ESH&Q DIVISION
RADIATION CONTROL DEPARTMENT

Radiation Worker II Training Study Guide
SAF802C

July 2019

revision 0

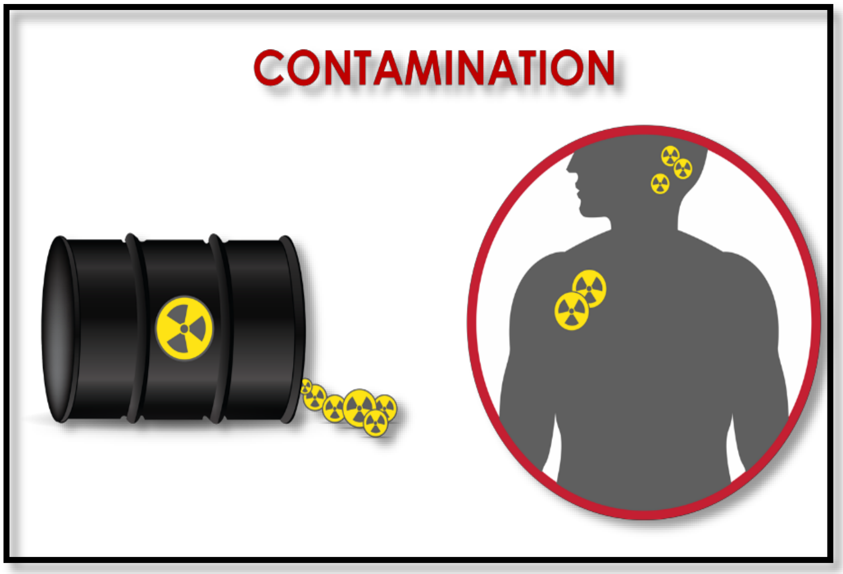
Thomas
Jefferson
National
Accelerator
Facility

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Table of Contents

UNIT 1: INTRODUCTION

From your previous Radiation Worker I (RW-I) training, you should remember that ionizing radiation is energy emitted from radioactive atoms, or generated from machines (e.g., CEBAF accelerator), that is capable of ionizing atoms. Additionally, radioactive material is material that contains radioactive atoms. The radioactivity contained in radioactive material may present a hazard – when not properly contained, it can spread to surrounding areas and personnel. This "spreadable" radioactive material is referred to as radioactive contamination and is the subject of this course.



Upon completion of this course, you will need to pass a proctored exam (SAF802T) and complete a graded practical demonstration (SAF802P) of what you have learned.

The proctored exam can only be taken in the SSC (Bldg. 28), at the User Liaison Office (CEBAF Center, Bldg. 12), or at the Radiation Control Department (RCD or RadCon)in Building 52 (ESH&Q). The RCD can provide you with a paper exam (upon request); however, the other testing locations only offer computer-based exams. The practical factors exercise (*must* be scheduled in advance) may be taken after you pass the proctored exam.

Once you have completed all portions of this training, you will be qualified as a Radiation Worker II (RW-II). As with RW-I, the RW-II qualification expires every 24 months. To maintain your RW-II status, you will need to re-take this course and pass the exam. If you do not re-qualify within 2 years of the expiration date, you will need to start over as though you had never been qualified.

If you have any questions regarding this training, training alternatives, or other radiological issues, contact the RCD Training Coordinator (x6806) or visit the Training link on the RadCon homepage at https://www.jlab.org/eshq/radcon

UNIT 2: FOUNDATIONS

By the end of this unit, you should be able to:

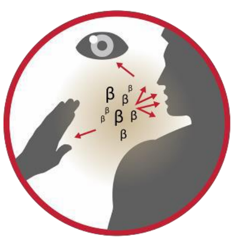
- define and know the difference between fixed and removable contamination
- define airborne radioactivity
- define the limits and minimum posting requirements for:
  - contamination areas
  - high contamination areas
  - airborne radioactivity areas
- identify the units used to measure and report contamination

Lesson 1: Radioactive Contamination

Radioactive contamination is radioactive material in an undesirable location. It can be further broken down into three categories: fixed, removable, and airborne radioactivity.

