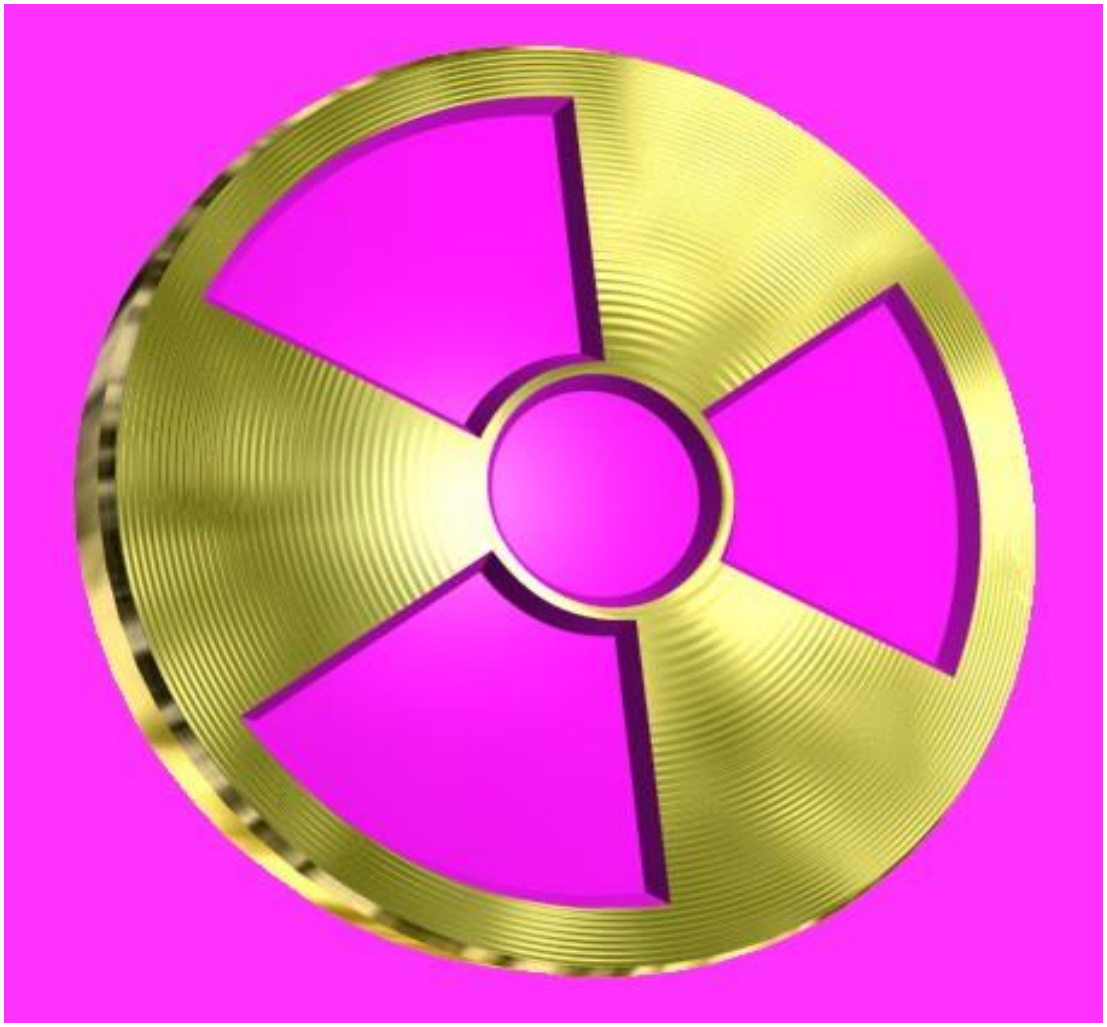
Radiation Safety at LLNL
General Employee Radiological Training

GERT

HS6001-W



LLNL-BR-731845

December 2020

Disclaimer

Notice to Users

Security Notice

This Website is part of a Federal computer system used to accomplish Federal functions. Lawrence Livermore National Laboratory (LLNL) uses software programs to monitor this Website for security purposes to ensure it remains available to all users and to protect information in the system. By accessing this Website, you are expressly consenting to these monitoring activities.

Unauthorized attempts to defeat or circumvent security features, to use the system for other than intended purposes, to deny service to authorized users, to access, obtain, alter, damage, or destroy information, or otherwise to interfere with the system or its operation is prohibited. Evidence of such acts may be disclosed to law enforcement authorities and result in criminal prosecution under the Computer Fraud and Abuse Act of 1986 and the National Information Infrastructure Protection Act of 1996, codified at section 1030 of Title 18 of the United States Code, or other applicable criminal laws.

