SLAC NATIONAL ACCELERATOR LABORATORY

ENVIRONMENT, SAFETY & HEALTH DIVISION

Radiological Worker II Study Guide

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Acronyms and Abbreviations

ACR	Accelerator Control Room
ACS	accelerator cooling system
ALARA	as low as reasonably achievable
BDE	Beam Dump East
BSY	Beam Switchyard
cpm	count per minute
DOE	Department of Energy
dpm	disintegration per minute
dps	disintegration per second
HEPA	high-efficiency particulate air
SI	International System of Units
linac	linear accelerator
LCW	low conductivity water
MFD	Mechanical Fabrication Department
NDR	North Damping Ring
NFF	North Final Focus
PPE	personal protective equipment
PPS	personnel protection system
PAMM	planned access machine maintenance
RP	Radiation Protection
RPFO	Radiation Protection, Field Operations
RAM	radioactive material
RWP	radiological work permit
SLAC	SLAC National Accelerator Laboratory
SDR	South Damping Ring
SFF	South Final Focus
SSRL	Stanford Synchrotron Radiation Lightsource
WBT	web-based training

1 Introduction

Radiological Worker II Training (RWT II, ESH Course 250) is the final course in a series that introduces radiation workers to the SLAC National Accelerator Laboratory radiation protection program. After completing this course and passing the required exams you will be qualified to perform the following types of radiological work in a manner that is consistent with the as low as reasonably achievable (ALARA) process:

- Accessing contamination areas
- Handling contaminated material
- Machining radioactive materials (drilling and filling)

This study guide is one of the resources used in training and it is the basis for preparing for challenge exams after initial certification.

Note *A copy of the current version of this study guide is available online at all times for anyone preparing for a challenge exam.*

The Radiation Protection Department (RP) is looking forward to your successful participation in SLAC's radiation protection program.

1.1 Course Administration

The prerequisite for RWT II (ESH Course 250) is RWT I (ESH Course 116). The initial RWT II certification requires that you complete the web-based training (WBT) course, complete the WBT exam, and complete RWT II practical training.

RWT II training expires every 24 months. After completing the training for initial certification, you may choose to pass a challenge exam rather than repeating the WBT to be recertified each time your certification expires.

- **WBT exam.** The exam covers the material in the RWT II course. You must achieve a minimum score of 80 percent to pass.
- **Challenge exam.** Passing the challenge exam allows you to recertify ESH Course 250, without repeating the WBT.
- **Practical exam.** In addition to a written exam, you must also pass a hands-on, or practical, exam. A practical is part of the initial training and recertification cycle. The practical (ESH Course 250PRA) is scheduled separately from ESH Course 250.

1.2 Purpose

RWT II training prepares you to recognize sources of radioactive contamination and apply methods to prevent and control its spread. Training in contamination control practices and diligent application of them will help ensure a working environment in which radiation exposure remains ALARA.

1.3 Course Objectives

Upon completion of RWT II training, you will be able to discuss the methods used to control the spread of radioactive contamination. You will be able to select the correct response that verifies your ability to

- Define removable, fixed, and airborne contamination
- State sources of radioactive contamination at SLAC
- State locations of radioactive contamination at SLAC
- State the indicators of potential contamination
- Explain the purpose and use of personnel contamination monitors
- State the appropriate response to area or personnel contamination alarms
- Describe and demonstrate methods used to control radioactive contamination
- Identify and demonstrate the proper use of protective clothing
- Identify the normal methods used for decontamination

2 Radioactive Contamination Control

2.1 Terminology

The terminology for radioactivity and radioactive contamination is very specific and cannot be used interchangeably. For the purposes of implementing the radiation protection program, RP defines these terms as follows.

2.1.1 Radiation

Radiation, simply defined, is energy that is transferred through space and matter.

2.1.2 Ionizing Radiation

Ionizing radiation is the energy (in the form of particles or photons) emitted from radioactive atoms that can cause ionization.

2.1.3 Radioactive Material

Radioactive material is material that contains radioactive atoms. When radioactive material is properly contained (encapsulated), it may emit radiation and be an external dose hazard, but it will not be a contamination hazard. If radioactive material is no longer contained (becomes un-encapsulated or loose), it becomes radioactive contamination.

2.1.4 Contamination

Contamination, simply defined, is radioactive material that can be easily transferred from one place to another. Under normal conditions exposure to radiation will not cause a worker to become contaminated.

2.1.5 Radioactive Contamination

Radioactive contamination, simply defined, is small particulate radioactive material on surfaces that can be removed by non-destructive means (such as wiping or brushing against the material) or by the use of solvents.