- *Fixed contamination* is contamination that cannot be readily removed from surfaces by nondestructive means. This material, however, can be liberated when the surface is aggressively disturbed as with buffing, grinding, welding, etc. This differs slightly from activation (discussed extensively in Radiation Worker I) – while activation results in the volume being radioactive, fixed contamination occurs at the surface of the material.

- *Removable contamination* is that which can be removed from surfaces by casual contact like wiping, brushing, or washing. Air movement can cause removable contamination to become airborne; this is especially true for areas or items with high levels of removable contamination.



- *Airborne radioactivity* is radioactive material in any chemical or physical form (beyond natural background radiation) that is present in ambient air.

Radioactive contamination is generally reported as the amount of activity measured over a known surface area. For example, the DOE removable contamination limit for beta-gamma emitters is 1000 dpm per 100 square centimeters. Disintegrations per minute, or DPM, is related to the type and magnitude of the radioactive material.

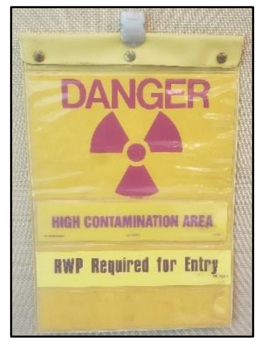
Lesson 2: Limits and Postings

A location can be designated as a contamination area, a high contamination area, or an airborne radioactivity area. All postings shall include the standard radiation warning trefoil in black or magenta imposed upon a yellow background (area-specific wording is listed below).

- *Contamination Area*

  - an area where removable contamination levels may be **greater than specified DOE limits** (1000 dpm/100 cm^2 for beta-gamma emitters) **but less than 100 times the specified DOE limits**
  - posting shall include the words "*Caution, Contamination Area*"; and, may have additional information such as "RWP *Required for Entry"*

- *High Contamination Area*
  - an area that may have removable contamination **greater than 100 times the specified DOE limits** (100,000 dpm/100cm^2 for beta-gamma emitters)
  - posting shall include the words "*Caution, High Contamination Area*" or "*Danger, High Contamination Area*"; and, may have additional information such as "RWP *Required for Entry"*



- *Airborne Radioactivity Area*

  - an area where the concentration of airborne radioactivity (above natural background), exceeds, or is likely to exceed, specified DOE limits; or
  - an area where an employee, without respiratory protection, could receive an intake of 12-DAC hours in one week (See Unit 4, Lesson 2: Internal Exposures and Dose, for more on DAC)
  - posting shall include the words "*Caution, Airborne Radioactivity Area*" or "*Danger, Airborne Radioactivity Area*"

While not official postings per DOE Regulations in 10 CFR 835, systems and items with known or potential internal contamination are often identified via signs indicating the potential for such, as well as the required contact information for *entry to the system* or *disassembly of the item*.

Review

1. What is the DOE beta-gamma surface contamination limit for a contamination area?
   a. 100 dpm per 1000 cm^2
   b. 1000 dpm per 100 cm^2
   c. 100 times the nuclide-specific limits in 10 CFR 835
   d. greater than the DAC value for the nuclide

2. Which of the following **is not associated with** removable contamination?
   a. radioactive material that is removed from surfaces by casual contact like wiping, brushing, or washing
   b. radioactive material that can become airborne, especially at high levels
   c. radioactive material liberated when the surface is aggressively disturbed as with buffing, grinding, or welding
   d. radioactive material resulting from the activation of beamline components

3. Contamination area postings may contain all of the following **except**:
   a. the words "Caution, Contamination Area"
   b. the standard radiation warning trefoil
   c. yellow labeling on a magenta or black background
   d. the words "RWP Required for Entry"

4. The minimum contamination levels within a high contamination area are expected to be ____ times the limits for posting a contamination area.
   a. 450
   b. 100
   c. 0.01
   d. 1000

5. What is DPM?
   a. unit of radioactivity: disintegrations per minute, the expected number of radioactive decays from a material in a minute
   b. standard approach for radiological controls: DOE principle method, the method used to determine radioactivity using a contamination instrument
   c. unit of contamination: radioactive disintegrations per month, the expected number of radioactive decays from a material in a minute
   d. DPM is a fundamental unit of radioactivity relating to the chemical toxicity of the material

