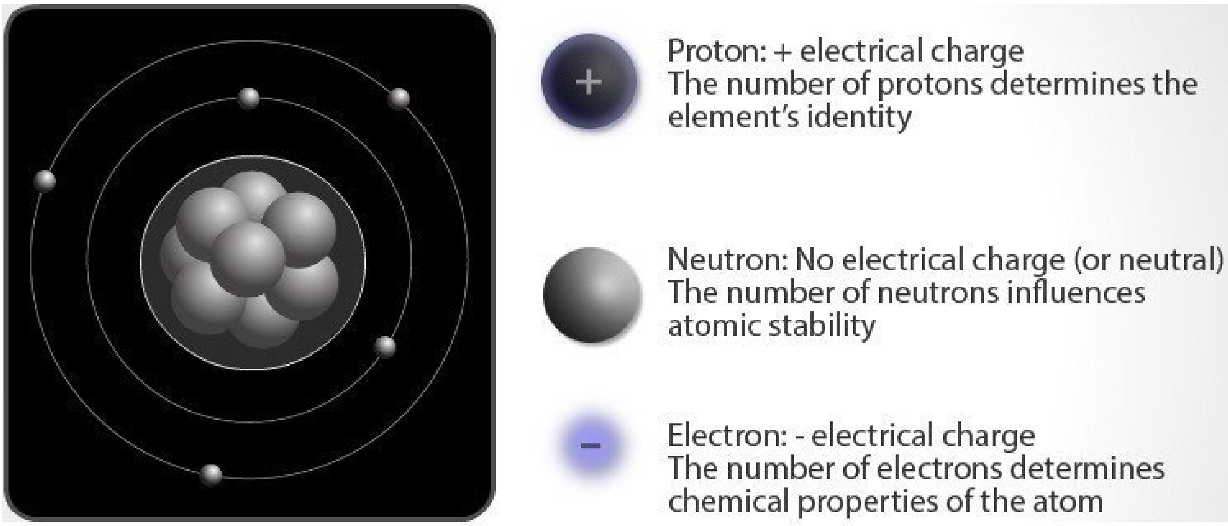
Introduction

General Employee Radiological Training (GERT) is provided to all new employees and other site workers who may routinely enter Controlled Areas or encounter radiological barriers,postings or radioactive materials. Employee responsibilities for observing and obeying radiological control postings and procedures are emphasized throughout this training.

- It is important to note that the risk of exposure to radiation and/or radioactive materials for general Argonne employees is minimal.
- Additional training beyond GERT is required for employees who are identified as radiological workers.

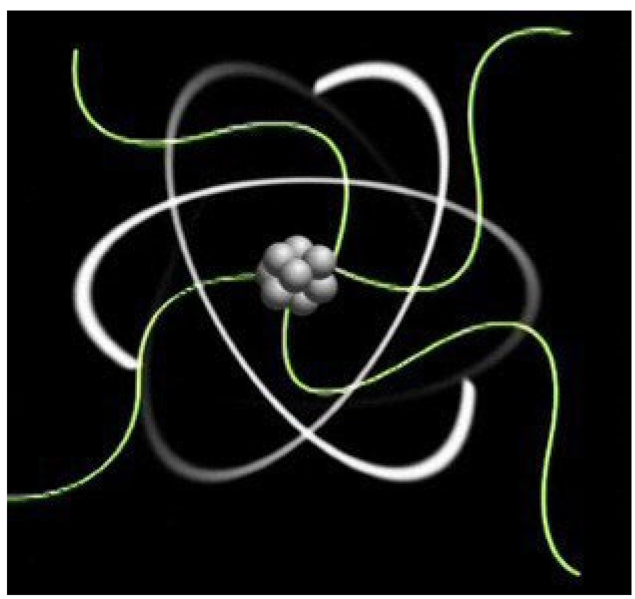
Three Basic Particles of the Atom

All matter is composed of atoms. Atoms are made up of three basic particles: protons, neutrons and electrons. Protons and neutrons are in the center of the atom called the nucleus. Electrons can be thought of as circling the nucleus as the planets orbit the sun.