2.1.6 Activated Material

Activated material is material that has become radioactive due to a radiological energy transfer process. Activated material is not considered to be contaminated. However, if some type of destructive action such as welding, grinding, or machining is applied to the activated material, contamination could be generated by the material removed from the activated material. (See also *radioactive material*.)

2.1.7 Radiological Buffer Area

A radiological buffer area is an area adjacent to the contamination area that is usually located at the exit/entrance point of the contamination area where contamination may be present.

2.2 Contamination Types

Radioactive contamination can be loose (removable), fixed, or airborne.

2.2.1 Loose

Loose (also known as transferable or removable) contamination can be readily removed from surfaces. It may be transferred by casual contact, wiping, brushing, or washing.

2.2.2 Fixed

Fixed contamination cannot be removed from surfaces by casual contact but may be released when the surface is disturbed, for example by grinding, drilling, or cleaning with volatile liquids. Over time, fixed contamination may weep, leach, or otherwise become removable.

2.2.3 Airborne

Airborne contamination is contamination that is suspended in air.

2.3 Contamination Units of Measure

Radioactive contamination is expressed as radioactivity per unit area or in the corresponding “counts” measured by an instrument. The most common units are

- Curies / 100 cm^2 or Curies / volume for liquids
  - For tritium the units are picocuries per liter, or pCi/L
- Disintegrations per minute (dpm) / 100 cm^2
- Becquerel or disintegrations per second (dps) / 100 cm^2
- Counts per minute (cpm) / 100 cm^2

Note *100 cm^2 is approximately equal to 4 x 4 inches square.*

2.4 Contamination Control Limit

The Department of Energy (DOE) sets limits for fixed and removable radioactive contamination in Title 10, *Code of Federal Regulations*, “Energy,” Chapter 3, “Department of Energy,” Part 835, “Occupational Radiation Protection”, Appendix D, “Surface Contamination Values” (10 CFR 835 Appendix D).

The control limit for contamination depends on many factors. The control limit for fixed contamination limit is generally 5,000 dpm / 100 cm^2 above background. The control limit for removable contamination varies, depending on a number of factors captured in Table 2-1, such as nuclide and radiation type.

Note *1,000 dpm is equal to approximately 100 cpm on a frisker, which is an instrument that measures radiation. For a beta-gamma isotope, the efficiency depends on the isotope, radiation type, and geometry of the source in relationship to the detector. The approximate efficiency for an open window frisker type beta-gamma meter is 10 to 20 percent. Frisking instruments are further described in Section 2.9.1, "Contamination Monitoring Equipment."*

When a level of radioactive contamination is detected at or near the control limit, some level of action is required, such as posting the area, donning protective clothing, and applying control measures as detailed in Section 2.11, "Contamination Control Methods."

Note *Background radioactivity generally registers at between 50 and 100 cpm, so 100 cpm is considered to be an extremely low level.*

Table 2-1 Removable Contamination Control Limits per 10 CFR 835

Radio nuclide	Control Limit (dpm/100 cm^2)	Frisker Reading (cpm/100 cm^2)
Removable contamination (beta and gamma; these are the most common form at SLAC)	1,000	100 (GM Pancake detector)
Uranium	1,000	100
Transuranics (alpha)	20	5 (Ludlum 3030, 2241)
Thorium-natural	200	20
Tritium	10,000	Not detectable in the field

2.5 Contamination Indicators and Sources

At SLAC, contamination is localized to the small areas affected by beam loss. Knowing where sources of radioactive contamination are and how to conduct work in such areas is essential in keeping contamination confined. Unless all required work practices are followed, radioactive material can be spread to uncontaminated areas.

In spotting potential contamination, look for such indicators as

- Components that are posted as hot spots, as illustrated by the signage in Figure 2-1
- Damaged radiological containers
- Metal chips located next to a component that is or may potentially be radioactive (such as a beam dump, collimator, magnet, or target)
- An increase in the audible count rate on the contamination survey meter while frisking
- Leaks, spills, or standing water from portions of the low conductivity water (LCW) system that have been identified as potentially radioactive

Figure 2-1 Signs That Indicates a Hot Spot and Radioactive Contamination

The following sections discuss the location and requirements pertaining to actual and potential contamination sources such as LCW systems, which may contain tritium, and beam line components, which may release contamination when they are disassembled. Other potential sources of radioactive contamination include airborne contamination, radiological containers, poor work practices, machine operations, and poor housekeeping.