Answers

1. b
2. d
3. c
4. b
5. a

UNIT 3: SOURCES OF CONTAMINATION

Upon completion of this unit, you will be able to provide examples of:

- systems likely to have contamination
- contaminated systems at Jefferson Lab

Contamination Sources

Radioactive contamination may exist in a variety of forms and is a concern because it can easily be spread to personnel. Radioactive contamination sources include:

- systems with open radioactive liquid containers or sealed systems that have leaks;
- airborne contamination from any source that settles on surfaces;
- air filters and air-handling equipment in areas where airborne radioactivity can be produced;
- accelerator components that have become highly activated; and,
- water systems that have been used near beam pipes, targets, dumps, etc.

As an RW-II-qualified person, you should be aware that contamination is expected in several Lab systems.

- In Halls A and C these include the beam dump cooling water systems, target systems and exit lines, and beam dump stubs.
- The tagger, target irradiator and beam diffuser chillers in Hall D.
- Additional examples
  - beam switchyard dump local cooling water system
  - air filters and vacuum pump oil from beam enclosures
  - certain beam-line components with localized hot spots > 250 mR/hr on contact

Review

1. All water systems within the accelerator controlled area (within the accelerator fence) are considered potentially contaminated.
   a. true
   b. false

2. Examples of potential JLab sources of contamination includes all of the following **except**:
   a. air filters and vacuum pump oil from systems within the beam enclosure
   b. LCW used for cooling near the target chamber in Hall A
   c. resin tanks used to maintain purity of the Hall C beam dump cooling water
   d. sealed radioactive sources used for checking instruments

Answers

1. b
2. d

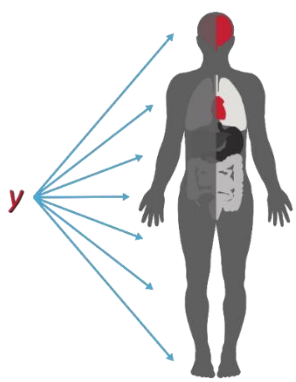
UNIT 4: EXPOSURES

The primary concern with radioactive contamination is its potential to spread. Improperly controlled radioactive contamination may lead to internal and external exposures of personnel.

Upon completion of this unit, you will be able to:

- describe the difference between external and internal exposures
- state the pathways by which internal exposures can occur
- relate airborne radioactivity limits with potential dose to personnel
- identify special considerations for Be-7

Lesson 1: External Exposures



External exposures stem from radioactivity outside of the body.

At Jefferson Lab, external exposure due to contaminants comes from two sources – charged particle emitters (i.e., beta radiation emitters) and non-charged particle emitters (i.e., gamma-only emitters).

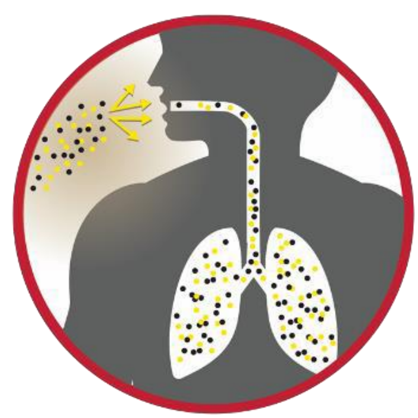
Beta emitters deliver a higher dose to exposed tissue than materials which emit only gamma radiation. This is because essentially all the beta particles are stopped by the skin so the damage is exclusively external.

Gamma radiation is penetrating and presents an exposure hazard even at a distance.

Lesson 2: Internal Exposures and Dose

Internal exposures stem from radioactive material taken into the body.

Significant doses due to internal exposures is unlikely at Jefferson Lab due to the type of radionuclides and the typical magnitude of contamination encountered.



Internal exposures may occur as a result of inhalation, ingestion, or absorption of radioactive material; these are referred to as exposure pathways. The primary exposure pathway for material at Jefferson Lab is inhalation for beta-gamma emitting nuclides. Tritium is one isotope encountered that may be absorbed through the skin. Properly controlled contamination limits the potential for internal exposures.