Protons have a positive electrical charge.
Neutrons have no electrical charge. The number of neutrons influences atomic stability.
Electrons have a negative electrical charge.

Atoms Can Emit Radiation

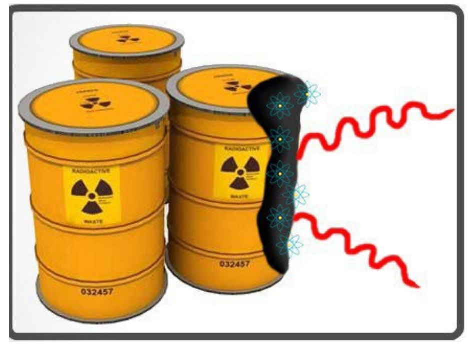


An atom's stability is determined by the ratio of protons to neutrons in the nucleus. An atom is unstable when there are too many or too few neutrons relative to the number of protons. Unstable atoms will go to a more stable condition by getting rid of excess energy from the nucleus of the atom.

This excess energy is expelled by emitting radiation, such as energetic particles or waves that car-rye the energy away. This process is known as radio-active decay. A distinct result of radioactive decay is that the amount of radioactivity occurring will diminish over time as more and more atoms undergo the decay process, eventually becoming stable.

Radioactive Materials

Radioactive material is any material containing unstable atoms that emit ionizing radiation. Recall that the atoms are unstable because their ratio of neutrons to protons is too high or too low. Radioactive material can be man-made or naturally occurring and can be in any of these physical forms:



- Solid
- Liquid
- Gas
- Dust
- Powder

Radioactive Contamination

When radioactive material is uncontained in an unwanted place, this is known as radioactive contamination.

Fixed contamination is radioactive contamination that is firmly affixed to, or imbedded in, a surface and cannot be removed without damaging the surface.

Dispersible contamination (a.k.a. loose or smearable) is radioactive contamination that is readily removed, even by casual contact or ambient air flow. Note that dispersible contamination can even become airborne.

The main concerns with radioactive contamination are:

- Spreading it to different locations
- Having it enter the body

Using Fire to Explain Radiation

Let's compare radiation, radioactive material and radioactive contamination to a fire. When logs burn, they give off heat. This is a form of radiation. We know that radioactive material emits energy in a form of particles or waves. The burning material is similar to radioactive material as they both release energy through space. The sparks can jump and spread the fire to areas where they are not desired. This can be compared to radioactive contamination.

Definition of REM

Roentgen Equivalent Man (rem)

- Is the basic unit of radiation dose equivalent
- It is usually expressed in a smaller unit called millirem (mrem)
- 1000 mrem = 1 rem
- The rem and mrem measure biological damage or health risk to humans

Ionizing Radiation and Non-Ionizing Radiation

Ionizing radiation can be defined as radiation having sufficient energy to remove electrons from atoms.

Non-ionizing radiation does not have the amount of energy needed to remove electrons from the atom.

Examples of non-ionizing radiation are:

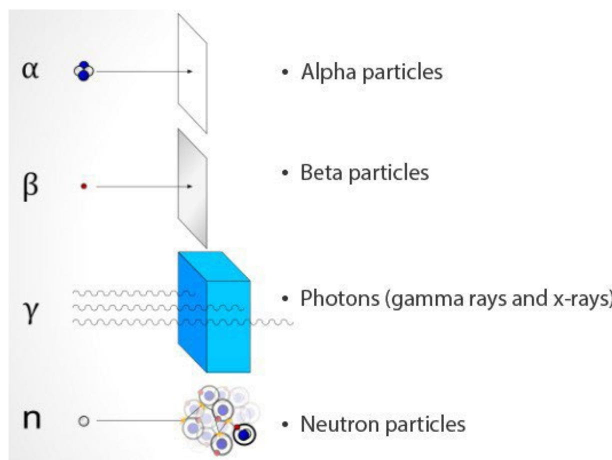
- Visible light
- Radio waves
- Microwaves
- Infrared

Four Types of Ionizing Radiation

Most radiological work will expose workers to at least one of the four basic types of ionizing radiation.