2.5.1 Low Conductivity Water Systems and Tritium

2.5.1.1 Radioactivity in LCW Systems

Certain sections of the LCW system are radiologically controlled because

- The LCW system location or the systems they serve may cause certain impurities in the water to become radioactive
- The water may become radioactive as tritium (^{3}H), a radioactive isotope of hydrogen, is formed
- Filters and resin columns such as the ones shown in Figure 2-2 can trap radioactive materials and thereby become potentially contaminated
- Wear products of the piping may become radioactive

The RP Field Operations Group (RPFO) lists systems that are potentially radioactive or may contain tritium in the LCW Radiological Status Sheet.

Figure 2-2 LCW Resin Bottles Connected to Cooling Systems

These systems are labeled, and may include, but are not limited to

- Accelerator cooling systems (ACS) in sectors 1, 2, and 3, 19, 20, 29, and 30
- 11-08 system at Sector 11
- Wave guide cooling system, Sector 28
- Klystron cooling system, Sector 5
- Positron source at Sector 20
- Positron source at Sector 20 (PS 20)
- A-Beam Dump (ABD) LCW system
- Beam Analyzing Station (BAS) II at Sector 20
- Beam Switchyard (BSY) collimator LCW system
- BSY, A Magnet
- BSY, B Magnet
- Slit 10 (SL 10) LCW system
- Slit 30 (SL 30) LCW system
- Beam Dump East (BDE) LCW system
-

2.5.1.2 LCW System Work Practices

- Always notify RPFO before changing out any LCW systems resin or filter of any listed system.
- LCW systems that may be contaminated by tritium are designated with a radiological tag as shown in Figure 2-3.
- If any listed system develops a leak or break that might expose internal surfaces, RPFO technicians must be present before any work begins to avoid the possible spread of contamination.
- Wear gloves to control the transfer of any tritium contamination when the tritium concentration is greater than 20,000 pCi/L; this is the threshold value for a system that is considered contaminated.

Note *Tritium is difficult to detect with typical field portable instruments because of its low beta radiation.*

Figure 2-3 Label Warning of Potential Contamination in an LCW System or Component

2.5.2 Beam Line Component Disassembly

2.5.2.1 Radioactivity in Beam Line Components

Contamination in a beam line component may be below measurable limits on external surfaces, but contamination may exist on internal surfaces. Disassembling any such component could result in the release of radioactive contamination. This especially applies to components near a hot spot.

2.5.2.2 Disassembly Work Controls

Contact RPFO before disassembling any beam line component in the accelerator housing or in a shop if there is a potential for contamination to be generated. RFPO will determine if additional contamination controls are necessary. These may include

- RWT II qualification of certain personnel
- Requirement to wear protective clothing
- A radiological work permit (RWP)
- Attending a briefing regarding exposure and contamination control techniques
- Radiological surveys during disassembly

2.5.3 Airborne Contamination

Any airborne radioactivity is typically associated with short-lived gases rather than particulate matter. The probability for airborne particulate contamination at SLAC is low. (Contamination control methods are discussed in Section 2.11.) Control methods particular to limiting airborne contamination when working with radioactive material include

- Using high-efficiency particulate air (HEPA) filter respirators for welding, as required
- Using proper radiological controls such as HEPA-filtered vacuum cleaners and ventilation to contain radioactive particulate during machining
- Using special containments for grinding

2.5.4 Radiological Containers

Radioactive or potentially radioactive material (RAM) must be labeled and contained in clear bags. Most RAM containers are stored in radioactive material areas. Any bag or other container that may contain RAM that is not properly labeled, not in a radiologically posted area, or looks suspicious must be reported to RPFO immediately. In such cases, do not allow others to enter the area or handle the container.

2.5.5 Contamination Area Work Practices

Good work practices in a contamination area are essential because carelessness may cause a small contamination area to become larger. To avoid spreading contamination

- Make sure you understand from the radiological briefing where any contamination is located
- Be aware of the best route; avoid unnecessary walking
- Wear PPE, only handle what is necessary to accomplish the work, and properly dispose of PPE after working in a contamination area

2.5.6 Machining Operations

Operations that may generate removable radioactive contamination and deposit it on surfaces include operations that involve high-speed machining of radioactive material, including welding, cutting, or drilling.

Important Any machining of radioactive material requires special radiological controls, including RPFO involvement and a job-type radiological work permit (RWP).

