GERT
TRAINING

STUDY GUIDE

Jefferson Lab Radiation Control Department
(2010)

1 Introduction

General Employee Radiological Safety Training (GERT) is provided to inform the employee of basic radiation protection concepts and the Radiological Control Program established here at Jefferson Lab (TJNAF).

This study guide is provided to help you become more familiar with the TJNAF accelerator site, its potential radiological hazards and how to avoid them. If you are attending a classroom presentation of this training, you should follow along in the study guide with the instructor's presentation. This booklet should also be used as a self-guided review for retraining purposes.

1.1 General Requirements

GERT is required for:

- All TJNAF employees.
- Visitors, users, and subcontractors who expect to be at TJNAF for more than 30 days, or make routine short-duration visits.

Note: Persons who may need routine access to radiological areas are required to be trained as Radiological Workers.

Employee responsibilities in observing and obeying radiological control postings and procedures are emphasized throughout GERT to ensure the employee knows his/her part in TJNAFs Radiological Control Program.

GERT is designed to ensure that all employees are trained to perform their jobs in the safest manner possible. As a part of the DOE complex and the nature of the work performed at TJNAF, everyone must be aware of and play an active part in the site's Radiological Control Program.

1.2 Qualification

When you have completed GERT you will:

- Be qualified to enter Controlled Areas at TJNAF without an escort.
- Be qualified to escort visitors into the site Controlled Area.
- Be qualified in aspects of GERT training common to all DOE sites.

Note: You must receive site-specific training to be fully qualified for unescorted access at another DOE site.

Completion of GERT <u>does not</u> permit you to:

- Enter Radiologically Controlled Areas (identified by yellow and magenta signs with the three bladed radiation warning symbol) without an escort and a dosimeter.
- Handle radioactive material without an escort and dosimetry.
- Enter any area posted as Radiation, High Radiation, Contamination, or Airborne Radioactivity Area at any time - <u>even when being escorted</u>.

You must pass a written test following this training with a minimum score of 75% in order to receive the GERT qualification.

Retraining on GERT is required every two years. To re-qualify on GERT, or to transfer your GERT qualification from another DOE facility, you may review this material at your own pace and take a proficiency exam.

When significant configuration or radiological program changes occur at TJNAF, you may be required to attend briefings or training sessions to familiarize you with these changes.

2 Objectives

On completion of this class, you should be able to DISCUSS the Radiological Control Program in regards to radiological terminology, hazards and risks, identification systems and employee responsibilities for maintaining radiation exposures as low as reasonably achievable (ALARA).

You will be able to select the correct response from a group of responses to verify your ability to:

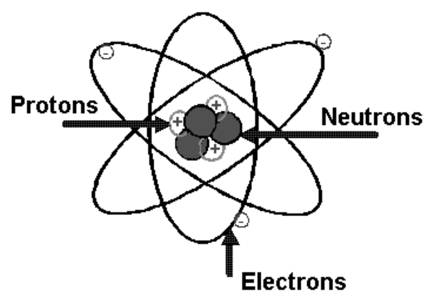
- *Define* the terms radiation, radioactive material, and radioactive contamination.
- *Identify* sources of radiation, both in the environment and at TJNAF.
- *Identify* the measurement unit used for personnel radiation dose.
- *State* the potential biological effects from chronic radiation exposure.
- *Identify* the ALARA concept and practices.
- *State* the whole body radiation exposure limit for non-radiological workers.
- *Identify* radiological postings and identification used for radiological hazards.
- *Identify* requirements for entry to Controlled Areas and Radiological Areas at TJNAF.
- *State* management and individual responsibilities for the Radiological Control Program.

3 Radiological Fundamentals

3.1 Atoms

The elements that make up all matter are composed of atoms. Each atom is made up of three major parts that help form the atom's physical and chemical properties. The three basic particles are:

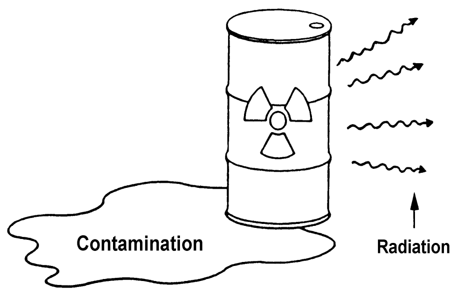
- **Protons**- positively charged particles in the nucleus, their number determines the element type.
- **Neutrons**- also found in the nucleus, these particles have no charge, but are needed for stability.
- **Electrons**- negatively charged particles orbiting the nucleus.



