Lawrence Berkeley National Laboratory

# EHS 0470

## General Employee Radiological Training

*PUB-3152*

*This work was supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231. Lawrence Berkeley National Laboratory is an equal opportunity employer.*

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# General Employee Radiological Training

This is the pdf version of the General Employee Radiological Training (GERT).
After reading this document, please use the link at the end to receive course credit.
If you need assistance, please contact EHSS Training (510) 495-2228, or email ehs_training@lbl.gov

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# Introduction

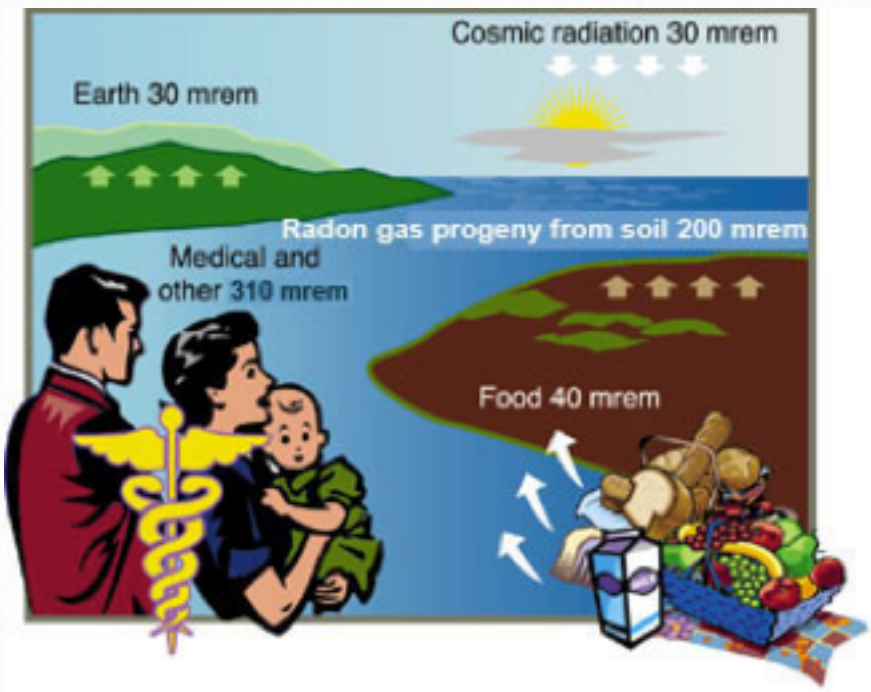
A variety of radioactive materials and radiation-producing machines, such as X-ray machines, electron beam devices and accelerators, are used in research at the Berkeley Lab. Department of Energy (DOE) regulations require that, to ensure employees and guests are aware of the potential hazards associated with these activities, at a minimum general employee radiological training (GERT) must be completed prior to any work with radioactive materials, radiation producing machines, or unescorted access into posted Controlled Areas. Regulations also required that an employee complete additional radiological worker training before performing unescorted work assignments as a radiological worker. A radiological worker is defined by 10CFR835 as a general employee whose job assignment involves operation of radiation producing devices, working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose.

This training provides initial radiological safety instruction to all staff as part of New Employee Orientation. Individuals who have completed GERT may escort untrained visitors into Controlled Areas with which they are familiar. The escort is responsible for ensuring that the untrained visitor complies with all applicable radiation safety requirements. This training also provides general information about radiation, its risks, the controls Berkeley Lab implements to ensure the safety of workers and the environment, and each individual's rights and responsibilities. For specific information about your work area contact your Supervisor/Work Lead, Division Safety Coordinator, or the Environment, Health & Safety Division.

**What Is Radiation and Where Does It Come From?**

The type of radiation referred to in this training is ionizing radiation, invisible particles or waves of energy emitted from radioactive atoms or radiation generating devices. Non-ionizing radiation (e.g., laser light and microwave radiation) presents very different hazards and is controlled through the Nonionizing Radiation program (refer to EH&S PUB-3000 for additional information). The common types of ionizing radiation are alpha, beta, neutron, X ray, and gamma radiation. Some radioactive atoms (e.g., uranium-238

and thorium-232) are natural; others (e.g., plutonium-239 and iodine-131) are man-made. If the energy from the radiation is deposited in a person, he or she receives a radiation dose. Radiation doses are measured in millirems (mrem) or rems. One thousand millirems equal one rem (1,000 mrem = 1 rem). The international unit for radiation dose, sievert (Sv) or millisievert (mSv), may also be used.