Disclaimer of Liability

With respect to documents available from this server, neither the U.S. government nor the Lawrence Livermore National Security, LLC, nor any of their employees, makes any warranty, express or implied, including the warranties of merchantability and fitness for a particular purpose, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

Disclaimer of Endorsement

Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. government or the Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. government or the Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

Copyright Status

LLNL-authored documents including, but not limited to, articles, photographs, drawings, and other information subsisting in text, images, and/or other media, are sponsored by the U.S. Department of Energy under Contract DE-AC52-07NA27344. Accordingly, the U.S. government retains a nonexclusive, royalty-free license to publish or reproduce these documents, or allow others to do so, for U.S. government purposes. All documents available from this server may be protected under the U.S. and Foreign Copyright Laws. Permission to reproduce may be required. LLNL is not responsible for the contents of any off-site pages referenced.

Privacy Notice

LLNL utilizes web measurement technology in order to improve this website and provide a better user experience for customers. The Office of Management and Budget (OMB) classifies this as a Tier 2 usage, since LLNL is utilizing a multi-session web measurement technology that does not collect any personally identifiable information (PII). This technology anonymously tracks how visitors interact with llnl.gov, including where they came from, what they did on the site, and whether they completed any pre-determined tasks while on the site.

This website uses Piwik open analytics technology to collect information used to optimize this website; help determine top tasks, improve user interface and diversify content offerings to meet the needs of customers. No personally identifiable information is collected, so the anonymity of the end user is protected. The measurement data that is collected is only retained for as long as is needed for proper analysis and optimization of the website and is not shared with anyone beyond the support staff to this website, except when required by law enforcement investigation.

Contents

Radiation **1**
Federal Law 1
Nuclear Safety Rules 1
General Employee Radiological Training **2**
What Is Radiation and Where Does It Come From? 3
Occupational Dose Limits 4
Risks Associated with Radiation Exposure 5
Protecting the Embryo/Fetus 6
Basic Radiation Safety Controls **7**
External Radiation Protection 7
Internal Radiation Protection 7
Radiation Signs 8
Radiological Work 10
TLD Report 10
Responsibilities **10**
References **10**

Radiation

Federal Law

The federal government requires Lawrence Livermore National Security (LLNS) and other Department of Energy (DOE) contractors to comply with the requirements of nuclear safety rules. DOE, through the Office of Enterprise Assessments, self-regulates contractor compliance with these requirements. Regulatory compliance is assured when LLNS employees understand and follow Laboratory policy and procedures designed to implement nuclear safety requirements.

Failure to follow Laboratory nuclear safety policy and procedures, including those described in the LLNL Radiation Protection Program, constitutes a noncompliance with DOE nuclear safety requirements. DOE requires LLNL to report these non-compliances and to take corrective action to prevent recurrence of the reported noncompliant condition. Non-compliances that DOE considers significant enough to warrant independent investigation may result in DOE determining that violations have occurred, not only subjecting LLNL to possible federal enforcement action including civil penalties (i.e., fines) and contract fee reductions, but also potentially seriously damaging the Laboratory's reputation.

Nuclear Safety Rules

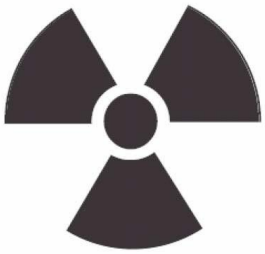
The following sections of Title 10 of the Code of Federal Regulations comprise the nuclear safety rules currently enforced by the Department of Energy:

1. 10 CFR 835, "Occupational Radiation Protection," protects LLNL workers from the potentially harmful effects of radiation.
2. 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance," describes Quality Assurance requirements applicable to all LLNL facilities and operations that create a potential to cause radiological harm.
3. 10 CFR 830, Subpart B, "Safety Basis Requirements," describes requirements specific to nuclear facilities and operations that utilize high-hazard radioactive materials such as plutonium.
4. 10 CFR 820, "Procedural Rules for DOE Nuclear Activities," describes general requirements for managing nuclear activities, including reporting of noncompliances with nuclear safety rules.
5. 10 CFR 708, "DOE Contractor Employee Protection Program," protects your right to express concerns about nuclear safety without fear of reprisal from your employer.

The LLNL *Radiological Control Manual* contains LLNL's and DOE's radiation safety program requirements.