The Department of Energy provides numerical limits for airborne radioactivity in terms of the radionuclide-specific concentration in the air. These limits are provided as derived air concentration (DAC) values, which are specific to individual radionuclides. The DAC values are generally referred to in units of µCi/ml and correspond to the air concentration that would result in a dose to the exposed individual equal to the DOE limits. Note that this limit may be either the total effective dose or an organ-specific dose and assumes a worker is exposed to this environment for 2000 hours without respiratory protection. The DAC values are based on international standards for relating the intake of radioactivity to dose. These standards define an Annual Limit on

Intake (ALI), which is the amount of radioactivity taken into the body that would result in a dose equal to the dose limit.

As an example, the ALI for Co-60 is 24 μCi which would result in an effective dose to the whole body of 5 rem.

Because of the potential for higher doses, the DAC for beta-gamma emitting radionuclides is typically lower (more restrictive) than it is for gamma-only emitters. That is why most contamination limits are actually based on the ease of detection of beta emitter radionuclides.

Here's an example. Let's compare your whole-body dose if you inhaled 50,000 dpm of Co-60 (a beta-gamma emitter) versus the same amount of Be-7 (a pure gamma-emitter). The fact that Co-60 emits beta radiation in addition to the gamma radiation makes it more "potent" for delivering dose. Fortunately, this also makes it easier to detect.

Nuclide	ALI	Amount inhaled	Whole-body dose
Co-60	24 μCi	50,000 dpm	4 mrem
Be-7	1.92E4 μCi *	50,000 dpm	0.005 mrem

*(800 times higher than Co-60!)

Lesson 3: Special Considerations

At Jefferson Lab, Be-7 is produced from the electron beam's interaction with air. Beryllium-7 does not emit a charged particle and, therefore, is not easily detectable with instruments used in the field. The presence of other radionuclides often takes precedence over Be-7. Some systems contain only Be-7 contamination that must be detected. To detect Be-7 contamination at the limit of 1000 dpm/100 cm^2, field samples are analyzed with highly sensitive gamma detectors. When Be-7 (or any other non-charged particle emitter) is known, or suspected to be the major component in a contamination source, RadCon will implement enhanced contamination controls to minimize the potential for transfer. While these controls help ensure that statutory limits are met, they are *not* dictated by the work's radiological impact.

Review

1. In general, a beta-emitting radionuclide has a ________ DAC value as compared to a radionuclide that only emits a gamma ray during decay.
   a. lower
   b. higher

2. Which is not a standard internal exposure pathway?
   a. inhalation
   b. ingestion
   c. osmosis
   d. absorption

3. Significant doses due to internal exposures are ______ at the Lab due to ______.
   a. likely; the long-lived alpha emitters
   b. unlikely; the type and levels of contamination typically encountered
   c. unlikely; the long-lived beta-gamma emitters encountered at JLab
   d. likely; the penetrating gamma radiation

4. Be-7 has a higher DAC value than Co-60 because Be-7 does not emit a charged particle during its decay.
   a. true
   b. false

5. Which statement BEST describes the term ALI?
   a. The amount of radioactive material that, if taken into the body, would cause measureable response due to the radiation emitted.
   b. The amount of radioactive material taken into the body that would provide a dose to the individual corresponding to an external exposure hazard from the same amount of material.
   c. The amount of radioactive material that, if taken into the body, would cause a dose to a person equal to the DOE limits for exposure.

6. Why can contamination remain an external hazard if the contamination is not on the skin?
   a. The beta radiation is highly penetrating and presents a whole-body exposure hazard.
   b. The gamma radiation is highly penetrating and presents a whole-body exposure hazard.
   c. The alpha radiation is highly penetrating and presents a whole-body exposure hazard.
   d. None of the above

7. If an individual without respiratory protection is exposed to air containing radioactivity equal to one DAC for 2000 hours, they: (select all that apply)
   a. will have had a likely intake equal to an ALI
   b. have likely received a dose from internal exposure equal to the DOE limits
   c. have likely received a dose from external exposure equal to the DOE limits
   d. have been within an airborne radioactivity area

Answers

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

UNIT 5: CONTAMINATION CONTROLS

Upon completion of this unit, you should be able to identify:

- methods of administrative control for minimizing the spread of contamination, as well as
- common engineering controls for radioactive contamination

Lesson 1: Administrative Controls

As with most control and mitigation of hazardous conditions, the Lab uses both administrative and engineered methods.