Background radiation is radiation from our natural environment. Everyone is exposed to some amount of background radiation. This exposure primarily comes from cosmic rays, radioactive material in the earth (such as uranium-238), ingestion of naturally occurring radionuclides in food (such as potassium-40), and inhalation of radon gas progeny (in particular the short-lived alpha emitters). In the United States, the average background radiation dose is 310 mrem/yr (3.1 mSv/yr) from naturally occurring sources. The Bay Area has a slightly lower average dose of approximately 200 mrem/yr (2 mSv/yr) from naturally occurring sources, because radon levels are lower here. Manufactured sources contribute an additional background radiation dose of approximately 310 mrem/yr (3.1 mSv/yr). Of this amount, approximately 300 mrem (3.0 mSv) is from medical procedures (e.g., X-rays, CT scans and diagnostic tests). Consumer products such as fertilizer, lantern mantles, smoke detectors, and uranium-glazed pottery contribute roughly 13 mrem/yr (0.13 mSv/yr). Fallout radiation that is present in our environment contributes less than 1 mrem/yr (0.01 mSv/yr).

**Occupational Dose Limits**

In the course of their work, some individuals may receive exposure above background levels. The DOE carefully monitors these levels at all of its facilities and sets limits for acceptable doses. The DOE annual whole body dose limits for occupational radiation exposure at Berkeley Lab are shown in Table 1. The limits include dose from both internal

and external sources. These limits are in addition to the average background dose of 200 mrem/yr (2mSv/yr) and do not include exposures from medical sources.

**Table 1. Berkeley Lab Annual Occupational Dose Limits.**

| *Group* | *Dose limit (mrem/yr)* |
|---|---|
| LBNL radiological worker | 5000 (50 mSv) |
| Embryo-fetus of a radiological worker | 500 (5 mSv)** |
| Minors, members of the public, and general employees* | 100 (1 mSv) |

*The internal guideline for general employees is more restrictive than the DOE limit.

**500 mrem/gestation

Berkeley Lab strives to keep radiation doses to workers, the public, and the environment as low as reasonably achievable (ALARA) below the annual dose limits set by the DOE. As Figure 2 shows, Berkeley Lab has been very successful in keeping radiation exposures ALARA.