These are alpha particles, beta particles, photons (gamma rays and X-rays) and neutron particles.

The radiation originates in the nucleus, with the exception of X-rays, which are produced in the electron orbitals.



Radiation Generating Devices

Ionizing radiation is also generated by radiation producing machines such as this analytical X-ray device.

Other radiation generating devices include particle accelerators such as the Advance Photon Source (APS) and electron microscopes.

Question

Which number below do you think is the average annual radiation dose to the general population?

a) 60 mrem/yr
b) 360 mrem/yr
c) 620 mrem/yr
d) 980 mrem/yr

Answer: The average annual radiation dose to the general population is 620 mrem/yr from natural back-ground and man-made sources.

Background Radiation

The average annual radiation dose to the general population is 620 mrem from natural background and man-made sources.

Below are some of the sources of ionizing radiation to which we are all exposed:

Radon – Comes from the decay of radium, which is naturally present in soil. As a gas, radon can travel through the soil and enter buildings. Radon and its decay products emit alpha particles which are an internal hazard to the lung.

Cosmic – Comes from the sun, stars and other sources in outer space. It consists of charged particle and gamma rays. The dose rate increases with altitude, since there is less atmosphere to shield this radiation.

Terrestrial – Natural sources of radiation are present in soil, rocks, and building materials. These include potassium, radium, thorium, and uranium, which give us a continuous low level radiation exposure.

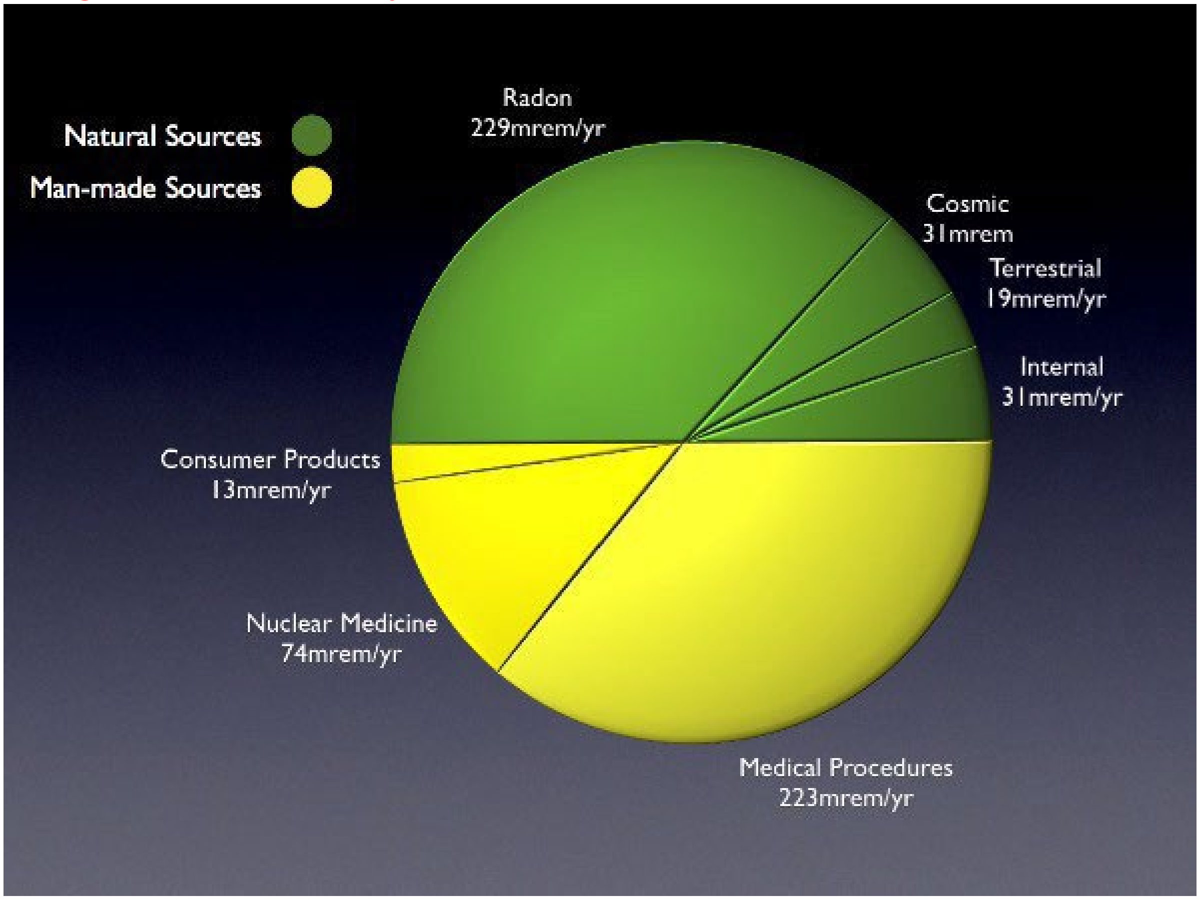
Internal – Food and water contain trace amounts of natural radioactive materials. Most of our internal dose is from radioactive form of potassium called K-40.