Pre-job administrative methods include:

- frequently inspecting liquid systems; looking for leaks or other potential problems
- establishing adequate controls in advance of starting work (including a radiological briefing)
- wrapping non-contaminated items
- only bringing needed materials into contamination areas
- selecting tools and materials that are easily decontaminated

Additional administrative methods are employed while doing work. These include:

- practicing good housekeeping and post-job cleanup;
- changing protective clothing (gloves in particular) often to prevent cross-contamination of equipment;
- utilizing disposable work surfaces for contaminated or potentially contaminated items to prevent the spread of contamination; and,
- following approved procedures (like Radiological Work Permits [RWP]) when working in contamination areas or with contaminated material.

Lesson 2: Engineering Controls

Engineering control methods are equally important and will generally be addressed with an RWP or other work control documentation. The Radiation Control Department should be consulted prior to establishing any type of engineering controls so we can evaluate the impact on overall doses.

The use of engineering controls is based on many factors. For example, a cost-benefit analysis may indicate that the expense of an engineering control does not provide enough benefit to warrant implementation. Other factors that may influence the adoption of an engineering control are the dose consequence of establishing the control (i.e., installing the control would result in more dose than performing the job without it) and physical limitations of the area which may prevent establishing an engineered control.

Examples of engineering control methods

- carefully selecting the materials used in systems subject to activation
- minimizing corrosion in cooling water systems
- using work-site ventilation to move air from areas of least contamination to areas of higher contamination; using high-efficiency particulate (HEPA) filters to remove radioactive particles from the air
- performing work in containment items like glove bags, drapes, and/or fume hoods to control contamination as close to the source as possible

Review

1. Which is a good example of an administrative control measure?
    a. changing outer gloves after handling an object with known removable contamination
    b. wearing your dosimeter
    c. installing a drape for performing work
    d. maintaining proper water chemistry in LCW systems

2. Administrative controls are only employed by the direction of an RWP or in consultation with RadCon.
    a. True
    b. False

3. For what reason(s) would an engineering control not be employed? (select all that apply)
    a. the overall exposure to personnel would be higher when accounting for installation of the control than performing work without the control
    b. personnel performing the work have years of experience with a stellar performance record
    c. cost/benefit analysis is unfavorable to the control method
    d. physical limitations prohibit the installation of the control

Answers

1. a
2. b
3. a, c, d

UNIT 6: DECONTAMINATION

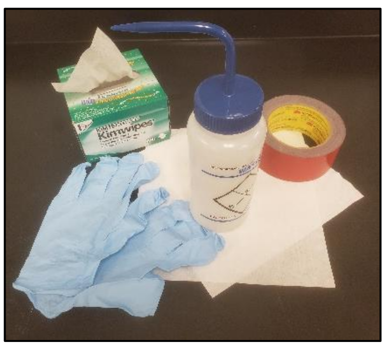
At the end of this unit, you should be able to identify typical methods for decontaminating personnel, materials and/or areas. You will also know who must be present when performing decontaminations.

Lesson 1: Background

Decontamination, the process of removing contamination from a surface, can be performed in a variety of ways (explored in this unit). *Decontamination should NEVER be attempted without direction of qualified RadCon personnel.*

Decontamination may not always be feasible and, based on the conditions present, may actually be undesirable. For instance, the cost of time and labor may outweigh the hazards involved; or, the dose rates or other radiological conditions may far exceed the benefits of decontamination. In cases like these, some alternatives might be preferable. These may include: temporary storage for later use in contaminated areas; permanent storage to allow the radioactivity to decay; or, disposal as radioactive waste. Final disposition of contaminated items must be made by the Radioactive Material Custodian (responsible for the area where the material was generated) in conjunction with RadCon personnel.

Lesson 2: Decontamination of Materials and Areas



Decontamination may be employed when contamination is found in an undesirable location. Several methods (below) are utilized to decontaminate objects or areas.

- wiping with a dry or water-dampened cloth (ensuring wiping is done from areas of lower contamination levels to areas of higher contamination levels)
- placing items into ultrasonic sinks
- application of industrial abrasives
- tape presses

Lesson 3: Personnel Decontamination

If personnel become contaminated, steps for decontamination may be employed.

