ES&H Course 8530 April 2000

Refresher

General Employee Radiological Training

Los Alamos
NATIONAL LABORATORY

Refresher General Employee Radiological Training is intended for *general employees.* If you are a *radiological worker,* you may complete this refresher training if you choose, but you are not required to do so.

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General Employee Radiological Training

In this Section

In general

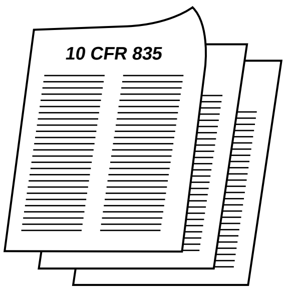
Using this section and the student self-assessment, you will recognize basic radiological principles and terms, radiological hazards, the risks of exposure to ionizing radiation, and radiological controls.

What you will learn

When you have completed this training, you will be able to recognize

1. basic radiological terms,
2. sources of background ionizing radiation,
3. the biological effects of ionizing radiation and the risks of exposure,
4. how to report a pregnancy,
5. radiation dose limits for occupational exposure,
6. methods used to monitor workers' radiation doses,
7. the *as low as reasonably achievable* (ALARA) concept and the ways to decrease radiation dose,
8. the different radiological controls and postings,
9. managers' and workers' responsibilities for radiological protection, and
10. emergency procedure information.

Radiological Control Program



Required training

General Employee Radiological Training is required by 10 CFR 835. As part of a radiological control program, this training introduces the *general employee* to radiological hazards and risks of exposure and the controls used to protect against them.

Information about radiological control

Information about radiological control at the Laboratory is available from the following groups:

Health Physics Operations (ESH-1)	7-7171
Health Physics Measurements (ESH-4)	5-6064
Radiation Protection Services (ESH-12)	7-5296

Radiological Control Program—continued

Health Physics Operations Group

ESH-1

- reviews and assesses general Laboratory radiological protection needs and
- provides operational radiological protection support.

Health Physics Measurements Group

ESH-4

- analyzes samples of radiological materials,
- repairs and calibrates radiation/contamination survey instrumentation, and
- distributes and processes external radiation dosimetry.

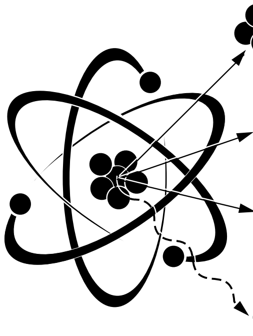
Note: *The Inorganic Trace Analysis Group (CST-9) processes internal dosimetry samples.*

Radiation Protection Services

ESH-12

- develops policies, standards, and procedures for radiological protection and
- evaluates, investigates, and documents workers' personal radiation doses.

Radiological Terms



Radiation is energy in the form of particles or waves

Definition: radiation

Radiation is energy in the form of particles or waves. The fundamental unit of matter is the atom. Atoms contain three basic particles: protons, neutrons, and electrons. Certain combinations of neutrons and protons result in a stable atom. Too many or too few neutrons for a given number of protons result in an unstable (radioactive) atom. An unstable atom releases excess energy in the form of particles or waves.

Definition: radioactivity

Radioactivity is the physical property, or capability, of certain atoms to emit radiation as they decay (disintegrate). These radioactive atoms can be either naturally occurring or manmade.

Definition: nonionizing radiation

Radiation that does not contain enough energy to strip electrons from atoms is nonionizing radiation. Examples of nonionizing radiation include microwaves, radio waves, and visible light.

Definition: ionizing radiation

Radiation that contains enough energy to strip electrons from atoms is ionizing radiation. Examples of ionizing radiation include alpha, beta, neutron, and gamma or x-ray.

Note: *This section is concerned with only ionizing radiation. For information on nonionizing radiation, see the Industrial Hygiene and Safety section of this handbook.*

Definition: ionization

Ionization is the process of stripping an electron from an atom, resulting in a charged atom called an ion.