Such operations take place in the following locations:

- Building 25, Mechanical Fabrication Department (MFD), Light Fabrication
- Building 26, MFD, Heavy Fabrication
- Building 31, MFD, Vacuum Assembly
- Accelerator enclosures, such as accelerator (linac) housings

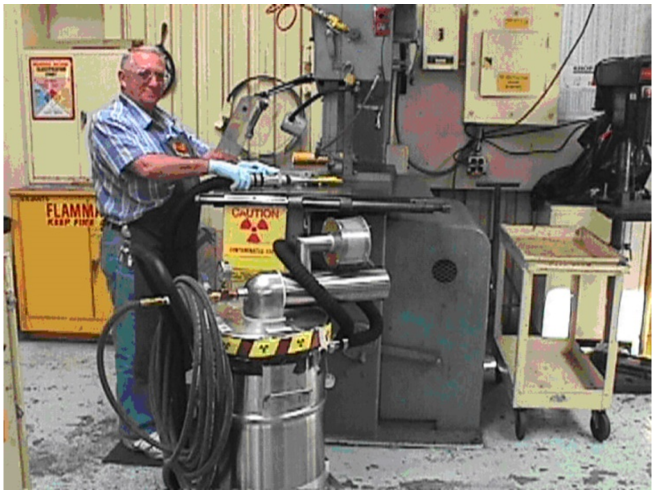

Figure 2-4 A HEPA-filtered Radiological Vacuum Removes Machined Radioactive Material

2.5.7 Housekeeping

Actual contamination areas at SLAC are few; however, areas listed in Section 2.7 have been identified as potentially contaminated areas that require special radiological controls for entry.

Contaminated or potentially contaminated areas should be kept free of unnecessary material (such as trash or debris) that might inadvertently become contaminated. Good housekeeping is illustrated in Figure 2-5 by the absence of trash or debris. Practice good housekeeping while in these areas by

- Being familiar enough with the area to know the location of actual contamination
- Carefully double bagging any materials suspected of being contaminated in clear uncolored plastic bags. Cover any sharp edges. RPFO will survey such materials.

Figure 2-5 Good Housekeeping in the Linac Housing

2.6 Radiological Buffer Area

A radiological buffer area is a posted area adjacent to a contamination area, usually located at the exit/entrance to a contamination area. RP uses this posting to help to facilitate contamination control.

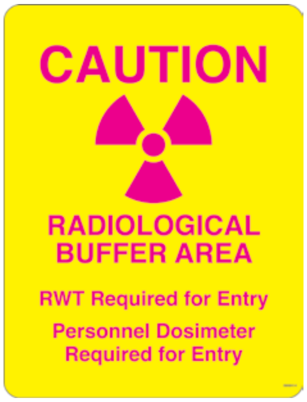

Figure 2-6 Radiological Buffer Area Posting

2.7 Contamination Area Locations

The boundary of a contamination area is identified with signage such as shown in Figure 2-7. The signs may be mounted on yellow and magenta ropes or at the doors and the gates.

Figure 2-7 Signs That Indicate a Contamination Area and a High Contamination Area

Under normal conditions, high contamination areas are not generated at SLAC. There are, however, known areas that may contain actual or potential contamination:

- North Damping Ring (NDR)
- South Damping Ring (SDR)
- Beam Switchyard (BSY)

- A portion of the Slit 10/30 LCW system alcove
- North Final Focus (NFF) and dump area
- South Final Focus (SFF) and dump area
- Beam Dump East (BDE)
- Positron Vault at Sector 20
- Beam housing in Sectors 2, 19, and 20
- Stanford Synchrotron Radiation Lightsource (SSRL), BL 11-2 preparation room

2.8 Contamination Area Entry and Exit Requirements

The following are required to enter and exit any contamination area:

- RWT II qualification
- Radiological work permits:
  - A routine area RWP
  - A job-type or routine task RWP with work procedures
- Strict observance of the prohibition on food, drinks, or anything that can be chewed; if you need to drink water, exit the area first
- Personal protective clothing (contamination PPE): observance of the appropriate protocol for
  - Donning
  - Doffing at contamination area boundary when exiting
- Personal protective equipment, such as construction PPE, if required
- Whole-body frisking upon exiting

2.9 Frisking

Conducting a whole body survey for contamination is called frisking. Frisking is generally done on yourself using the appropriate type of contamination monitoring equipment called a frisker.

2.9.1 Contamination Monitoring Equipment

2.9.1.1 Frisking Instrument Types

- To detect alpha radiation, use the Ludlum 2241 with ZnS detector. This type of frisker is appropriate for certain types of experiments conducted at SSRL.
- To detect beta and gamma radiation, use the Eberline RM 25 with GM pancake detector shown in Figure 2-9. It is sensitive enough to detect 100 cpm above background.