Medical – X-rays, CAT scan, and diagnostic and therapeutic uses of radioactive sources contribute the largest dose from man-made sources. Common medical sources include gallium-67, technetium-99m, thallium-201, and iodine-123,125,131.

Consumer Products – A small amount of radiation comes from consumer products such as old vacuum tube televisions, radium dial clocks and watches, smoke detectors and some ceramics. Smokers get a significant radiation dose to the lungs from polonium isotopes in tobacco leaf.

Other – Other man-made radiation sources include residual fallout from 1950's and 60's atmospheric nuclear weapons tests. Industrial uses include X-rays for baggage inspections andtransportation of radioactive materials.

Background Radiation Exposures in the US



Potential Health Risks

Our knowledge of radiation health effects is mainly from cases where high doses of radiation were received over short periods of time. These are known as acute radiation doses.

However, workers at radiological facilities who receive any radiation tend to receive small doses over long time periods. These are called chronic radiation doses.

Persons who receive chronic radiation doses may increase their risk of cancer. The probability of cancer due to occupational exposure adds very little (less than 1%) to the average natural cancer death rate (around 20%).

Health Risks

Radiation induced genetic disorders that are passed on to future generations are called heritable effects. These have been measured in plants and animals but have not been observed in humans. We assume that heritable effects can occur in humans, but the probability is low compared to the normal rate of genetic disorders.

Prenatal radiation health effects have been observed in humans and animals exposed to high radiation doses while in the womb.

These include:

- Lower birth weight
- Increased rate of mental retardation
- Stunted physical growth
- Reduced IQ

The effects have only been seen when fetal dose exceeded 15 rem.

Another concern is that prenatal radiation exposure may increase the risk of a future cancer such as leukemia.

Health Risks

DOE and Argonne want to minimize radiation exposure to the fetus/embryo. A pregnant worker or an individual who is planning to become pregnant and who is monitored for occupational radiation exposure may voluntarily declare their pregnancy in writing. Once the pregnancy is "declared", a more restrictive radiation dose limit is applied. Argonne policy is to keep the fetal radiation dose as far below the 500 mrem limit as reasonably achievable.

- The individual declaring pregnancy is required to fill out a Declaration of Pregnancy (ANL-943) form.
- Once "declared" contact the Area Health Physicist for a consultation and work restriction determination (ANL-243). Work duty options are offered to reduce the risk of radiation exposure. Argonne employees should also consult with the Medical Department.