Radiological Terms —continued

Contamination is radioactive material in an unwanted place

Definition: radioactive contamination

Radioactive contamination is radioactive material in an undesirable location such as outside the glove box or hood in which it is being handled; in homes or offices; or in the soil, air, or other areas of the environment.

Note: *External exposure to radiation alone does not result in contamination of the person. Radiation is a type of energy; contamination is a material that emits radiation. For example, radiation is like the heat you feel from a camp fire; contamination is like glowing embers from the camp fire landing on your clothes.*

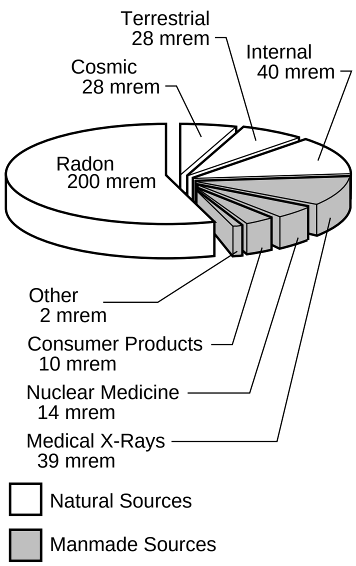
Definition: radiation dose

Radiation dose is the amount of energy from ionizing radiation that a person absorbs from both external and internal sources.

Definition: radiation dosimetry

Radiation dosimetry is the measurement of radiation dose. Radiation dose is reported in rem or millirem (mrem), the unit of measurement that takes into account biological damage to the human body.

Background Radiation



Average annual dose from background radiation

Background radiation and its sources

Background radiation is both naturally occurring and manmade radiation in the environment. The average nationwide dose from background radiation is about 360 mrem per year.

In Los Alamos, background dose averages about 400 mrem per year because of higher altitude and radon levels. (Reported in *Environmental Surveillance at Los Alamos during 1997*, LA-13487-ENV, September 1998.)

Naturally occurring background radiation

Naturally occurring background radiation comes from

- cosmic rays from the sun and stars—the thinner atmosphere at higher altitudes provides less shielding from cosmic rays;
- radioactive materials in the earth—uranium, thorium, and radium are found in soil, rocks, building materials, and water;
- radioactive materials in the body—potassium-40 occurs naturally in foods; and
- radioactive materials in the air—radon gas, which comes from the decay of uranium and thorium, is present in the air and can travel through the soil and collect in the home.

Manmade background radiation

Manmade background radiation comes from

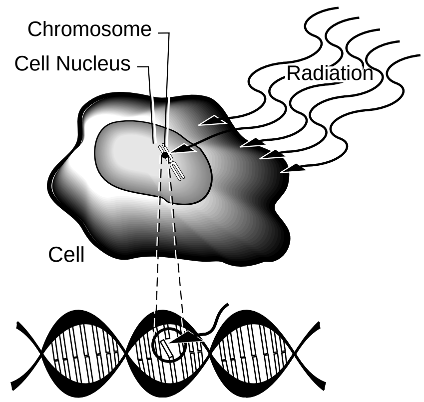
- medical procedures such as dental and chest x-rays, diagnostic tests, and radiation therapy;
- consumer products such as televisions, older luminous-dial watches, and smoke detectors; and
- industrial uses such as radiography or soil-density meters.

Risks of Exposure

Biological effects

Radiation causes damage to any material by ionization of the atoms in the material. Radiation damage to the human body begins with ionization of the atoms that make up human cells. Cells make up the tissues of the body. Tissues make up the organs of the body.

The ionization of atoms in a human cell can cause chemical changes which, if not repaired, can result in biological damage to the cell. If the damage is great enough, the cell will die. Lesser damage to the cell's nucleus can alter the cell's chromosomes.



Radiation damage to a cell

Types of effects

The effects of radiation damage may appear in the exposed person or may theoretically be passed on to the children of the exposed person.

Effects that appear in the exposed person are called *somatic* effects. Effects that appear in the children of the exposed person are called *heritable* effects.