General Employee Radiological Training

A variety of radioactive materials and radiation-generating devices (RGDs) (e.g., x-ray machines, electron beam devices, and accelerators) are used at LLNL to accomplish its research and development mission. To ensure that individuals are aware of the potential radiological hazards associated with such activities, General Employee Radiological Training (GERT) is required as part of the general training requirements for all new LLNS employees and supplemental labor workers. GERT must be completed before individuals are allowed unescorted access into areas posted with the radiation symbol (below). In addition, GERT is required before individuals are allowed to receive an occupational radiation dose in posted areas, whether or not they are escorted.



Radiation Symbol

Table 1 describes additional Radiological Worker training courses required prior to unescorted access to Radiation Areas, Contamination Areas, and Airborne Radioactivity Areas.

Table 1. Courses Required for UNESCORTED ACCESS to Radiologically-Controlled Areas

Course	Area Posting
HS6001-W, General Employee Radiological Training (GERT) (Alternates: HS0001, HS6901-W, HS6010-W)	• Radioactive Material (RMA) • Radiation Generating Device (RGD) Area
HS6002-W, Unescorted Radiological Buffer Area (RBA) Access (Alternates: HS6901-W, HS6010-W)	• Radiological Buffer Area (RBA)
HS6901-W, Radiological Worker Core Training (Alternates: HS6010-W)	• Radiation Area (RA)
HS6010-W, Radiological Worker + HS6010-P Practical	• High Radiation Area
HS6300-W, Contamination Control	• Contamination Area (CA) • High Contamination Area (HCA) • Airborne Radioactivity Area (ARA)

For course information, contact your training coordinator or the Safety Education and Training Section (SETS) (ext. 2-0587), or access the Livermore Training Records and Information Network (LTRAIN) or the SETS Website at: https://esh-dir.llnl.gov/sets/sets.html.

GERT retraining is:

- Required every two years.
- Satisfied by reading the information presented in this document.
- Automatically documented in LTRAIN when the employee uses the link presented in the web course and acknowledges that they have read this material.

Other individuals (e.g., visitors and contractors who are not enrolled in LTRAIN) may receive this information by completing the web-based course from offsite (https://training.llnl.gov/ltrain-external-courses) or by reading this GERT booklet.

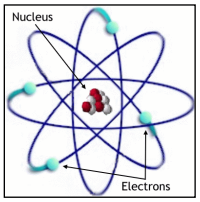
An individual who has completed GERT may escort untrained workers into areas requiring GERT training (e.g., a Radioactive Material Area or an RGD Area). The escort is responsible for ensuring that the untrained worker complies with the posted radiation safety requirements.

This document provides general information about radiation and the controls that LLNL implements to ensure the safety of workers, visitors, and the environment. For specific information about your work area, consult your area supervisor or ES&H Team health and safety technician.

What Is Radiation and Where Does It Come From?

All material is made up of atoms. Most atoms are stable, but some are inherently unstable and release energy in the form of ionizing radiation, which is radiation with enough energy to remove electrons from neighboring atoms. (Non-ionizing radiation, such as laser light and microwaves, usually does not have enough energy to remove electrons from neighboring atoms.) The common types of ionizing radiation are alpha, beta, neutron, x-ray, and gamma. Some atoms (e.g., uranium, thorium, and tritium) are naturally radioactive, whereas others (e.g., most medical radioisotopes) are made radioactive in reactors or accelerators. Devices such as x-ray machines and accelerators can generate radiation, and are collectively referred to as 'radiation-generating devices', or RGDs.

When radiation deposits energy in a person, he or she receives a 'radiation dose.' Radiation doses are measured in units of rem or millirem (mrem). One thousand millirem is equal to one rem (1000 mrem = 1 rem).



Ionizing radiation is present everywhere in the universe. The average non-occupational dose from radiation in the U.S. is: 620 mrem/year and comes from the following:

<u>Background radiation</u> is naturally found in the environment. It comes primarily from cosmic rays, radioactive material in the earth, naturally occurring radionuclides (such as potassium-40) in food, and radon gas in the air we breathe. In the United States, the average background radiation dose is about 310 mrem/year in the United States.

Radioactive material is found in everything we eat and drink.

<u>Medical and other manufactured sources of radiation</u> contribute an additional dose of 310 mrem/year, of which approximately 300 mrem/year is from medical procedures (e.g., CT scans, dental x-rays, and certain diagnostic tests). Consumer products and activities (e.g., cigarette smoking, building materials, and commercial air travel) contribute roughly 10 mrem/year.