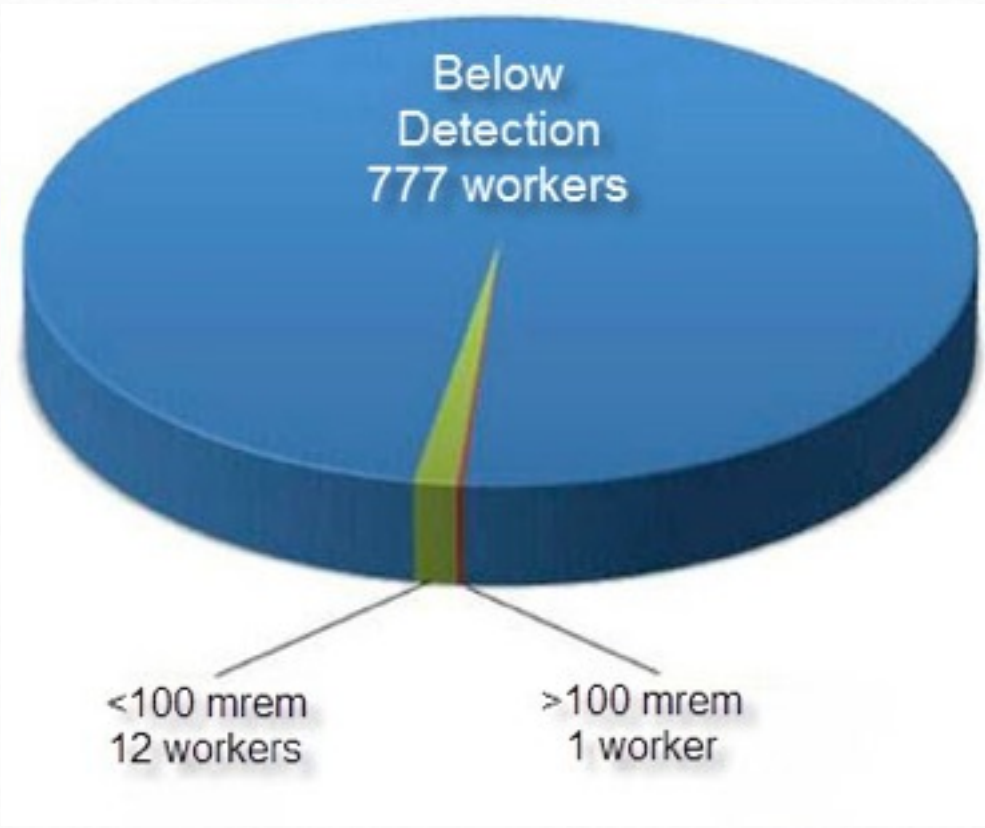



Figure 2. Occupational Radiation Doses Received by Berkeley Lab Personnel in 2011

In 2010, 99 percent of all personnel monitored received no measurable occupational radiation exposure. This exposure distribution is typical at Berkeley Lab. For a perspective Table 2 shows the average doses received by workers in other occupations.

Table 2. **Average Annual Occupational Radiation.**

| Occupation | Approximate Exposure (mrem/yr) |
|---|---|
| Airline flight crew member | 500 (5 mSv) |
| Nuclear power plant worker | 310 (3.1 mSv) |
| Medical personnel | 70 (0.7 mSv) |

**Risks Associated with Radiation Exposure**

The primary risk from occupational radiation exposure is an increased risk of cancer. The amount of risk depends on the amount of radiation dose received, the time over which the dose is received, and the body parts exposed. Scientists postulate that low-level radiation exposure may increase one's risk of cancer, however medical studies have not demonstrated adverse health effects in individuals exposed to small chronic radiation doses (i.e., up to 10,000 mrem [0.1 Sv] above background). The increased risk of cancer from occupational radiation exposure is small when compared to the normal cancer rate in today's society. The current lifetime risk of dying from any type of cancer in the United States is approximately 25 percent (see Figure 3). If a person were to receive, over a lifetime, a cumulative radiation dose of 10,000 mrem (0.1 Sv) to the entire body (above background), his or her estimated risk of dying from cancer would increase to 25.4 percent.

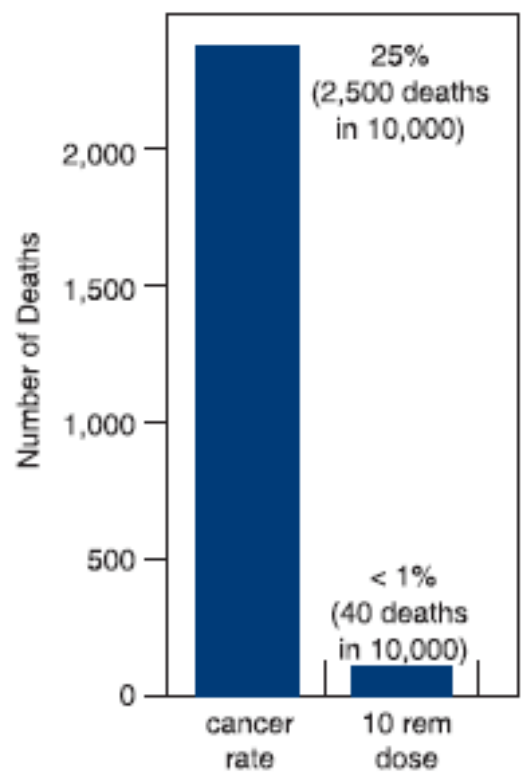



**Figure 3. Estimated Cancer Risks to a population of 10,000.**

**Protecting the Embryo-Fetus**

Although heritable effects from radiation exposure have not been observed in humans, the embryo-fetus is known to be more sensitive to radiation than adults. Therefore, radiological workers who are pregnant, suspect they are pregnant, or are planning a pregnancy may want to notify the Laboratory's Health Services Department (510-486-6266) as early as possible. Health Services will arrange to have the workplace evaluated for potential hazards to the embryo-fetus. (If desired, this evaluation can be conducted confidentially.) Workplace or task modification is typically not necessary because 99 percent of all Berkeley Lab personnel who are monitored receive only radiation dose consistent with background levels. The Berkeley Lab cannot give this special consideration until the pregnancy is declared.