Risk factors

The risks of exposure to radiation depend on

- the type of radiation,
- the dose received,
- the period over which the dose is received, and
- the part of the body that received the dose.

Note: *For more information on the risks of exposure, see the BEIR V Report, issued in December 1990 by the National Research Council's Fifth Committee on the Biological Effects of Ionizing Radiation.*

Risks of Exposure —continued

Chronic exposure

Chronic exposure occurs when a dose of radiation is received over a *long* period, typically from months to years. A chronic, low-level dose is usually less harmful because the body has time to repair or replace damaged cells. The effects of chronic, low-level exposure, if any, may not appear until years after the dose is received. Examples of chronic, low-level exposure are

- the dose received from background radiation and

- the dose typically received from occupational exposure.

A somatic effect from chronic, low-level exposure may be a slight increase in the risk of developing cancer. The exact increase in the risk of cancer is not known. Estimates range from too small to be measurable up to three percent.

No heritable effects in children of exposed persons have been observed in populations that have been clearly linked to chronic, low-level exposure.

Acute exposure

Acute exposure occurs when a dose of radiation is received in a *short* period, typically from seconds to days. An acute, high-level dose causes physical effects because the body cannot repair or replace cells fast enough. Most effects from acute, high-level exposure appear within minutes to weeks, depending on the dose received. Examples of acute, high-level exposure are

- the localized dose received during medical radiation therapy and

- the whole-body dose received by atomic bomb survivors.

Effects from acute, high-level exposure result from doses many times greater than occupational limits allow.

Prenatal effects of exposure

The embryo/fetus is especially sensitive to radiation because cells of the embryo/fetus are dividing rapidly.

High doses of radiation can result in miscarriage, low birth weight, mental retardation, birth defects, and increased risk of developing cancer and other diseases.

Because the effects of low doses of radiation are not precisely known, it is wise to avoid *any* unnecessary radiation exposure during pregnancy.

Reporting a pregnancy

If you are pregnant and have the potential for exposure to radiation in the workplace, you are encouraged to notify your supervisor; ESH-12, MS K483; and/or the Occupational Medicine Group (ESH-2), MS D421, in writing.

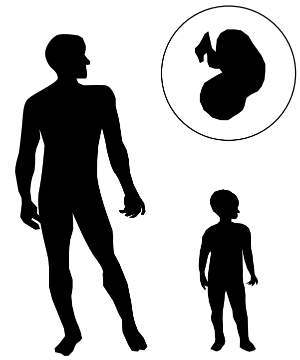
ESH-12, through the RHHP, will evaluate your work situation to determine if your job tasks must be modified to minimize exposure and will provide the option of a reassignment of job tasks.

Note: *For more on reporting a pregnancy and the RHHP, see the Occupational Medicine section of this handbook.*

Your rights are protected

You are protected from discrimination by Title VII of the Civil Rights Act of 1964, as amended, while you are reassigned to tasks in which exposure to occupational radiation is unlikely.

Risks of Prenatal Exposure



The embryo/fetus is especially sensitive to radiation

Risks in Perspective

Comparing occupational exposures

The average radiation dose received from occupational exposure by DOE employees and site workers is 44 mrem per year. The following chart compares this amount with the average radiation doses received by workers in other occupations.

Note: *These occupational doses are in addition to background radiation doses.*

Average occupational radiation dose

	mrem per year
Airline flight crew members (cosmic radiation)	1000
Nuclear power plant workers (radiological work activities)	700
Grand Central Station workers (building materials)	120
Medical personnel (patient treatment/diagnosis)	70
DOE employees and site workers (radiological work activities)	44

(Reported in *DOE Study Guides,* DOE/EH-0259T-2 Rev. 1, DOE/EH-0260T-2 Rev. 1, and DOE/EH-0261T-2 Rev. 1, May 1994.)

Risks in Perspective—continued

Comparing health risks

Health risks can be evaluated by comparing the average days of life lost due to health risks of various occupations. The health risks of occupational radiation exposure are very low when compared with other occupational health risks.