Atoms may be referred to as *stable* or *unstable*.

- Stable atoms do not contain excess energy.
- Unstable atoms contain excess energy. This is caused by an imbalance in the ratio of protons to neutrons in the nucleus of the atom. These atoms release their excess energy during the process known as *radioactive decay*. The energy released in the process is called *ionizing radiation*.

Radiation (or ionizing radiation) is energy in the form of waves (rays) or particles which can penetrate matter and cause ionization.



Radioactive Material is any material which contains unstable atoms that emit radiation. Radioactive material may exist in any physical form, such as solids or liquids. Any radioactive material which is in a form that is easily spread or has been transferred to surfaces, liquids, or the atmosphere is known as **radioactive contamination**. Contamination is a concern due to the potential for its spread to personnel.

A simple definition for radioactive contamination is radioactive material in an unwanted place.

Radiation may be emitted from sources other than radioactive materials. Certain physical processes (such as those used in x-ray machines) may cause the production of ionizing radiation. The operation of the electron accelerator at TJNAF involves such processes. Due to the high energy nature of TJNAF's beam, it can also cause the formation of radioactive material. This material is produced in and among the components of the accelerator.

3.2 Exposure and Dose

When people are exposed to radiation, the energy of the radiation is deposited in the body. *This does* <u>*not*</u> *make the person radioactive or cause them to become contaminated.*

An analogy would be to shine a bright light upon your body. The body absorbs the light (energy), and in some cases the absorption of the light energy may cause noticeable heating in the body tissue. However, your body does not become a light source or emit light now that it has absorbed the light.

When your body absorbs radiation, the tissues of your body may be damaged by the penetration and conversion of the radiation energy. Since absorption of radiation can damage tissue, a way to measure that damage and ensure that it is kept to a minimum is necessary. The amount of radiation energy absorbed in a body is known as **dose**. The special unit for measuring dose in a person is the **rem**.

The rem is the unit used for equating radiation absorption with biological damage.

Since the rem is a fairly large unit, radiation exposure is usually recorded in thousandths of a rem - or millirem.

1000 millirem = 1 rem
(millirem is usually abbreviated as mrem)

For example, if you receive a chest x-ray, the amount of exposure - or *dose* - would be approximately 10 mrem (0.010 rem). This same amount of dose or biological harm, could be received from making 2-3 coast-to-coast airline flights (each round trip involves about 5 mrem from elevated cosmic radiation levels in the upper atmosphere). The source of the exposure is relatively unimportant, once the dose has been measured in a standard unit, it can be compared to other doses, added to other doses, or used in risk comparisons regarding non-radiation risks. We will make some of these comparisons later.