For additional information on the effects of radiation and other toxic agents on human reproduction, see Workplace Hazards to Reproductive Health. This pamphlet is available from Health Services.

**Monitoring Radiation Exposure**

To ensure that exposures are as low as reasonably achievable ( ALARA), Berkeley Lab monitors many of its workers to determine the actual exposures received. Most of these individuals ar monitored for external or penetrating radiation and wear dosimeters to measure their exposures. A dosimeter is a device that is worn like a name tag and measures the radiation dose a person receives from external sources. Currently, about one-fourth of all Berkeley Lab staff routinely wear dosimeters. Dosimeters are exchanged and the radiation doses are measured monthly or quarterly by the Dosimetry Lab. Your supervisor will be able tell you whether or not you should be in this program. Even if you are not required to wear a dosimeter in your work area, one can be made available to you upon request. If you would like a dosimeter, contact the Dosimetry Lab at 510-486-7497 to make arrange-

ments. The type of dosimeter routinely used at Berkeley Lab is an optically stimulated luminescence dosimeter (OSL) (see Figure 4). OSLs contain crystals that absorb energy when exposed to ionizing radiation. It is useful for a broad range of the penetrating radiation fields found at the Berkeley Lab, including beta, gamma, and X rays. Workers who need to be monitored for neutron radiation exposure are issued an additional CR-39 track-etch dosimeter.


**Figure 4. Optically Stimulated Luminescence Dosimeter**

All Berkeley Lab workers who wear dosimeters are provided with an annual exposure summary, even if they received no measurable radiation exposure that year.

Additionally:

- If a worker receives a radiation dose at any point during the year, a radiation dose report will be sent to the worker at the end of the exchange cycle.
- A worker can request an exposure report at termination of employment.
- Anytime LBNL must report an exposure to DOE, the individual will also receive the report.
- Anyone who has worn a dosimeter at the Berkeley Lab may obtain a copy of his/her dose report upon request from the Dosimetry Lab or via the web at https://ehswprod.lbl.gov/Rems/Login.asp.

A few radiological workers are also monitored for internal doses. A person may receive an internal dose through the ingestion or inhalation of radioactive materials. This monitoring typically focuses on a few individuals who routinely handle dispersible radioactive materials. Dose levels are assessed by measuring radioactivity excreted by the body or by measuring the radiation emitted from inside the body. Positive internal doses are reported to the individual and are included in his or her personnel dosimetry record, in the same manner as external doses recorded by the OSLs.

## Radiation Safety Controls

Before any radiological work is allowed, it must be thoroughly reviewed and approved by the Radiation Protection Group. Authorizations that describe the work, hazards, controls, and evaluations are formally implemented to ensure that all work is performed safely. Each individual's roles and responsibilities are specifically assigned during this process. For more information, see Chapter 21 of PUB-3000 (Berkeley Lab Health and Safety Manual). The two primary types of radiation safety controls that are used at Berkeley Lab are engineered and administrative. Engineered controls—such as shielding, interlocks, ventilation, alarms, warning signals, and material containment—are the primary means of control. Administrative controls—such as signs, procedures, dosimetry, and training—supplement the engineered controls. All work is planned with the objective of keeping exposures ALARA. In particular, the following techniques are used by all radiological workers:

- Minimize the time you are exposed to radiation sources.
- Maximize your distance from radiation sources. The radiation level decreases significantly as you move away from the source.
- Employ appropriate shielding between you and the radiation source. For some sources, a plastic barrier is appropriate; for others, a lead shield is used.

## Radiation Signs

One of the most important components of the Berkeley Lab safety program is the posting of warning signs in areas that are controlled for purposes of radiation safety. These signs alert personnel to the potential hazards from radiation in these areas. All radiation hazard signs can be recognized by the radiation trefoil symbol and being either yellow and black or yellow and magenta.  Individuals who have completed GERT training are authorized to enter Controlled Areas without escort. Controlled areas serve as a warning which indicates there are radiological hazards in the vicinity, such as radiological material or radiation-producing machines. The area within the Controlled Area where the radiological material is


handled or where a radiation field exists may be posted with an additional yellow-and-black or yellow-and-magenta sign with the radiation trefoil symbol. Individuals must check with personnel authorized to work in those areas prior to entry.