Occupational Dose Limits

The DOE and LLNL occupational radiation dose limits are shown in Table 2.

Table 2. Occupational Radiation Dose Limits

Group	Dose Limit
General employees (any LLNS or subcontractor employee)	5,000 mrem/year
Embryo/fetus of a declared pregnant worker	500 mrem/gestation
Minors and members of the public entering areas posted with the radiation symbol	100 mrem/year

LLNL has been very successful in keeping occupational doses as low as reasonably achievable (ALARA) below the legal dose limits. In fact, in 2016 (a typical year as far as radiation dose is concerned) more than 98% of LLNL workers did not receive any occupational radiation dose. For comparison, Table 3 shows the average annual dose received by workers in other occupations. The occupational dose limits were selected so the risk from radiation exposure would be commensurate with the risks associated with other 'safe' occupations.

Table 3. Annual Radiation Dose by Occupation

Occupation	Average dose (mrem/year)
Airline flight crew member	240
Nuclear power plant worker	150
Medical personnel	80
LLNL Radiation Workers	10
LLNL Non-Rad Worker	Below detection limits

Risks Associated with Radiation Exposure

The primary risk associated with whole body occupational radiation dose is an increased risk of cancer. The degree of risk depends on the amount of radiation dose received, the time period over which it is received, and the body parts that receive the dose. Although regulations presume that low-level radiation doses increase one's risk of cancer, studies have not demonstrated any adverse health effects in individuals who are chronically exposed to small radiation doses over a period of many years (e.g., a total of up to 10,000 mrem above the natural background dose). The Health Physics Society has stated, "at radiation doses of 10,000 mrem or less above background, the observed radiation effects in people are not statistically different from zero." That is, if there is an effect at doses below 10,000 mrem above background, the effect is so small as to be undetectable.

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 an adult. Therefore, LLNS employees male or female who are planning a pregnancy, as well as those who suspect (or know) that they are pregnant, are strongly encouraged to notify the Health Services Department (ext. 2-7459) as soon as possible. Health Services will provide a 'Declaration of Pregnancy' form and information and, with the individual's concurrence, will arrange to have the workplace evaluated (confidentially, if desired) for potential hazards that could affect the fetus. Based on the interview with the individual and/or the workplace evaluation, Health Services will recommend whether or not a medical restriction is warranted and, again with the individual's concurrence, will issue a medical restriction that limits exposure to pregnancy-related hazards. (Note: A medical restriction that limits exposure to radiation is issued only if the employee signs the "Declaration of Pregnancy" form.) Contractors must declare their pregnancy with their employers, who are then responsible for informing LLNL of the work restriction.

Basic Radiation Safety Controls

Engineered controls (such as shielding, ventilation, alarms, warning signals, and material containment) are the primary means of controlling radiation doses at LLNL. Administrative controls (e.g., signs, procedures, dosimetry, and training) supplement these engineered controls.

External Radiation Protection

An external radiation dose is a dose received from a radiation source outside of the body. You may encounter low-level radiation fields (i.e., fields less than 5 mrem in an hour) in Radioactive Material Areas, Radiation Generating Device Areas, and Radiological Buffer Areas. While in such areas, you can reduce your external radiation dose by:

1. **Minimizing the time you are exposed to sources of radiation.**
2. **Maximizing your distance from radiation sources (radiation level decreases significantly with increased distance from the source).**

Internal Radiation Protection

An internal radiation dose is a dose received from radioactive material taken into the body. Intake of radioactive material can result from inhalation, ingestion, injury, or, in some cases, absorption through the skin. All persons receive some internal dose of radiation from their diet, but LLNL strives to prevent internal occupational exposures by controlling releases of airborne radioactive material and controlling eating or drinking in areas where dispersible radioactive material is handled. In addition, radiation workers are required to use personal protective equipment (e.g., lab coats and gloves) to keep dispersible radioactive material off their clothing and body.

Radiation Signs

Signs with the radiation symbol are used to identify radiologically controlled areas and to inform workers of access requirements. (Controls for work are contained in the applicable work control document.) Individuals who have completed GERT, or who are escorted by a GERT-trained worker, may enter areas posted with the signs shown in Figure 1. Unless you are informed to wear a TLD in those areas, TLDs are *not* normally required to access these areas.