Dose Limits

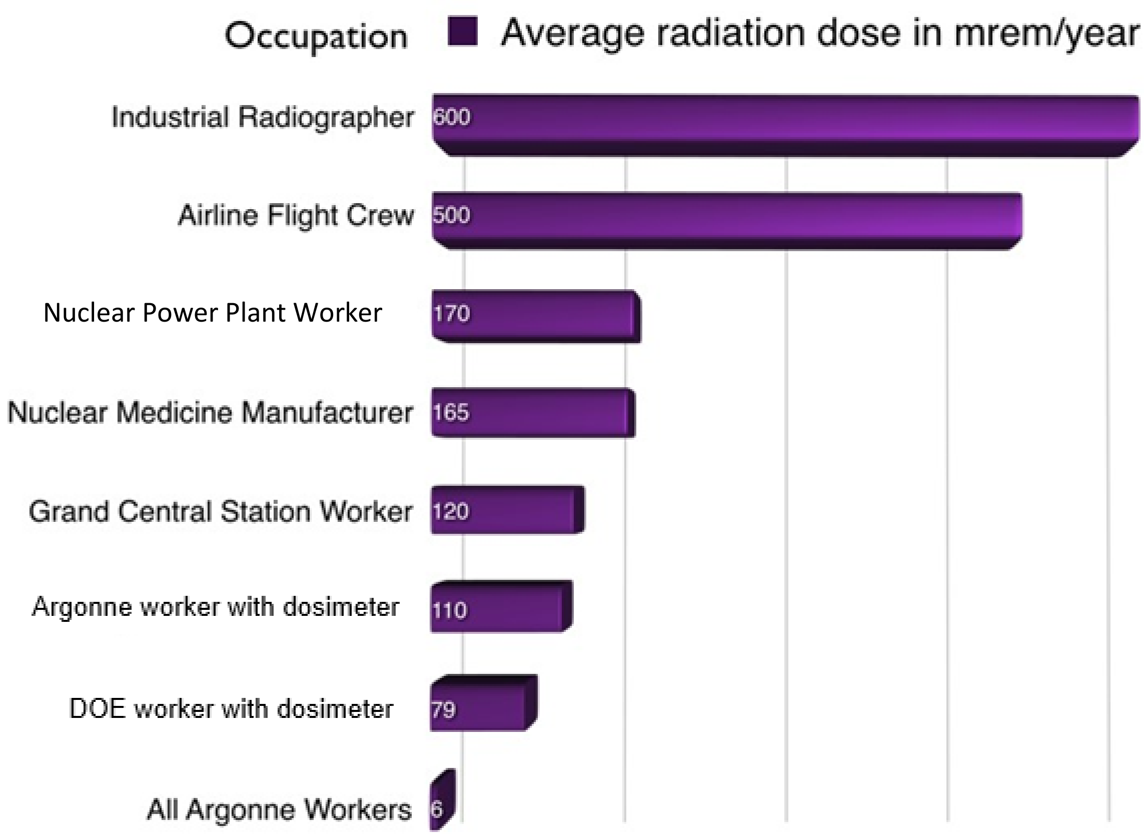
The radiation dose limit for workers at DOE facilities is 5000 mrem/year. The Argonne administrative dose limit is 1000 mrem (except some workers in Alpha Gamma Hot Cell Facility (AGHCF) which is 1500 mrem). While for site visitors and the general public the limit is 100 mrem/year.

Workers who expect to receive above 100 mrem/year are required to complete Radiological Worker Training.

Generally, persons like yourself are expected to receive less than 100 mrem/year due to occupational radiation exposure. This General Employee Radiological Training (GERT) is sufficient for your current needs.

Risk Comparison

The health risks associated with occupation radiation exposures are very small and should be considered acceptable when compared to other risks we take daily. The chart below illustrates how your expected radiation dose compares with that for other occupations.