4 Sources of Radiation

4.1 Background Radiation Exposure

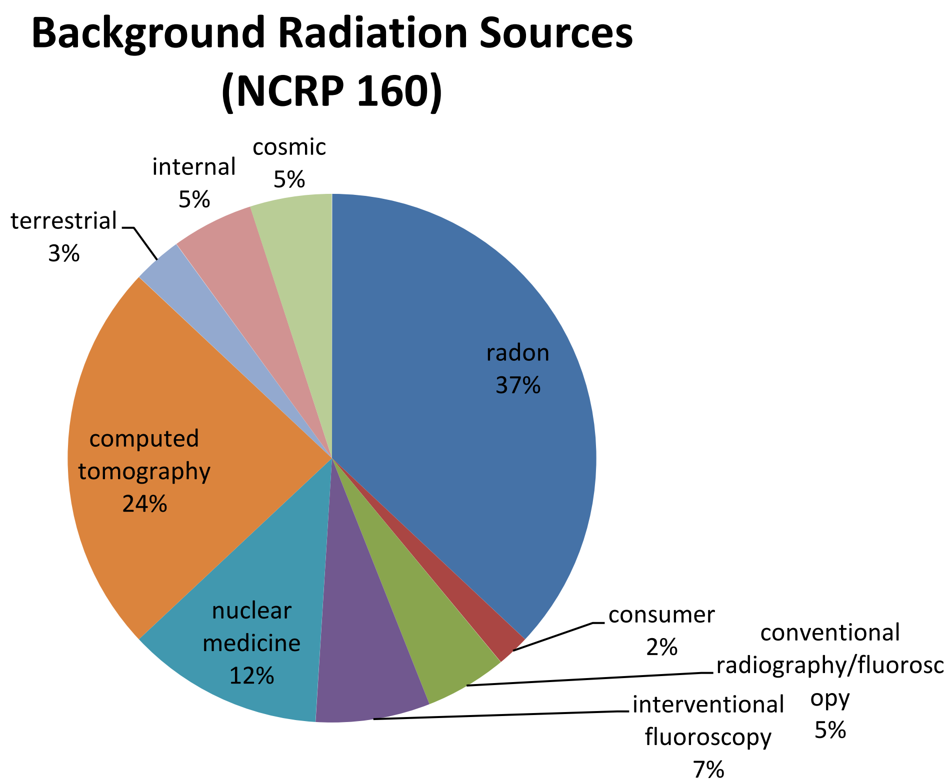
People have always been exposed to radiation. We are exposed to radiation from our environment and our bodies. Most people are not exposed to radiation as a consequence of their job. However, ALL people are exposed to radiation from background sources. These background sources can be divided into natural and human-made sources. Some of the specific sources of these types of radiation are listed below. Refer to the pie chart for the relative amounts of exposure.

<u>Natural background radiation</u>

This exposure is a result of cosmic radiation (i.e., sun and outer space), material in the earth's crust (i.e., rocks, radon, and soils), and radioactive material present in our bodies.

<u>Man-Made sources of radiation</u>

This exposure includes medical and dental use of X-rays and nuclear medicine, consumer products (e.g., smoke detectors, lantern mantels), fallout from nuclear weapons testing, and commercial uses of nuclear energy and radioactivity.



An average person in the US receives about 620 mrem/year from all sources.

4.2 Occupational Radiation Exposure

Some types of work and workplaces involve radiation exposure to workers above the normal background radiation that we are all exposed to. At TJNAF, if your job involves the likelihood of occupational exposure to radiation, you must be trained at a level commensurate with the hazard.

As a GERT trained worker, you are <u>not</u> considered an occupationally exposed person, and your exposure to radiation from these sources will be negligible; however; you should be aware of the existence of radiation hazards at TJNAF, how to identify them, and minimize your exposure to them.

4.3 Sources at TJNAF

There are several sources of radiation present at TJNAF. Most important among them are:

- Operation of TJNAF's electron beam
- Radioactive material produced by the operation of the beam
- Radioactive test sources and x-ray producing devices

4.3.1 Prompt Radiation

Some radiation is produced whenever the beam is operating. This radiation results from the interaction of the high energy electrons in the beam with objects such as beam targets and dumps. This is referred to as prompt or direct radiation, and only lasts as long as the beam is on. This radiation stops immediately when the beam is turned off, much like the radiation produced by an x-ray machine.

4.3.2 Residual Radiation

The interaction of the beam with matter can also cause the formation of radioactive material. This process is often referred to as **activation**. This radioactive material emits radiation for some time following the operation of the beam. Most of these radioactive materials are short-lived and become stable within minutes or hours following shutdown of the beam. A few of these materials have longer half-lives, and may stay radioactive for long periods.

4.3.3 Radioactive Test Sources

Small, sealed sources of radioactive material are used for testing various detector systems in use at TJNAF. Most of these sources are very low intensity check sources. X-ray sources are also used. All test sources are to be handled and used only by specifically authorized personnel. Should you encounter such a source in use, make sure you follow all posted instructions regarding access to the area and dosimetry requirements.

5 Biological Effects

Large exposures to ionizing radiation (WWII bomb survivors, radium dial painters, etc.) have been shown to be harmful to humans. Large doses received in relatively short periods of time (known as **acute doses**) can cause a range of serious injuries or death. We also know that large doses of radiation may cause an increase in the risk of some forms of cancer, cataracts, genetic defects in future generations, and harmful effects in the unborn embryo or fetus.