Figure 5. Controlled Area Sign

Those who have completed EHS 470 General Employee Radiological Training (GERT) can enter a Controlled Area

**Additional training is required** prior to handling radioactive material, potentially contaminated items, or working in a posted area other than a “Controlled Area”. All radioactive material must be kept within a clearly designated area and, in most cases, within a posted Radioactive Material Area. Figure 6 shows examples of various radiological signs.

If you don’t understand a sign, DO NOT cross its boundary. Check with your supervisor or contact the Radiation Protection Group (510-486-7652).

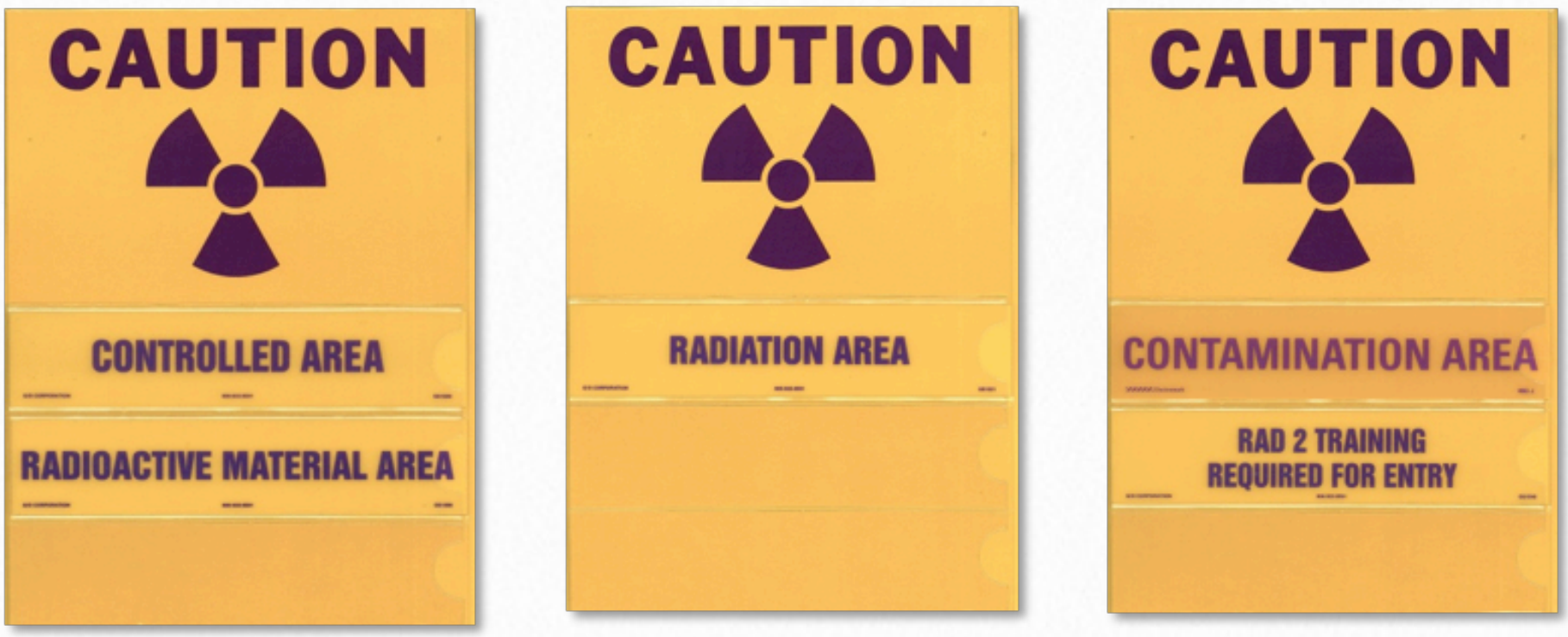



Figure 6. Various Radiological Signs. (No entry without additional training).

## Radioactive Material/Radiation-Producing Machines

All procurement, handling, transfer, and use of radioactive materials or radiation producing machines must be authorized by an approved work authorization from the Radiation Protection Group, which details work activities, locations, and authorized personnel. Chapter 21 of PUB-3000 provides detailed guidelines for working with radioactive materials. All shipping or receipt of radioactive material or equipment must be performed by the Radiation Protection Group.