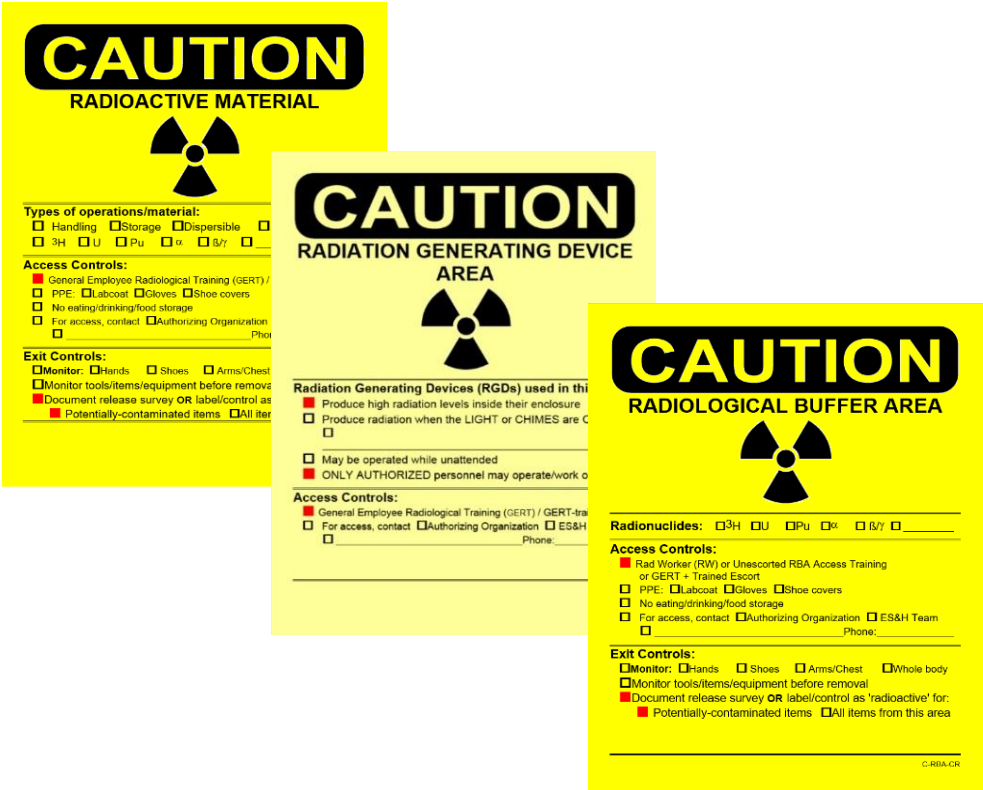
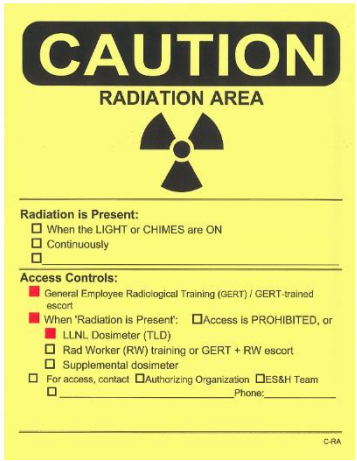


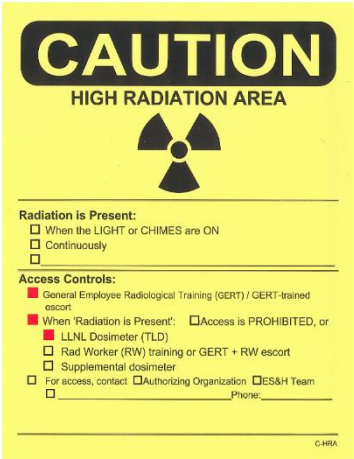
Figure 1

To enter areas posted with the signs shown in Figure 2, workers must have additional radiological training; or, they must have completed GERT and be escorted by a trained Radiological Worker. Note: Everyone entering a Radiation Area or High Radiation Area must wear a TLD unless otherwise authorized by the Radiological Control Manager. Wear TLD on upper torso between waist and shoulders (front). Only use your LLNL TLD at LLNL. Do not pack it into your suitcase when traveling.

Read the signs carefully, because access requirements may change (as noted by marked boxes) depending on whether or not radiation is continuously or intermittently present in the area.

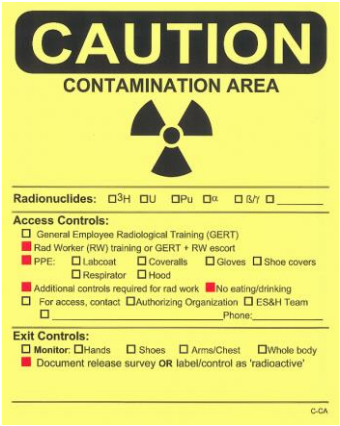
Individuals entering an area posted with the radiation symbol must adhere to the posted requirements.