However, the large doses referred to above are not received as a result of occupational exposure. Stringent dose limits are in place which prevent measurable increases n these effects in exposed groups. The small doses received over long periods of time by radiological workers are referred to as **chronic doses**.

5.1 Potential Risk From Chronic Dose

Even in the cases of small doses of radiation, it is reasonable to assume that there is some risk for effects, like cancer, even though the risk is not directly observable. Using this assumption and the knowledge of the risks associated with high doses, the *probability* of a certain effect can be calculated based on the amount of dose received.

In this way, the rem can be used as a unit of *potential* harm. For instance, the relatively well known cancer risk from doses in the range of hundreds of rem can scaled to assess the potential risk from a dose of 100 mrem (0.1 rem). This scaling, or extrapolation is considered to be a conservative approach (may over-estimate) to estimating low-dose risks.

Note: Using this method, even exposures to background radiation can be assessed and used in comparisons to help put the risks from exposure into perspective.

The chart below uses the method above to provide some comparisons for occupational and non-occupational risks we encounter routinely in daily life.

Industry Type or Activity	**Estimated Days of Life Expectancy Lost**
Smoking 20 cigarettes a day	2370 (6.5 years)
Overweight by 20%	985 (2.7 years)
Mining and Quarrying	328
Construction	302
Agriculture	277
Government	55
Manufacturing	43
Radiation - 340 mrem/yr for 30 years	49
Radiation - 100 mrem/yr for 70 years	34

5.2 Genetic and Prenatal Effects

Genetic effects are those that may appear in the children of an exposed person due to damage to his/her genetic material.

Genetic effects have been extensively studied in plants and animals, but risks for genetic effects in humans are considerably smaller than the risks for effects that occur in the exposed person. Therefore, the limits used to protect the exposed person from harm are equally effective in protecting future generations from harm.

Do not confuse a genetic effect with an effect that results from **prenatal exposure** (exposure in-utero) of a developing embryo/fetus. A developing embryo/fetus is more sensitive to ionizing radiation than an adult. The possible effects seen in the child of a woman who was exposed during pregnancy include:

- Growth retardation
- Mental retardation
- Childhood cancer

Note: These effects can also be caused by many other factors and are unlikely at occupational dose levels.

The risk of these effects occurring is minimized by having special protective measures for pregnant workers and by keeping all exposures as low as reasonably achievable (ALARA). DOE has established a special radiation dose limit for pregnant radiation workers of 500 mrem for the entire pregnancy. The policy also has provisions for providing for work assignments that will essentially remove the pregnant worker from the radiological environment for the duration of the pregnancy.

Since the dose limit for non-radiological workers is already below the radiation worker pregnancy limit, there are no special requirements for protection or reporting pregnancies for you to follow. ***However, if you are pregnant, or think you might be, and you need to make an escorted entry into a radiological area, it is recommended that you first consult with the Radiation Control Department.*** This will ensure that all ALARA considerations are taken into account and that dose minimization efforts and policies are consistently applied.

5.3 Conclusions About Radiation Risks

In general, it can be stated that:

The risks associated with occupational exposures are small and considered acceptable when compared to other occupational health risks and health risks encountered in daily life.(i.e., smoking, driving a car, etc.)

It is important that personnel develop a healthy respect for the hazards associated with radiation exposure. Understanding the overall risks in the context of other common hazards of life is a good way of assessing the risks. This should help prevent undue fear of radiation hazards or a careless attitude towards them.

6 ALARA Principle

The DOE and TJNAF are firmly committed to having a Radiological Control Program of the highest quality. This applies to those activities that manage radiation and radioactive materials that may potentially result in radiation exposure to workers, the public, and the environment.

Maintaining occupational exposures to radiation and radioactive materials **As Low As Reasonably Achievable** (ALARA) is an integral part of all site activities. There are three basic practices used to maintain exposures ALARA.

1. ***Time***-Reduce the amount of time spent near a source of radiation.

2. ***Distance***-Stay as far away from the source as possible.

3. ***Shielding***-Place some type of shielding between you and the source.

It should be easy to see that these methods, when combined with what we have discussed about potential risks from radiation, allow individuals to control and minimize their own radiation risks. Any occupational exposures to radiation should be made with a "risk versus benefit" approach. ALARA is well suited to this approach. A good description of the ALARA philosophy is that "*there should be no occupational radiation exposure to an individual without the expectation of an overall benefit from the activity causing the exposure".*

7 Radiation Dose Limits

The DOE has established radiation protection limits at all DOE facilities for non-radiological workers and visitors.