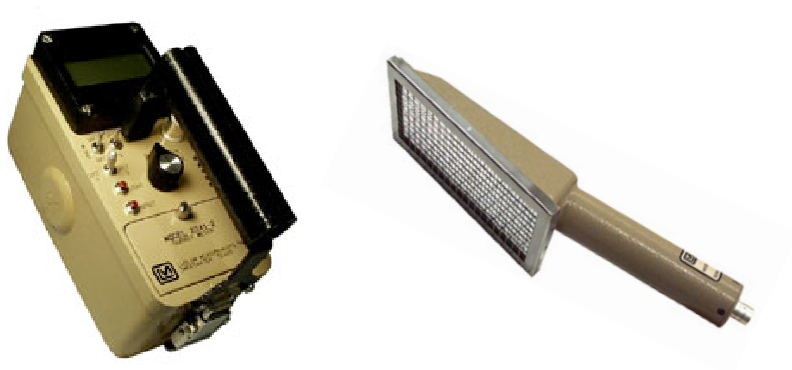

Figure 2-8 Ludlum 2241 Frisker

Figure 2-9 Eberline RM 25 Frisker

2.9.1.2 Frisking Station Locations

Friskers should be located directly outside the personnel protection system (PPS) gates where a contamination area may be located. The following areas may have a frisking station:

- Klystron Gallery, Sector 19 (outside door)
- BSY, near the big door entrance
- Positron Vault PPS gate (outside door)
- Buildings 25, 26, and 31

Note *The monitoring station may be some distance from where you exited the contamination or high radiation area.*

2.9.2 Frisking Procedure

Frisk yourself immediately upon exiting a contamination area. An RPFO technician does not need to be present unless you suspect contamination on your person. **If you suspect that you have been contaminated, proceed directly to the monitoring station without interacting with other personnel.**

Note Minimize cross contamination by not touching any contaminated areas.

1. Turn on instrument and survey hands before picking up probe.
2. Confirm the instrument is set to the proper scale (X 1).
3. Ensure the audible function of the instrument is on and can be heard; if not, turn up the volume.
4. Determine that the instrument background is <100 cpm. (The average background on the frisking instrument is 50 cpm. If you get a reading equal to or greater than 100 cpm above background you may have been contaminated.)
5. Survey your hands before picking up the probe, keeping hands about 1/2” from the probe.
6. Holding the probe approximately 1/2” from the surface being surveyed and moving it slowly at approximately 2 inches per second, perform the frisk in the following order:
   - Head (pause at mouth and nose)
   - Neck and shoulders
   - Arms (pause at elbows)
   - Chest and abdomen
   - Back, hips, and buttocks
   - Legs (pause at knees)
   - Shoe tops
   - Shoe bottoms
7. If the count rate increases during frisking, pause for 5 to 10 seconds over the area to provide adequate time for instrument response.

   If contamination is indicated by increased count rate or alarm, remain in the area and contact RPFO at ext. 4299 or Accelerator Control Room (ACR) at ext. 2151 immediately.
8. Return the probe to the holder. Place it on its side or face up to allow the next person to monitor their hands before handling the probe.

2.10 Contamination Response

The best indication of possible contamination is an increase in the audible count rate on the frisking instrument or the sounding of a preset alarm. If this occurs:

- Stay at the frisking station.
- Minimize the spread of contamination: avoid touching other surfaces and do not allow others to cross your path, to handle suspected contaminated materials, or to touch you.
- Call RFPO at ext. 4299. If there is no answer, contact ACR at ext. 2151.
- Wait for instructions.

2.11 Contamination Control Methods

2.11.1 Prevention

Methods for preventing contamination include establishing adequate work controls before beginning work. Such work controls include

- Completing a job-type RWP for radiological work
- Conducting pre-work radiological surveys
- Discussing ways to reduce or prevent the spread of contamination when conducting pre-job briefings
- Changing gloves or protective gear as necessary to prevent cross-contamination of equipment
- Informing and involving area managers of work being performed
- Arranging for support before beginning the job
- Scheduling work for down times, such as planned access machine maintenance (PAMM) days
- Keeping training qualifications current

Other methods for preventing contamination include the pre-staging of areas to prevent the spread of contamination from work activities. Pre-staging activities include

- Covering piping or equipment below a work area to prevent dripping contamination onto clean areas
- Covering or taping tools (such as a screwdriver) or equipment used for the job to minimize decontamination after the job
- Placing clear uncolored bags near the work area for potentially radioactive waste, tools and used gloves
- Discussing with RPFO methods and measures to control water from potentially contaminated LCW systems

2.11.2 Good Work Practices

An effective contamination control program is based on good housekeeping, good work practices, and effective communication of all involved groups. When you are dedicated to keeping your work area clean, you control the spread of contamination. Good work practices include

- Confining the spread of radioactive materials to the smallest area possible
- Preventing radioactive material releases by using a sound preventive maintenance program
- Controlling and minimizing all material taken into or out of contaminated areas
- Ensuring that the proper procedures are followed or implemented to avoid the spread of contamination

Potential violations to the basic principles of contamination control include

- Improper use of contamination control methods
- Bad or sloppy work practices
- Violation of basic procedures

- Radioactive material releases
- Liquid spills

2.11.3 Engineering Controls

Engineering controls can help keep radioactive contamination under control. Examples include using ventilation and HEPA filters.