This is typically accomplished by washing with mild soap and lukewarm (or tepid) water. The procedure is similar to the way in which someone would wash themselves, but there is an added focus of preventing material from entering body orifices (nose, mouth, eyes, etc.).

Radiation Control Department personnel shall be present to instruct individuals during the decontamination process.

Review

1. Decontamination is always preferred when material is identified as contaminated.
    a. True
    b. False

2. What is the primary method of personnel decontamination?
    a. tape press
    b. rubbing the affected area vigorously with an abrasive soap
    c. washing with lukewarm water and a mild soap
    d. personnel decontamination is never performed at Jefferson Lab

3. When should you perform decontamination of an item? (select all that apply)
    a. after receiving RadCon direction and approval
    b. when the cost and labor associated with decontamination is warranted
    c. as soon as contamination is identified
    d. after the Radioactive Material Custodian for the area has determined the item should be held to decay in storage

Answers

1. b
2. c
3. a, b

UNIT 7: WORKER RESPONSIBILITIES

Upon completion of this unit, you will be able to:

- list the entry requirements for contamination areas, high contamination areas, and airborne radioactivity areas
- provide work practices used in contaminated areas to minimize the spread of contamination
- list the components of a standard set of protective clothing used in contaminated areas
- understand the purpose of following a specific procedure for donning and doffing protective clothing
- describe the monitoring requirements when exiting a contaminated area
- list the actions taken when contamination is identified during a whole-body frisk

Lesson 1: Entry Requirements

Each area considered in this training has the same basic requirements for entry. These requirements have been established in accordance with DOE regulations, Lab requirements, and RCD experience. Under the direction of RadCon personnel, additional requirements may be implemented. These requirements are included in the applicable RWP.

The minimum requirements for entry include:

- Radiation Worker II qualification
- an approved RWP and pre-job briefing
- adequate personal protective equipment (PPE; as dictated in the RWP), the level of which is commensurate with the specific job hazard (For example, special plastic suits may be required when working with liquid systems.)
- a personal dosimeter and potentially an SRPD under the PPE (as dictated in the RWP)

Though infrequent for radiological hazards, airborne radioactivity areas may also require respiratory protection. Before an individual may wear a respirator, they must:

- complete the appropriate training;
- be medically cleared to wear a respirator; and,
- be properly fitted for a respirator.

Lesson 2: Work Performance

- Prepare the work area by securing all equipment (lines, hoses, cables, etc.) that crosses the contamination boundary; and, wrap or sleeve material and equipment to prevent cross-contamination
- Perform work from areas of lower contamination to areas of higher contamination. This prevents the spread of contamination from higher contamination areas.
- Avoid unnecessary contact with contaminated surfaces and liquids.
- Never touch exposed skin (e.g., rubbing your nose or mouth) - this is the leading cause of skin contamination incidents.
- Pay attention to the condition of your PPE. For instance, change out the outer set of gloves frequently and, if protective clothing becomes damaged while working, exit to the step-off pad and inform the radiological control technician covering the job.
- Remember! Material that enters or exits the area must always go across the step-off pad.
- Place contaminated materials in appropriate containers when you finish your work.
- <u>Only</u> exit contamination areas at the step-off pad or other designated spot. Follow the procedure for removing protective clothing and place tools and equipment in a clean bag on the step-off pad.

- Perform a whole-body frisk at the designated frisking station. (Refer to Lesson 4: Monitoring for Contamination, below.)

Lesson 3: Personal Protective Equipment

To help prevent cross-contamination of skin and clothing, use of protective clothing is essential when entering contamination areas. The level and type of protective clothing depends on the work area's radiological condition and the nature of the job. These requirements will always be identified in the RWP.

A standard "full" set of protective clothing consists of cloth or paper coveralls, two pairs of rubber or surgical gloves (optional cotton glove liners for comfort), plastic shoe covers, rubber overshoes, and a hood or surgeon's cap.

Protective clothing is donned and doffed following a specific and deliberate procedure. The general procedure was developed to minimize the potential for contamination to spread to unprotected areas and must be followed exactly. Depending on the area characteristics, job-specific modification to the general procedure may be included at the direction of RadCon personnel and documented via the RWP.