The limit for members of the general public and employees who are NOT radiological workers is 100 mrem/year.

This limit is 50 times lower than the limit for radiological workers. The low limit, in conjunction with the ALARA principle, helps ensure that radiation risks to non-radiological workers are insignificant.

8 Radiological Controls

In support of the ALARA concept, TJNAF has established a system of radiological controls to protect individuals from exposure to radiation and radioactive material. These controls include a system to identify radiological hazards, access control procedures for the site, and training requirements commensurate with hazards likely to be encountered. The TJNAF Radiological Control Manual contains complete descriptions of these and other control measures, rules, and requirements at TJNAF.

8.1 Radiological Identification System

Postings (signs, tags, labels) are used to alert personnel of a potential or known radiological hazard and to aid them in minimizing exposures and preventing the spread of contamination.

8.1.1 Site Controlled Area

The TJNAF accelerator site (fenced in area bounded by locked or guarded access gates) has been designated as a **Controlled Area** for radiological purposes. This means that within this area, you are likely to see postings for radiological areas, or radioactive material or possibly encounter slightly elevated levels of radiation. By design, a person who spends their entire work year in the site Controlled Area is not expected to receive enough radiation dose to require dosimetry (50 mrem).

Requirements to enter the Controlled Area are:

- Training in radiological controls (GERT is the minimum)

-OR-

- An escort who is trained at least to the GERT level

The security guard at the site access point will check your identification badge to ensure you have had the appropriate training.

You may also find Controlled Areas in:

- Locations within the Test Lab (Bldg 58)
- Locations within the EEL Building (Bldg 90)
- Designated Radioactive Material Storage Areas around the site

8.1.2 Radiologically Controlled Areas

Areas within the Controlled Area boundary are clearly posted to alert personnel to the presence of elevated radiation levels and/or radioactive materials. These areas are designated **Radiologically Controlled Areas (RCAs)**. Radiologically Controlled Areas contain radiation levels that require personnel radiation monitoring (dosimetry) for entry.

Requirements for unescorted entry:

- dosimeter
- Radiation Worker I training
- Signature on General Access Radiation Work Permit (in beam enclosure)

Note: GERT training does <u>not</u> qualify you to enter RCAs without a trained radiation worker escort!

Radiologically Controlled Areas are identified by the following:

- Signs that have the standard radiation symbol colored magenta (purple) or black on a yellow background.
- Signs with the words "Radiologically Controlled Area", or "RCA".
- In the absence of doors or other physical entry points, yellow and magenta rope, tape, chains or other barriers to designate the boundaries of the areas.
- Personnel dosimetry requirements.

Within RCAs, additional postings may be encountered. *You are <u>not</u> authorized to enter any of these radiological areas at any time except for emergencies*. These include:

- Radiation Areas (dose rates are between >5 mrem/hr)
- High or Very High Radiation Areas (dose rates >100 mrem/hr)
- Contamination Areas (contain loose surface radioactivity above certain limits)
- Airborne Radioactivity Areas (radioactivity is present in the air)

REMEMBER:

- You must not enter any Radiologically Controlled Area unless you obtain dosimetry and are escorted by a qualified person.
- Always follow instructions given by your escort and RadCon personnel.
- Minimize the amount of time you spend in the RCA.

8.1.3. Control of Radioactive Material

Only specially qualified workers and RadCon personnel are permitted to handle radioactive materials. All other personnel MUST NOT TOUCH OR HANDLE ANY RADIOACTIVE MATERIAL.

Tags and labels with a yellow background and either a magenta or black standard radiation symbol are used to identify radioactive material. Tags and labels will contain the words:

"CAUTION-RADIOACTIVE MATERIAL"

Yellow plastic wrapping may be used to package radioactive material, and designated areas are used to store the material.

If you discover radiological material that appears to be unattended, (e.g., discarded in a trash receptacle or loose outside or in building corridor), you should take the following actions:

1) Do not touch or handle the material.

2) Warn other personnel not approach the area.

3) Guard the area and have someone immediately notify RadCon.