The following chart compares the average number of days lost to workers in several occupations with the average number of days lost from continuous radiation exposure at 100 mrem per year.

Average reduction in life span

	days lost
Agriculture (for 47 years)	320
Construction (for 47 years)	227
Transportation (for 47 years)	160
All industry (for 47 years)	60
Manufacturing (for 47 years)	40
Radiation exposure at 100 mrem per year (for 70 years)	10

(Reported by Bernard M. Cohen, "Catalog of Risks Extended and Updated," *Health Physics,* Vol. 61, No. 3, September 1991.)

Radiation Dose Limits

DOE sets radiation dose limits

The DOE sets limits on the maximum radiation dose that workers, visitors, and the public are allowed to receive in a given period as a result of exposure from DOE sites.

Radiation dose limits, set forth in 10 CFR 835, are based on guidance from the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurement, and the Environmental Protection Agency (EPA).

The DOE annual radiation dose limits are listed in the following chart.

Note: *These limits are in addition to background radiation doses and include both external and internal doses.*

DOE annual radiation dose limits

	rem per year	mrem per year
Radiological Workers	5	5000
Embryo/Fetus	0.5 (for term of pregnancy)	500
Visitors and Public	0.1	100

Monitoring Radiation Dose

Radiation detection and dosimetry

Radiation cannot be detected with any of the human senses. Special detection and dosimetry devices are available for use by workers at the Laboratory.

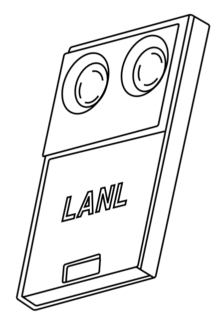
The *health physics checklist* is completed when a supervisor requests dosimetry for a worker. If you work on, with, or near radioactive materials or radiation-generating devices, you will have to complete this checklist to be included in the Laboratory's dosimetry program.

As part of the dosimetry program, you will be monitored regularly to determine the radiation dose you have received in the workplace.

External monitoring

The thermoluminescent dosimeter (TLD) is the primary device used to measure *external* radiation dose from sources outside the body.

TLDs must be worn between the neck and the waist with the LANL emblem facing away from the body. Proper care of the TLD, including its identification label, is important to prevent delays in badge processing.



Thermoluminescent dosimeter (TLD)

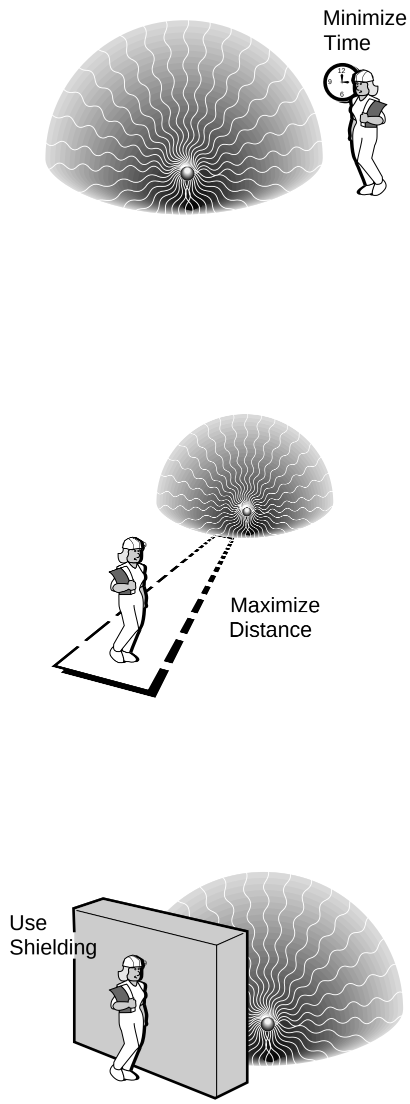
Internal monitoring

Internal radiation dose from radioactive material taken into the body is measured by whole-body counting or other bioassay methods such as urinalysis.