Perspectives on Risk

Another way to view risk is to measure the reduction in life span associated with various lifestyles.

Loss of average Life Expectancy	
Cause	Days Lost
Smoking one pack/day	2250
Being a coal miner	1100
25% overweight	700
Alcohol abuse (U.S. average)	365
Being a construction worker	227
Driving a motor vehicle	207
All industries	60
Radiation dose of 100 mrem X 70 years	10
Drinking coffee	6

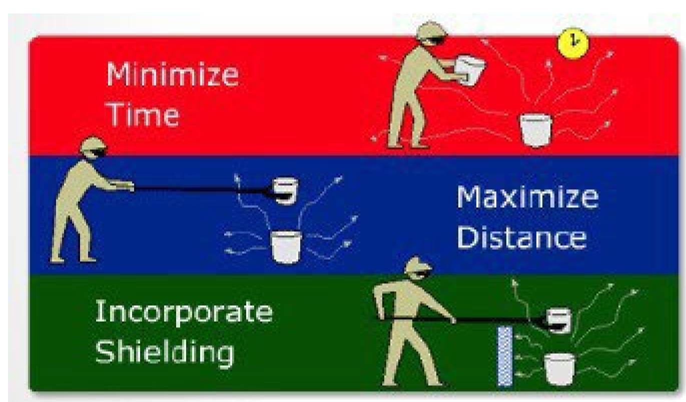
A.L.A.R.A.

As
Low
As
Reasonably
Achievable

The ALARA concept is an integral part of all activities that use radioactive materials or radiation producing machines. It works to minimize radiation exposures to workers, the public, and the environment from site activities.

You are responsible for maintaining your radiation dose ALARA.

The ALARA Coordinator serves as the secretary of the site ALARA committee and issues quarterly reports which track and trend worker radiation doses.
Division ALARA Coordinators assist in ALARA reviews and serve on the ALARA Committee.



Radiological Controls

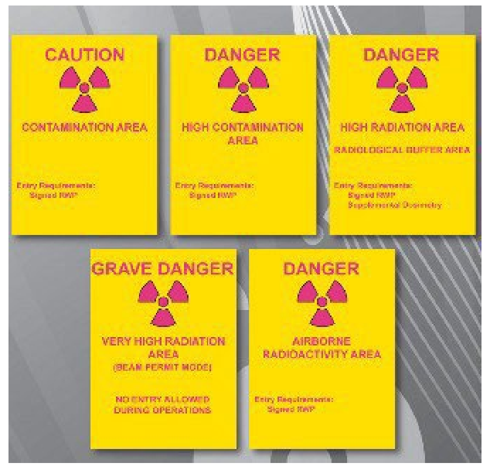
Since radiation cannot be detected with any of the senses, special detection devices must be used.

The Health Physics technicians routinely measure radiation and contamination levels in suspect areas throughout the site.

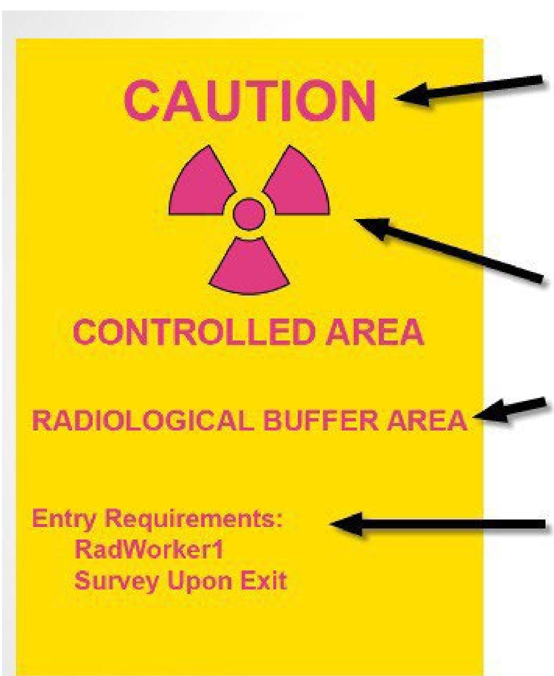
If radiological conditions are found, they will be clearly identified with radiological controls such as postings, labels, or tags.