Donning Procedure

Prior to donning protective clothing, inspect the coveralls for rips or tears and the gloves for holes – gloves that have been in storage under certain atmospheric conditions are susceptible to dry rot. Ensure overshoes and shoe covers fit correctly.

These are the steps for a full dress-out. The steps will be posted at the dress-out areas.

1. Stage five pieces of duct tape. Four of them must be long enough to wrap around the wrists and ankles – use "buddy tabs" on the tape so that it is easier to handle with gloves. The fifth piece must be long enough to cover the zipper on your coveralls.

2. Stretch the plastic shoe covers (booties). Stretch them fully around your shoes (with feet in them).

3. Put on the:
    a. cotton glove liners
    b. coveralls and use the duct tape staged earlier to tape the coveralls over the booties and the zipper
    c. rubber overshoes
    d. hood

4. Put on
    a. a pair of rubber gloves and tape them over the coveralls
    b. the second pair of rubber gloves

Doffing Procedure

As with the donning procedure, there is also a deliberate process for removing protective clothing. (This procedure will also be posted in the step-off area.) <u>All</u> protective clothing worn in contaminated areas shall be placed in the waste receptacle at the step-off pad.

1. First, remove the outer set of rubber gloves
2. Then remove the tape from the: inner set of gloves, then the booties and zipper (in that order)
3. Remove the rubber overshoes, then the inner set of rubber gloves, and the hood
4. Next, roll the coveralls from inside to outside
5. Remove the plastic booties and step onto the step-off pad
6. Lastly, remove the cotton glove liners.
7. Proceed <u>directly</u> to the monitoring point following the designated path

Lesson 4: Monitoring for Contamination

Contamination monitoring equipment detects radioactive contamination on both personnel and equipment. Personnel monitoring equipment (aka "the frisker") must be capable of an audible response and have either an audible or visual alarm. (Specific "whole-body frisk" steps are at the end of this lesson.)

If the frisker has an alarm, the instrument is set to alarm at 100 counts per minute above the background count rate. While it should be set up where the background count rate is less than 100 cpm, the background **must** be less than 300 cpm. This is designed to draw your attention to an increase (if any) in the audible count rate when doing a frisk. To maintain proper counting efficiency, the probe should always be within ½ inch of the surface being monitored. When frisking, move the probe at a pace of 1 to 2 inches per second. This rate allows time for the instrument to respond to localized areas of contamination, should they exist.

The meter reading is typically only used following an audible indication of elevated levels. If elevated levels are discovered (or the alarm sounds) during the frisk, pause for 5-10 seconds over the area and read the meter face. 100 cpm above the background count rate is equivalent to 1000 dpm, the DOE limit for beta-gamma surface contamination. If contamination is indicated, *contact RadCon immediately*. If no other personnel are in the area, use the nearest phone (making note of the travel path to the phone) to call RadCon at 876-1743.

A "whole-body frisk" is ONLY performed in a designated location and has a specific procedure that must be followed; when performed correctly, the procedure should take roughly 2-3 minutes.

1. Start by verifying that the:
   a. instrument is in service,
   b. that its audio is working, and
   c. the scale multiplier is at the lowest setting.
   – If equipped, ensure the response switch is set to "slow".

2. Before touching the probe, frisk your hands.

3. Survey your body methodically, paying close attention to the head (especially the face), followed by the neck, shoulders, arms, chest, abdomen, back, hips, seat of the pants, legs (especially the knees), and feet, finishing with the soles of shoes.

4. When finished with the frisk, return the probe to its holder with its face "up".

Review

1. Which is not required as part of a "full set" of protective clothing?
   a. hood
   b. cotton liners
   c. two pairs of rubber gloves
   d. coveralls

2. You are going to perform work in accordance with an RWP. The RWP specifies that the work will be conducted in a high contamination area. When you arrive to the jobsite, you notice the area is posted as a contamination area. The most appropriate course of action is:
   a. proceed with work - since high contamination controls are more restrictive, the RWP is more than adequate to handle work in a contamination area
   b. stop work - contact RadCon and supervision
   c. make a note of the discrepancy and include this in the post-job brief
   d. not enough information to answer; the action(s) taken will depend on the work being performed