Radiation dose reports

Annual reports of measured radiation dose are issued directly to workers who are monitored. Monthly reports for workers who wear TLDs are available in group offices.

The ALARA Program



Measures to reduce external dose

What is the ALARA Program?

The goal of the ALARA Program is to reduce external and internal radiation dose to a level that is *as low as reasonably achievable*. Management and radiological control personnel establish policies and procedures for the ALARA Program. However, you, the individual worker, are responsible for keeping your personal radiation dose ALARA.

Reducing external dose

External dose is reduced by the following basic protective measures:

- minimizing time spent near the source of radiation,
- maximizing distance from the source of radiation, and
- using shielding between the body and the source of radiation.

Reducing internal dose

Internal dose is reduced by the following control methods that keep radioactive materials from entering the body through the lungs, the mouth, or the skin:

- engineering controls (glove boxes, hoods, and ventilation systems);
- administrative controls (standard operating procedures [SOPs], radiological work permits [RWPs], and work practices); and
- PPE (coveralls, gloves, booties, hats, and respirators).

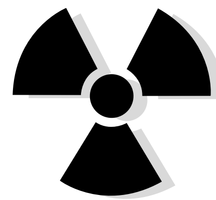
Radiological Controls and Postings

Controls and postings for your protection

In support of the ALARA concept, the Laboratory uses various radiological controls to protect workers from exposure to radiation.

All areas, materials, and machines that are controlled for radiological purposes are identified by posted signs, tags, or labels, combined with physical barriers where appropriate.

The standard radiation caution symbol (trefoil), with the unique color combination of black or magenta on a yellow background, helps to make radiological hazards easy to recognize.

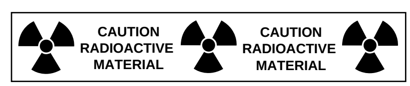


Trefoil

Recognizing radiological hazards

You will recognize areas or materials controlled for radiological purposes by one or more of the following:

- yellow and black signs, bearing the trefoil, with appropriate radiological control information, posted at areas where radiological hazards exist;
- yellow and black or magenta tags and labels, bearing the trefoil, that identify specific radiological hazards within an area controlled for radiological purposes;
- yellow and magenta ropes, tapes, chains, or other barriers that define the boundaries of posted areas; and
- yellow plastic wrapping or labeled containers, bearing the trefoil, that package radioactive materials.



Label

Radiological Controls and Postings —continued

Areas controlled for radiological purposes

Areas controlled for radiological purposes, established by the DOE in 10 CFR 835, are based on the potential for external radiation exposure and/or the potential for contamination.

At the Laboratory, signs for these areas have a black trefoil with black lettering on a yellow background. Specific signs for each area alert workers to the type and/or level of radiation present.

Types of areas

Work areas are categorized as follows:

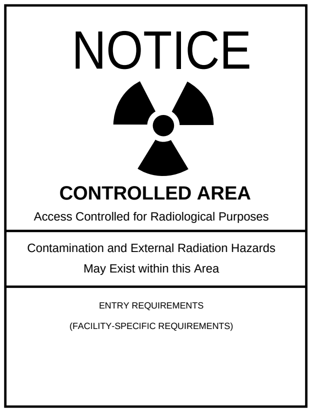
- controlled areas that have relatively low radiological risk, have controlled access, and surround radiological buffer areas or radiological areas;
- radiological buffer areas that have a relatively higher radiological risk, have controlled access, and are boundary areas around radiological areas that contain greater radiological hazards; and
- radiological areas that contain identified radiological hazards; these areas include radiation, contamination, and airborne radioactivity areas.