- Ventilation may be used to maintain a slight negative pressure on SSRL beam hutches where potential contamination exists.
- Engineered HEPA ventilation systems are installed at some SSRL beam hutches for actinide experiments. These units are tested at least once each year. Call RP to report any test date that has expired.
- High-efficiency filtration can be used to remove radioactive particles from the air. For example, using a HEPA vacuum cleaner while machining provides a control that captures potential radioactive contamination.

Note *Point ventilation air flow away from personnel.*

2.11.4 Radiological Vacuums

Radioactive material can only be vacuumed using a special vacuum cleaner equipped with a HEPA filter. This type of vacuum is shown in Figure 2-10.

Radiological vacuums may only be serviced by RPFO:

- Never open a radiological vacuum.
- Contact RPFO to change the vacuum bag or to report an expired test date (the vacuum is tested annually).

Figure 2-10 Radiological Vacuum

2.11.5 Containment

Containment generally refers to vessels, pipes, cells, glovebags, gloveboxes, tents, and/or plastic coverings that contain and control radiological contamination. Bags are used extensively to contain and hold contaminated materials. Figure 2-11 shows a worker using a glovebag.

Figure 2-11 Worker Using Glovebag

2.11.6 Removing Contaminated Material

Any items or material brought into a contamination area must remain in the area until removed by RPFO. Contaminated material must be bagged in clear (uncolored) plastic bags with the open end of the bag completely sealed with tape.

Note Only RPFO may remove material from a contamination area.

2.11.7 Radiological Work Permits

An RWP is required for entering a contamination area. Additionally, a job-type RWP may be required for performing radiological work in a contamination area. (Radiological work is any work that may change or increase radiological hazards.)

2.12 Personal Protective Clothing

A contamination area potentially contains contamination levels above specified limits, so it is required that you wear protective clothing to prevent contaminating your skin and clothing. The degree of protection required depends on the radiological conditions in the work area and the nature of your job. The two levels of required protective clothing are minimum and full.

Before donning (putting on) protective clothing:

- Inspect all protective clothing for proper size and rips, tears, or holes.
- Pre-stage undressing area with at least two yellow bags for protective clothing disposal.

After donning protective clothing, proceed directly from the dress-out area to the work area. Contact RPFO if PPE or protective clothing becomes damaged.

Materials to be removed from the contamination area, including used protective clothing, are left inside in the contamination area boundary. RPFO will remove the materials from the area after conducting a survey.

2.12.1 Minimum Protective Clothing Requirements

Minimum protective clothing consists of rubber gloves and rubber shoe coverings.

Figure 2-12 Minimum Protective Clothing

2.12.1.1 Donning

1. Put rubber shoe coverings on.
2. Put rubber gloves on.

2.12.1.2 Doffing

Doff (remove) clothing at the contamination boundary in the indicated order to prevent spreading contamination:

1. Peel rubber gloves off, turning them inside out as they are removed.
2. Remove rubber shoes while stepping across the contamination area boundary.

Do not touch any outer surfaces with contaminated gloves or shoes.

2.12.2 Full Protective Clothing Requirements

Full protective clothing generally consists of

- Coveralls
- Hood
- Plastic shoe coverings
- Rubber shoe covers
- Rubber gloves

Tips to ensure maximum protection:

- Ensure that the coveralls are the proper size with extra room to conduct work while wearing.

- Avoid getting coveralls wet, as wet coveralls provide a means for contamination to reach the skin or clothing.
- Cotton liners may be worn inside rubber gloves for comfort, but should not be worn alone or considered as a layer of protection against contamination.

For an example of full protective clothing, see Figure 2-13.