Indicators that there could be radiological hazard present:

- Yellow and magenta postings
- Radiological workers with personal protective clothing
- Flashing lights
- Yellow and magenta rope
- Audible alarms



Radiological Postings



Three General Warnings:

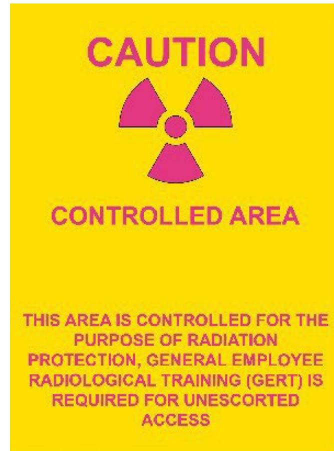
I. Grave Danger
II. Danger
III. Caution

Postings have magenta or black trefoil (propeller) symbol.

Radiological designation indicates the type and degree of hazard.

Always comply with entry requirements.

Entry Requirements



The posting to the right indicates a minimum radiological hazard. The space used for specific radiological designations is blank.

The dose rate inside a controlled area which has no radiological designation posted is less than 5mR/hour at 30cm (1ft) from source. If you see a sign like this, you must have the following for unescorted access:

- GERT qualification (training)
- Authorization by the area manager

If there is any other radiological designation, such as Radiation Area or Radioactive Material, you must have a qualified escort and comply with all entry requirements.

Radiation Dosimeter

Any worker that may receive a dose greater than 100 mrem/year will be issued a radiation dosimeter.
Please note that it is not unusual to assign a dosimeter to individuals who are not expected to receive an occupational dose greater than 100 mrem/year.
Each year, approximately 2,200 Argonne workers wear dosimeters. However, fewer than 250 workers receive a measurable dose.

Dose Record Access

The Dosimetry Group, located in Building 202, keeps permanent records for internal and external radiation dose.

- Dose reports are provided annually
- Individuals may request report at any time
- For a temporary dosimeter, Health Physics
- completes the ANL-141
- May contact your local HP office to receive dose information

Work Area Hazards

Your work area may have unique hazards, controls, warnings, and Emergency Response Procedures. Your supervisor will arrange for area specific training, typically included in your building orientation.

Responsibilities

Management Responsibilities:

- Establish radiation exposure control levels and ALARA goals
- Solicit feedback from the workforce on improvements to the radiological control program
- Implement policies and procedures to maintain radiation exposures ALARA
- Hold workers accountable for radiological performance

Your Responsibilities:

- Obey all signs and postings and comply with all radiological safety rules and procedures
- Do not enter any controlled area without authorization by the area manager
- Follow instructions if visiting a radiological area with a designated escort
- Obtain and wear required dosimeter(s)
- Use ALARA techniques to minimize exposure
- Know how to contact Health Physics in your area and be alert for and respond to unusual radiological situations

Using Hand and Foot Monitor

In some locations, you will be required to check for radioactive contamination by using a hand and foot monitor. Follow the directions on the monitor.

If the monitor alarms:

- Stay in the area
- Keep your hands away from your face
- Call Health Physics
- Wait for help to arrive

Nuclear Medicine

Nuclear medicine procedures are a very common medical tool. Your doctor may recommend a test that requires you to drink or be injected with a radioactive substance. Your body will emit radiation during and a few days following the procedure.

If you work in a building that has posted radiological areas, and you received or plan to receive nuclear medicine, you are responsible for notifying the area Health Physics group. The radiation from the procedure could potentially set off radiation/contamination monitors.

It is not necessary to notify HP if you get an X-ray, CAT scan, or MRI.