3. When frisking out of a contamination area, you notice the audible response increase. What do you do?
   a. notify others in the area and immediately contact RadCon
   b. wipe the area with a cloth and re-frisk; repeat this action until the increased levels dissipate
   c. Hold the probe over the area for 5-10 seconds to confirm the increased levels while monitoring the meter reading. If the levels remain, contact RadCon for assistance.
   d. turn the audible response off and complete the frisk based on the meter readings

4. What does 100 cpm above background on the frisker correspond to?
   a. the DOE dose rate limit for internal exposures
   b. the DOE beta-gamma contamination limit of 1000 dpm per 100 cm^2
   c. the JLab administrative dose limit of 1 mrem per year
   d. the DOE overall contamination limit of 100 dpm

5. What is the proper distance for the probe face when performing a frisk for beta-gamma contamination?
   a. within ½ inch of the surface
   b. within ¼ inch of the surface
   c. within 1 inch of the surface
   d. none of the above

6. If a frisk is performed correctly by scanning at a rate of ________, the whole-body frisk should take roughly ________to complete.
   a. 1-2 inches; 5 – 10 minutes
   b. 2-3 minutes; 5 – 10 seconds per inch
   c. 5-10 seconds per minute; 2-3 inches
   d. 1-2 inches per second; 2-3 minutes

Answers

1. b
2. b
3. c
4. b
5. a
6. d

UNIT 8: CASUALTY RESPONSE

Lesson 1: Injuries

If an injury occurs in a radiological area, immediately call 911 and then x5822 (269-5822). If the injury occurred in a contaminated area, administer emergency first aid as needed – DO NOT move the person to another location – wait for emergency responders.

Never keep emergency personnel from entering an area if their assistance is needed. Health concerns and care will always take precedence over radiological concerns.

Lesson 2: Spills

A spill is defined as an uncontrolled release of radioactive material which can be in liquid or solid form. In the event of a spill, remember the acronym: SWIM'N

- **S**top the source or spread of the spill – for example, upright an overturned container, close a valve, or place absorbent material around the area
- **W**arn others in the area
- **I**solate the area – close doors or use convenient items to form a barrier
- **M**inimize your exposure – complete initial steps and move away from the area
- **N**otify the Radiation Control Department ASAP

Stop spill if possible
Warn others in the area
Isolate the area
Minimize exposure
Notify the RCD (RadCon)

It is important to note that these steps do not have to be performed in a certain order. The best advice is to use your initial instinct if you confront a spill.

Review

1. An individual working in a contamination area collapses with chest pain. You should:
   a. leave the individual where they are; exit the area as normal; call 911 and x5822; and, stay out of the way of emergency responders
   b. seek assistance from nearby workers (if possible) to call 911 and x5822; leave the victim where they are and apply initial first aid if you are qualified to do so; allow emergency responders to enter the area and respond
   c. move the individual out of the contamination area to minimize their exposure; call 911 and x5822; apply initial first aid – if you are qualified to do so; allow emergency responders to enter the area and respond
   d. seek assistance from nearby workers (if possible) to call 911 and x5822; leave the victim where they are and apply initial first aid (if you are qualified to do so); allow emergency responders to enter the area and respond. Make sure everyone who enters the area frisks on the way out.

2. You must wait for RadCon before taking actions to stop an active spill.
   a. True
   b. False

3. While in a contamination area you accidently knock over a poly bottle containing LCW, spilling the liquid all over the area. Which of the actions listed below are inappropriate in response to this spill?
   a. move away from the spill area to minimize your exposure
   b. warn other personnel in the area so they are aware of the spill
   c. stop the spill by turning the poly bottle upright
   d. clean the affected area using proper decontamination techniques

Answers

1. b
2. b
3. d

GETTING CREDIT

Congratulations – you have completed the Radiation Worker II course! Next, you will need to take a proctored exam (SAF802T) and schedule a time to complete your practical (SAF802P).[1]

If you have questions or to be given credit for using this study guide to review, please contact radcon_train@jlab.org or anyone in the Radiation Control Department.

[1] required only upon initial qualification or long lapse (>2 years) in training