## Employee/Visitor Responsibilities

You are responsible for doing your job safely. You should thoroughly understand all hazards and controls associated with your work. If you have safety concerns, discuss them with your supervisor or EH&S Division personnel before beginning the work. You may need additional radiological training before performing work. Consult with your supervisor or contact the Radiation Protection Group. If you are a supervisor or manager, you are responsible for providing a safe work environment and for ensuring that the requirements in PUB-3000 are implemented for those workers who are under your supervision. If you are a visitor, you are responsible for obeying all posted signs, attending required training, and reporting any unsafe conditions to your hosts.

## Bibliography and References

1. National Council on Radiation Protection and Measurements (NCRP), Ionizing Radiation Exposure of the Population of the United States, Report 160, Bethesda, MD, 2006.

2. U.S. Department of Energy “Occupational Radiation Protection, Final Rule,” Code of Federal Regulations, Title 10, Part 835, January 1, 2008.

3. The National Research Council Committee on the Biological Effects of Ionizing Radiation, Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR V, Washington, D.C.,1990.

4. Health Physics Society, Radiation Risk in Perspective, Position Statement, 2004.

5. U.S. Nuclear Regulatory Commission, Instruction Concerning Risks from Occupational Radiation Exposure, Regulatory Guide 8.29, Rev. 1, NRC, Washington, D.C., February 1996.

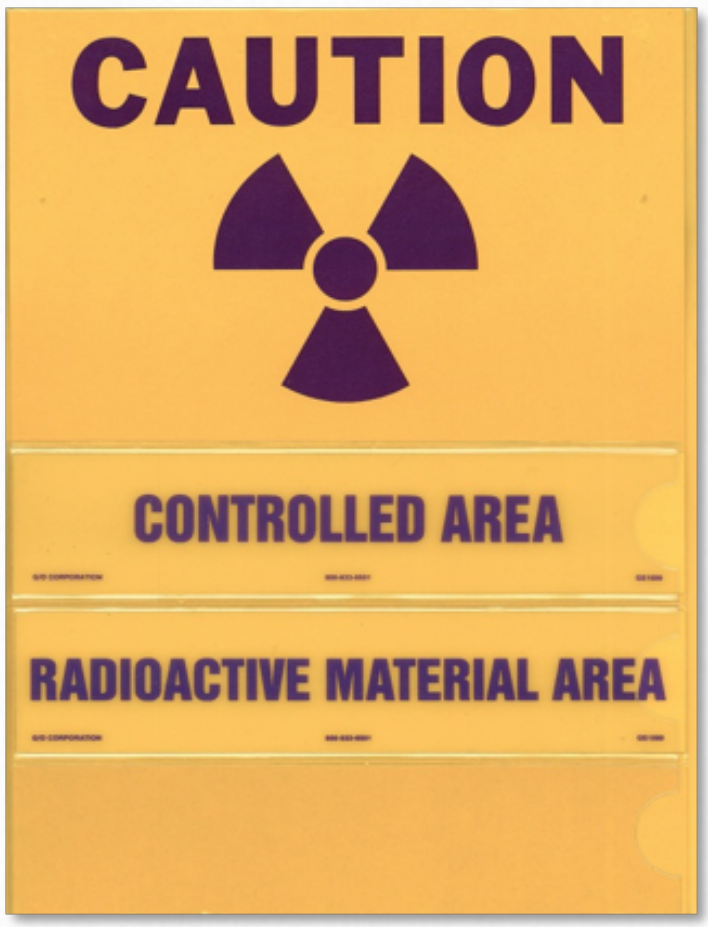
6. American Cancer Society, Cancer Facts and Figures 2007, Atlanta, GA, 2007.

7. International Council on Radiation Protection (ICRP), Recommendations of the International Commission on Radiological Protection, Publication 60, Oxford, England, 1990.

**Key Facts**

Controlled Area
Unescorted access to this area requires GERT.


Radioactive Material Area
No Entry without additional training.



## Other Sources of Information

LBNL Health and Safety Manual, PUB-3000

(http://www.lbl.gov/ehs/pub3000/)

EH&S Division Web Site

(http://www.lbl.gov/ehs/)

Radiation Protection Group

510-486-7652

510-486-7277 (24 hour urgent RPG assistance)

Dosimetry Lab

510-486-7497

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## Get Course Credit

Click the link below (or copy and paste into your browser) to launch the webpage used to grant credit for this training. Login using your LDAP information. If you do not have an LDAP login, select Non-LDAP, and provide the required information including your LBNL badge ID (if this has been provided to you).

https://coursebuilder.lbl.gov/course/exam.aspx?cid=134&sid=1749