4) Await RadCon personnel.

8.2 Personnel Safety System

The TJNAF Personnel Safety System (PSS) protects personnel from exposure to high radiation levels and other hazards in the accelerator enclosure associated with operation of the electron beam. PSS access controls include magnetically locked and interlocked doors and gates, key banks for controlled accesses, and status indicators. Other functions of the PSS include direct beam sensing and termination capabilities, radiation monitoring, and emergency shut off switches.

Status displays you should recognize include:

- **Machine State Status Indicator** - These automatic signs are located at each main access point to the beam enclosure. Access to the enclosure is permitted only during *Restricted Access* or *Controlled Access* modes. As a non-radiological worker, the only machine state in which you may enter is *Restricted Access*. You may only enter if all other requirements for entry are met (escort, dosimeter etc.).

- **Magenta Beacon** - The rotating magenta beacon signifies a condition in which access is not permitted. These beacons are located at access points which do not have Machine State Status Indicators.

- **Run/Safe Box** - Run/safe boxes are located strategically within the beam enclosure and provide an indication of the machine state as well as a means to terminate unsafe conditions in the event of an accident or other failure. If you visit the beam enclosure, take note of the Run/Safe boxes - they should indicate "Safe" with a green light. The red button can be used in case of an emergency. Hitting the button terminates any unsafe machine related condition which might occur.

- **Controlled Area Radiation Monitors** (CARMs)- CARMs are radiation monitors designed to detect accelerator produced prompt radiation outside the shielded accelerator enclosure. These instruments are interlocked to the PSS and will terminate operation of the electron beam if preset alarm set-points are reached.

Note: If you should encounter a CARM with the audible and/or visual alarm activated, exit the area immediately and call the Accelerator Crew Chief.

9 Personnel Monitoring (Dosimetry)

Since radiation cannot be detected with any of the human senses, special detection devices must be used. Workers should become familiar with the equipment and devices used to detect radiation and radioactive material.

Dosimeters are radiation detection devices used to record the amount of radiation received by the wearer. The two types of dosimeters routinely used at TJNAF are the optically stimulated luminescent dosimeter (OSL) and the Self Reading Pocket Dosimeter (SRPD).

- OSLs are issued to radiation workers on a permanent basis and are processed by a vendor every six months.

- SRPDs may be issued to visitors and other non-radiation workers on a temporary basis for entry into Radiologically Controlled Areas. Issuance of SRPDs must be authorized by RadCon.

Note: In cases where a temporary dosimeter is issued to a visitor or user, all escort requirements still apply. The possession of a dosimeter does not authorize you to enter Radiologically Controlled Areas without an escort.

If you are using a temporary dosimeter, remember:

- Wear the dosimeter between the neck and waist or other location designated by a RadCon representative.
- Return the dosimeter to RadCon at the end of the work shift.
- If you lose or suspect damage to the dosimeter, leave the RCA immediately an notify RadCon.
- Check the reading of the dosimeter (if SRPD) before entering, during your stay in the RCA, and after exiting the area.
- Report any irregular or suspect readings to your escort immediately.

10 Emergency Procedures

Radiological emergencies include fire, severe injury, or loss of life in a radiological area, high radiation exposure to personnel, and damage to or loss of radioactive material or radioactive sources. Responsibility for dealing with an emergency initially rests with the person discovering it. According to the TJNAF Safety Manual, immediate, appropriate action should be taken to:

- protect life, then property, then the environment
- warn others in the immediate vicinity
- minimize your own exposure to the hazard
- make the proper notification according to the information below

10.1 Accelerator Emergency

In the event of a radiological emergency which results from accelerator operations (i.e. beam-on emergency), the Crew Chief should be notified at the Machine Control Center (MCC) (phone numbers found on the yellow tag attached to all TJNAF phones). The Crew Chief has overall responsibility for safety and coordinating emergency response on the accelerator site.

10.2 Non-Accelerator Emergency

In the event of a radiological emergency involving spills or loss of radioactive material, potential excessive or unmonitored personnel exposure, or spread of contamination to personnel or uncontrolled areas, RadCon should be notified.

All security guard posts, the MCC, and the Experimental Hall Counting House have up-to-date emergency call-out lists which can be used to contact RadCon. The inside front cover of the TJNAF telephone directory contains phone numbers of EH&S staff including radiation protection personnel.