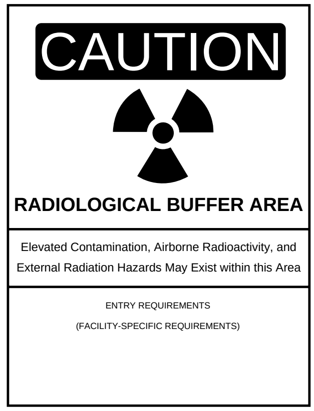
Note: *The precautions required for entry into a radiological area are listed on the posting.*

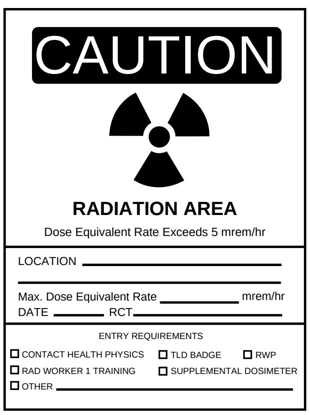
Radiological Controls and Postings—continued

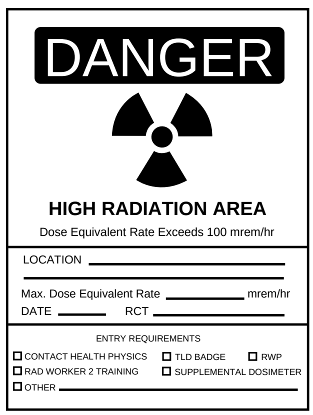
Radiological postings at the Laboratory

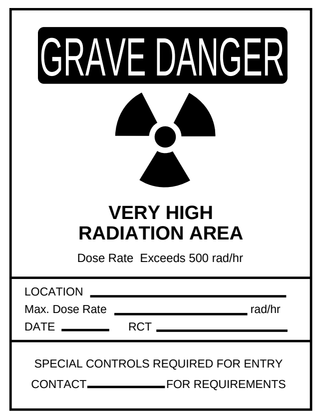
The following are examples of radiological postings at the Laboratory.

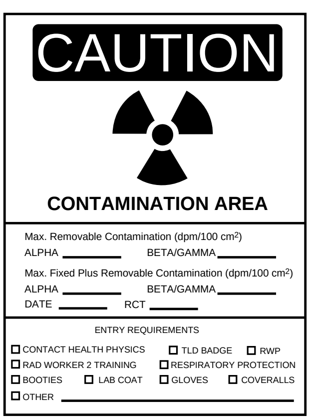


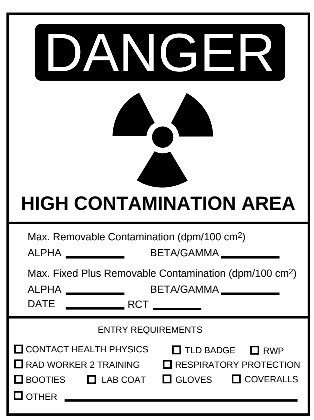


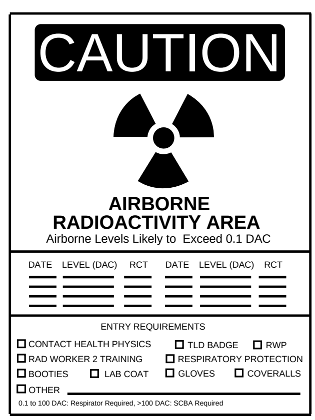












Training Requirements

Training required to enter different areas

Specific training is required to enter, without a qualified escort, different areas controlled for radiological purposes. The DOE divides the work force into the general employee, the radiological worker I, and the radiological worker II.

The following table lists the type of training required for unescorted entry into specific areas.

Note: *Additional entry requirements may exist for access to areas controlled for radiological purposes. Additional facility-specific training may be required at individual facilities at the Laboratory.*

This required training…	allows unescorted entry into a…
General Employee Radiological Training	Controlled Area
Radiological Worker I Training	Controlled Area Radiological Buffer Area Radiation Area High Radiation Area
Radiological Worker II Training	Controlled Area Radiological Buffer Area Radiation Area High Radiation Area Very High Radiation Area Contamination Area

Radiological Protection Responsibilities

Managers' responsibilities

Laboratory managers must

- help ensure that radiation doses received by workers, visitors, and the public are kept ALARA;
- determine which workers require dosimetry;
- identify radiological workers;
- ensure that their workers have completed appropriate radiological safety training; and
- establish radiological control programs at their facilities.