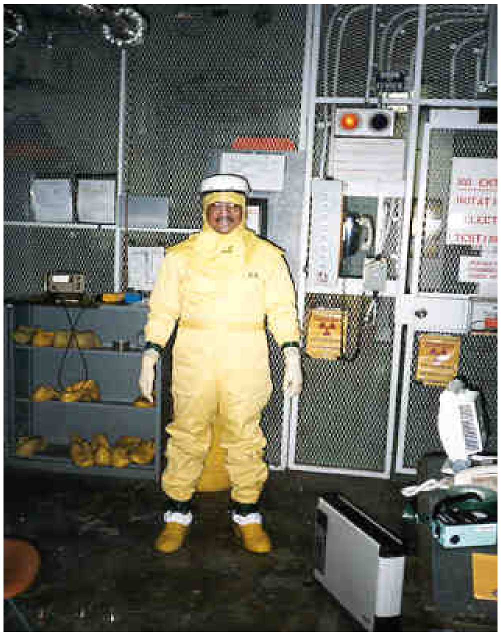

Figure 2-13 A Full Set of Protective Clothing

2.12.2.1 Donning Full Protective Clothing

The general order for donning protective clothing follows:

1. Personnel dosimeter clipped onto front of shirt, under the coveralls
2. Plastic shoe covering
3. Cotton gloves
4. Coveralls
5. Tape legs and sleeves of coveralls (optional), then don hood
6. Rubber shoe covers
7. First set rubber gloves
8. Second set rubber gloves, if required
9. Supplemental electronic dosimeter outside of coveralls, if required
10. Face shield, if required

2.12.2.2 Doffing Full Protective Clothing

Remove protective clothing at the contamination boundary in the following order to prevent contamination:

1. Second set of rubber gloves, if worn
2. Read supplemental dosimeters
3. Place supplemental dosimeter (if required) at the contamination area boundary
4. Hood
5. Unzip coveralls, remove outside tape, and then remove:
   – Rubber shoe covers
   – First set of rubber gloves, turned inside out as they are removed
   – Coveralls, rolling them down, touching the inner surfaces only
6. Plastic shoe covers as you step across the contamination area boundary

Proceed to the frisking instrument and follow frisking procedure.

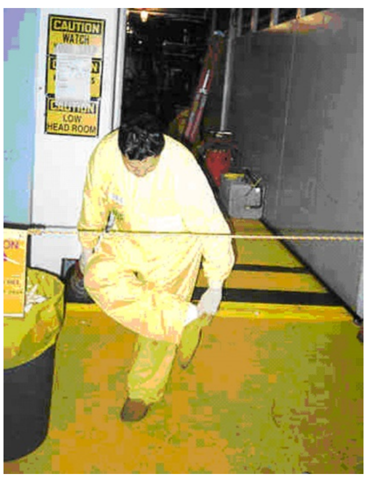

Figure 2-14 Doffing Protective Clothing at Contamination Area Boundary

2.13 Decontamination

Decontamination involves the removal of the radioactive material to a proper disposal location. Use only nonhazardous substances to remove contamination to avoid generating mixed waste.

Note *Alcohol, which is often used to clean surfaces, is a hazardous material.*

2.13.1 Personnel Decontamination

Contact RPFO immediately if contamination is measured on your clothing or skin.

Personnel decontamination is normally accomplished using masking tape and waterless hand cleaner. Mild soap and lukewarm water may also be used. If clothing is contaminated, parts or all of it may need to be removed. If this occurs, your privacy will be protected insofar as possible.

2.13.2 Material Decontamination

Material decontamination is the removal of radioactive materials from tools, equipment, floors, and other surfaces in the work area. In determining the best course of action, the two primary variables are available resources and the potential dose.

2.14 Medical Emergencies

Medical care and first aid take precedence over any radiological controls.

Radioactive contamination hazards are usually minor in comparison to the need for urgent medical treatment. In the event of a medical emergency, proceed as you would in any other area:

1. Assess the scene for safety (such as a chemical spill, electrical hazard)
2. If the scene is safe, assess the extent of the injury and call 911 if needed
3. Administer first aid to the best of your ability and training

3 Study Questions

1. Radioactivity and radioactive contamination are measured in units of (circle all that apply)

becquerel	disintegrations per minute (dpm)	
mrem	miles per hour	curies
cpm/100cm^2	counts per minute (cpm)	

2. The DOE limit for loose contamination for beta/gamma on surfaces is generally

   ______________dpm.

3. The average background reading in counts per minute (cpm) on the frisking instrument provided by RP

   is _______________cpm.

4. __________ cpm above background is considered to signal contamination.
5. What is tritium?
6. Hot spots are a likely place where loose contamination might be present. True or False?