10.3 Calling 911

The 911 emergency number can be reached from any TJNAF phone - there is no need to dial 9 for outside access.

Do not call 911 to report radiological emergencies unless:

- There are, or could be injuries involved
- There is a fire
- Emergency rescue or other similar aid is required

11 Responsibilities in the Radiological Control Program

A superior Radiological Control Program is maintained through open communications. The attitude that constant improvement is required in radiological work should be fostered at all levels.

Management Responsibilities

TJNAF Management is firmly committed to a Radiological Control Program of the highest quality. Some of the responsibilities that management has for the Radiological Control Program are:

- Provide sufficient resources, including personnel and provide for training to ensure individuals are qualified for their assigned duties.
- Establish radiation exposure goals and guidelines.
- Solicit feedback from the entire workforce on improvements for the Radiological Control Program.
- Hold employees accountable for radiological performance.
- Implement policies and procedures to maintain radiation exposures ALARA.

Individual Responsibilities

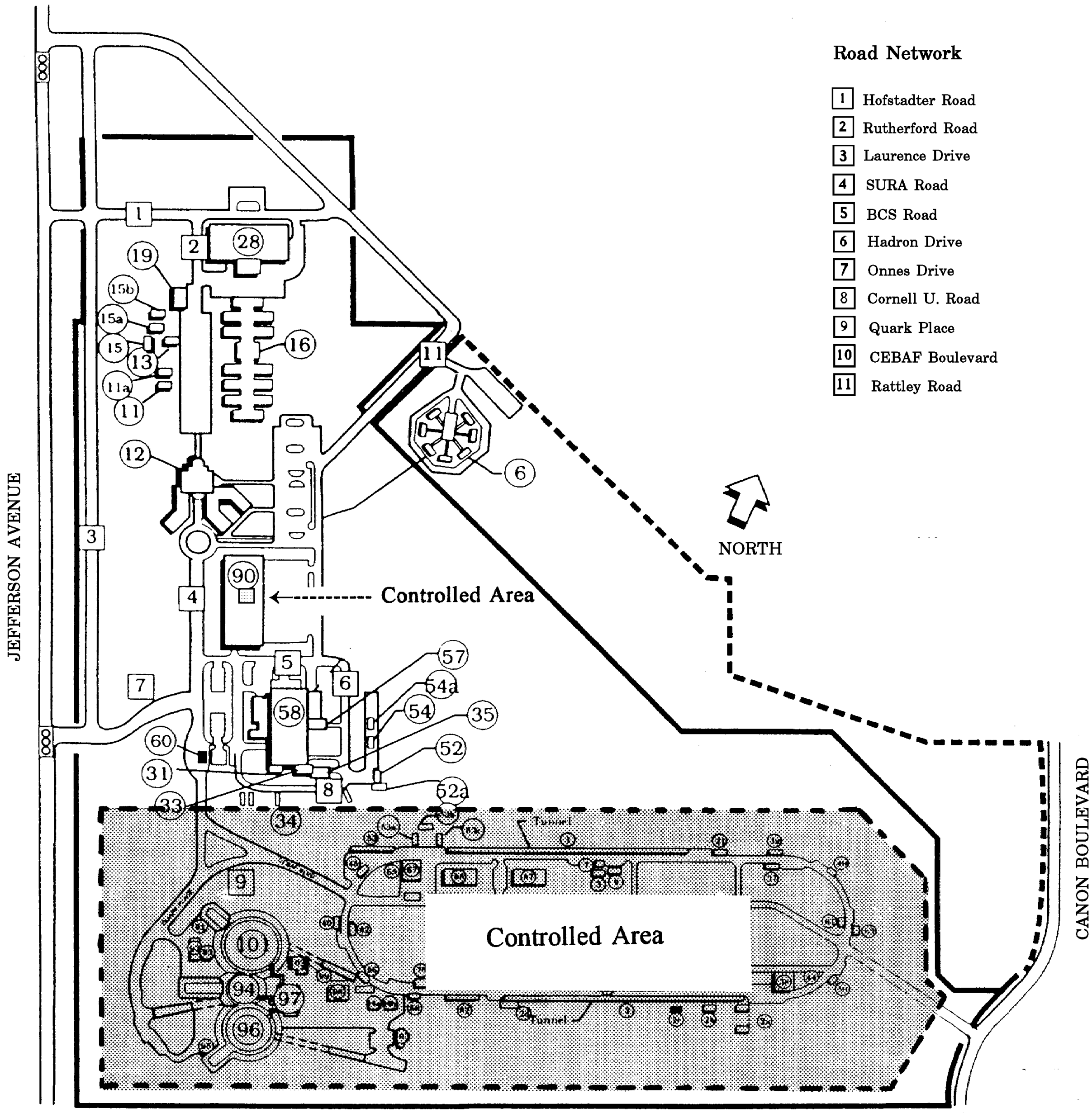
A positive radiological attitude is not limited to those who perform radiological work. All employees have an impact on a successful Radiological Control Program. Some of the employee responsibilities in the Radiological Control Program are:

- Comply with all radiological and safety rules.
- Be familiar with emergency procedures for your work area.
- Be alert for, and respond to, unusual radiological situations.
- Know where and/or how to contact RadCon personnel in your work area.

12 Review and Evaluation

Before taking the multiple choice exam, make sure you review the course objectives found in Section 2 of this handout. Review questions are provided in an attachment to this handout. Feel free to ask any questions of the instructor or exam proctor prior to taking the test. No notes or other reference materials will be permitted while taking the test. If you find a test question confusing or unclear, ask for clarification.

Appendix A: TJNAF Site Controlled Area



Appendix B: Review Questions

1. Radiation is best defined as:

   a. Material that emits particles or rays.
   b. Energy in the form of particles or rays.
   c. Material that glows.
   d. Ionized atoms.

2. The unit used to measure the biological damage done by radiation is the:

   a. ion.
   b. x-ray.
   c. rem.
   d. rad.

3. For people who receive small (chronic) doses of radiation, the main potential health hazard is considered to be:

   a. reddening of the skin.
   b. nausea, vomiting, and eventual death.
   c. an increase in the possibility of cancer.
   d. reduced ability of the immune system to fight disease.

4. Radioactive contamination is best defined as:

   a. a person who has been exposed to x-rays.
   b. radiation in the environment.
   c. any radioactive material.
   d. radioactive material in an unwanted location, such as on your skin.

5. Due to the existence of background radiation:

   a. you are never exposed to radiation.
   b. you are always exposed to radiation.
   c. you are very likely to get cancer.
   d. you are protected from radiation exposure at work.

6. Material which emits radiation is called:

    a. radioactive material.
    b. biodegradable material.
    c. ionized material.
    d. nuclear material.

7. One of the sources of radiation at TJNAF is:

    a. spent nuclear fuel.
    b. a nuclear reactor.
    c. nuclear weapons.
    d. a high energy electron accelerator.

8. You may enter the site Controlled Area without an escort only if:

    a. you are a Radiation Worker.
    b. you have written permission from DOE.
    c. you have radiological training such as GERT.
    d. you have a dosimeter.

9. As a non-radiological worker, your radiation dose limit is:

    a. 100 mrem per year.
    b. 1000 mrem per year.
    c. the same as a radiation worker.
    d. not regulated.

10. To enter a Radiologically Controlled Area you must:

    a. get permission from DOE.
    b. have approval from the Radiation Control Department Manager.
    c. have a Radiation Worker escort and appropriate dosimetry.
    d. get your supervisor to escort you.

11. As part of the ALARA principle, if you are visiting a Radiologically Controlled Area, you should:

    a. spend as much time there as possible.
    b. avoid posted Radiation and High Radiation Areas.
    c. check yourself for contamination when you exit.
    d. have a medical examination after exiting.

12. In the event that you discover radioactive material that appears to be unattended (such as improperly discarded in a trash receptacle), you should:

    a. not touch the material.
    b. keep yourself and others away from the area.
    c. contact RadCon.
    d. all the above.

13. The fundamental idea behind the ALARA (As Low As Reasonably Achievable) principle is:

    a. to keep anyone from being exposed to radiation.
    b. to make people think there is no risk from radiation exposure.
    c. to keep the risks from radiation exposure to a minimum by minimizing the dose.
    d. none of the above.

Answers to Review Questions

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