Your responsibilities

You are responsible for keeping your personal radiation dose ALARA. To do this you must

- obey all radiological signs and postings;
- follow all radiological and safety rules and procedures, including SOPs and RWPs;
- enter areas controlled for radiological purposes only if properly trained or escorted and only when necessary for your work;
- use ALARA techniques to reduce dose;
- report unusual radiological situations to your supervisor or the radiological control technician assigned to your work area;
- be aware of emergency procedures for your work area; and
- refresh General Employee Radiological Training every 24 months, unless you upgrade to Radiological Worker I and II Training.

Emergency Information

Nuclear criticality safety

Some kinds of plutonium and uranium are called fissile materials. This means that, if concentrated in a solution or brought closely together as solids in sufficient quantity, they can immediately release large amounts of radiation. If this occurs in an uncontrolled environment, a criticality accident results.

A criticality accident can cause injury or death to individuals in the immediate area from an acute, high-level dose of radiation, but typically does not cause a physical explosion or equipment damage. A criticality accident is a very localized event.

The control of fissile materials to prevent such accidents is called nuclear criticality safety. The Criticality Safety Group (ESH-6) provides nuclear criticality safety expertise to all Laboratory facilities in which plutonium and uranium are handled.

Note: *If your job assignment involves working with or near fissile materials, you will receive additional training on nuclear criticality safety.*

Information specific to facilities and work areas

Emergency procedures and alarms at the Laboratory vary for different facilities and work areas. You should know

- the emergency procedures specific to your work area,
- the warning sirens or alarms specific to your work area, and
- how to contact the radiological control technician assigned to your work area.

911

Note: *In an emergency, call 911. For more information on emergency procedures, see the Emergency Management section of this handbook.*

Student Self-Assessment

1. Radiation that strips electrons from atoms, resulting in the production of ions, is called

    a. excitation

    b. microwave radiation

    c. ionizing radiation

    d. an isotope

2. External exposure to radiation

    a. can be detected with the human senses

    b. does not result in contamination of the worker

    c. can be reduced by wearing proper dosimetry

    d. causes higher birth weights in babies

3. All but one of the following contribute to naturally occurring background radiation. The exception is

    a. radon gas in the air

    b. cosmic rays from the sun and stars

    c. medical radiation therapy

    d. uranium in the soil

Student Self-Assessment—continued

4. The maximum radiation dose a visitor to the Laboratory or a member of the public is allowed to receive annually is

   a. 100 mrem

   b. 5 rem

   c. 50 rem

   d. 15,000 mrem

5. ALARA means keeping radiation dose

   a. as long as reasonably acceptable

   b. as long as radiation is around

   c. as low as radiology allows

   d. as low as reasonably achievable

6. To reduce external radiation dose you should

   a. maximize time, minimize distance, and use shielding

   b. minimize time, maximize distance, and use shielding

   c. use PPE

   d. remove radiation signs that you think are not necessary

7. Laboratory signs for areas controlled for radiological purposes are

    a. yellow and white

    b. magenta and white

    c. magenta and black

    d. yellow and black

8. Completing General Employee Radiological Training allows unescorted entry into a

    a. Radiation Area

    b. Controlled Area

    c. Contamination Area

    d. all of the above

9. Emergency alarms at the Laboratory

    a. are specific to each facility and work area

    b. are consistent throughout the Laboratory

    c. do not include fire alarms

    d. are used if you have torn protective clothing

Student Self-Assessment —continued

Answers

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

Index

P

R

Note

To get credit for this training, you must complete the validated test *GERT Exam: General Employee Radiological Training (11575)*.

To schedule a time to complete *GERT Exam: General Employee Radiological Training (11575)*, contact the ESH-13 Registrar Office

- **by phone at 7-0059 between 8:00 am and 12:00 pm,**
- **by fax at 5-7953, or**
- **by e-mail at eshregistration@lanl.gov.**

Continue