7. Contact RPFO before: (circle all answers that apply)
   a. Working on potentially contaminated LCW systems
   b. Disassembling beam line components
   c. Entering into any accelerator housing
   d. Machining radioactive material
   e. Grinding or drilling in any accelerator housing
8. Entry into or exit from an area identified as a contamination area requires
   a. ____
   b. ____
   c. ____
   d. ____
9. To handle contaminated material, gloves are required as a minimum level of protection. After handling contaminated material, what must you do before touching any non-contaminated surfaces?

10. Can any vacuum cleaner be used in accelerator housings or to remove radioactive material?

    Yes No

11. A full set of protective clothing includes which items?
    a. ____
    b. ____
    c. ____
    d. ____
    e. ____
12. What material is generally used for personal decontamination?
13. First aid takes precedence over radiological controls. True or False?

4 Practical Exercises

4.1 Overview

Completion of the RWT II practical is required for RWT II qualification. The practical involves the evaluation of these four procedures:

1. Donning and doffing (putting on and taking off) a full set of protective clothing
2. Donning and doffing shoe covers and gloves only
3. Demonstrating contamination control techniques while in a contamination area
4. Performing a self whole body survey (frisk) for contamination

4.2 Donning and Doffing Protective Clothing

Before entering a simulated contamination area

- Review the RWP before donning clothing
- Inspect your protective clothing for damage before donning
- Demonstrate proper donning before entering a contamination area
- Demonstrate proper doffing at the contamination boundary

Be sure that you take great care in executing each step to demonstrate that you will not spread contamination to skin, clothing, or beyond the boundary due to an incorrect doffing procedure.

4.3 Demonstrating Contamination Control Techniques

While in a simulated contamination area, demonstrate contamination control techniques by

- Pre-staging the area with at least two pairs of gloves, two clear uncolored bags, and tape
- Demonstrating proper glove change while in a contamination area
- Bagging material properly by double bagging and sealing with tape
- Demonstrating contamination control techniques appropriate to working in a contamination area

You must demonstrate that you know how to keep contamination from spreading to skin, clothing, or outside of boundary while working in a contamination area to become RWT II qualified.

4.4 Performing the Frisking Procedure

After properly exiting a simulated contamination area and performing the correct doffing procedures, perform a personal whole-body contamination survey (frisk) based on guidelines in this study guide by:

- Demonstrating a proper whole-body survey
- Taking appropriate action(s) in response to a contamination alarm from the frisker

5 Related Documents

The following are related documents and forms. Always locate and use the latest version, either online from the addresses below or from the originating unit.

Table 5-1 Related Documents

Title	Document Number	Originating Unit	URL
Radiological Safety Program			
Radiological Control Manual	SLAC-I-720-0A05Z-001	RP	https://www-group.slac.stanford.edu/esh/documents/RCM.pdf
SLAC Environment, Safety, and Health Manual, Chapter 9, "Radiological Safety"	SLAC-I-720-0A29Z-001	RP	https://www-group.slac.stanford.edu/esh/general/radiological_safety/
Radiological Work Permits Procedure	SLAC-I-760-0A05C-002, FO 005	RP	https://slac.sharepoint.com/sites/esh/rp/fo/Procedures/FO%20005.pdf
Radiological Work Permit		RP	https://www-bis1.slac.stanford.edu/RWP/
LCW Radiological Status Sheet		RP	https://www-internal.slac.stanford.edu/esh-db/radlab/home.aspx
Radiation Protection Department		RP	https://www-group.slac.stanford.edu/esh/rp/
Radiation Protection – Field Operations		RP	https://www-group.slac.stanford.edu/esh/rp/fieldops.htm
ESH Course 116, Radiological Worker I Training (RWT I)	ESH Course 116	RP	https://www-internal.slac.stanford.edu/esh-db/training/slaconly/bin/catalog_item.asp?course=116
ESH Course 250, Radiological Worker II Training (RWT II)	ESH Course 250	RP	https://www-internal.slac.stanford.edu/esh-db/training/slaconly/bin/catalog_item.asp?course=250
ESH Course 250, Radiological Worker II Practical	ESH Course 250PRA	RP	https://www-internal.slac.stanford.edu/esh-db/training/slaconly/bin/catalog_item.asp?course=250PRA
Other			

Title	Document Number	Originating Unit	URL
Title 10, *Code of Federal Regulations*, "Energy," Chapter 3, "Department of Energy," Part 835, "Occupational Radiation Protection", Appendix D, "Surface Contamination Values"	10 CFR 835 Appendix D	GPO	https://www.ecfr.gov/cgi-bin/text-idx?SID=88bf1458767e8b5a72d64080e9f15b70&mc=true&node=pt10.4.835&rgn=div5#ap10.4.835_11304.d