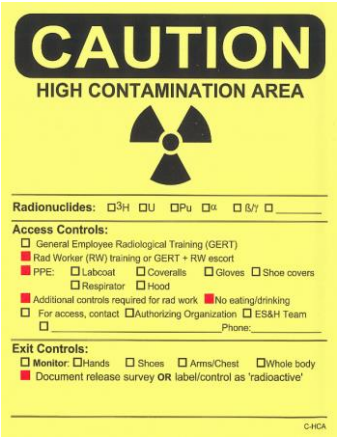




TLD required

For entry





PPE required

For entry

Figure 2. Additional Radiological Worker training is required for unescorted access to areas posted with these signs, or variations of these signs.

Radiological Work

Most radiological work requires a work authorization in the form a Work Control Document (WCD). Radiological work, including the handling of Class 0, I or II sealed radioactive sources (SRSs) or equivalent quantities of radioactive material, also requires additional radiological training.

Refer to the LLNL Radiological Control Manual (MAN-2050) for specific work planning and control (Chapter 14) and training (Chapter 16) requirements.

TLD Report

The annual summary radiation report includes; dose to the whole body, Total Effective Dose, and dose to the skin, hands, and eyes as applicable. To obtain a report of how much dose you received at LLNL you need to personally contact the Dosimetry Office (2-4381 or dosimetry@llnl.gov).

Responsibilities

Anyone entering a radiologically-controlled area (i.e., any area posted with the radiation symbol) is responsible for:

1. Obeying posted signs and instructions given by their escorts.
2. Not handling radioactive material or operating RGDs unless specifically trained to do so.
3. Reporting any unsafe conditions to the Responsible Individual, the ES&H Team health and safety technologist, or in the case of visitors, to their LLNL host.

Visitors monitored under the LLNL dosimetry program are responsible for returning their dosimeter at the end of their visit (or every 6 months for long visits).

1. Dosimeters can be returned at any security portal, or to the Dosimetry Laboratory in B253, or by lab mail to L-787.
2. New dosimeters can be obtained from the Dosimetry Office (B253/R1312) or by calling “2-GET1” (ext. 2-4381).

The ES&H Team health and safety technologist assigned to your facility can answer questions or refer you to a health physicist. You can also find ES&H Team contact information online at: https://rnre.llnl.gov/rnrewl/faces/main.jspx

References

1. National Council on Radiation Protection (NCRP) Report No. 160 “Ionizing Radiation Exposure of the Population of the United States” (2009)
2. U.S. Department of Energy, 10 CFR 835, Occupational Radiation Protection
3. The National Research Council Committee on the Biological Effects of Ionizing Radiation, “Health Effects of Exposure to Low Levels of Ionizing Radiation” (known as BEIR III) (1980)
4. The National Research Council Committee on the Biological Effects of Ionizing Radiation, “Health Effects of Exposure to Low Levels of Ionizing Radiation” (known as BEIR V) (1990)
5. International Council on Radiation Protection (ICRP), “Recommendations of the International Commission on Radiological Protection,” Publication 60 (1990)

Test Your Knowledge

Test your knowledge about GERT with these true or false questions:

1. Visitors require a dosimeter for access into posted Radiation Areas, unless otherwise authorized by the Radiological Control Manager?
2. GERT is required prior to receiving occupational exposure in an area posted with a radiation symbol?
3. GERT is required for unescorted access into areas posted with the radiation symbol?
4. Radiation Worker Core Training (HS6901) or an alternate, higher level course is required for unescorted access into Radiation Areas?
5. Additional Radiation Worker training is required before handling Class 0 or greater quantities of radioactive material or working with RGDs, and before unescorted access is allowed into contamination areas and airborne radioactivity areas?
6. Visitors can obtain a dosimeter by going to the Dosimetry Office (B253/R1312) or by calling "2-GET1" (ext. 2-4381)?
7. Anyone entering an area posted with the radiation symbol must adhere to the posted requirements?
8. Safety-related questions should be directed to the area supervisor, Responsible Individual or the ES&H Team?
9. LLNL's implementation requirements for occupational radiation protection are described in MAN-2050?
10. Visitors who are issued a dosimeter must return it to the Dosimetry Office or a Security kiosk at the end of their visit (or 6 months after it was issued), whichever comes first?

Answers: All answers are TRUE!