

# Radiological Worker FN000470

## Radiological Worker

### 1.1 Radiological Worker




### 1.2 Information About This Course

#### Information About This Course

**Browser**

This course is best viewed using the Chrome or FireFox web browsers. Internet Explorer may cause issues on the interactive pages.

**Interactive Pages**

Some pages in this training require you to complete all the interactions on the page before you can advance to the next page. These pages will have a  icon in the upper right corner. You will need to complete all the interactions on the page for it to be considered "visited".

**All Pages Must Be Visited**

The training menu on the left will allow you to review the pages in any order you choose. However, all pages in this training course must be visited in order for you to take the course test. You are required to take and pass the test in order to receive TRAIN credit for this course.

**Taking A Break**

If you are not able to complete this training in one sitting, you can close your browser and resume where you left off when you return.



Use the menu on the left and the button in the lower right corner to navigate this training course.

### 1.3 Department of Energy (DOE) Safety Policy

#### Department of Energy (DOE) Safety Policy

In conjunction with Fermilab, DOE is firmly committed to having a radiological control program of the highest quality. This program, as outlined in 10 CFR Part 835, *Occupational Radiation Protection* and the Fermilab Radiological Control Manual (FRCM), requires that managers and supervisors at all levels are to be involved in the planning, scheduling and conduct of radiological work. Adequate radiological safety shall not be compromised to achieve research objectives.



### 1.4 Main Menu

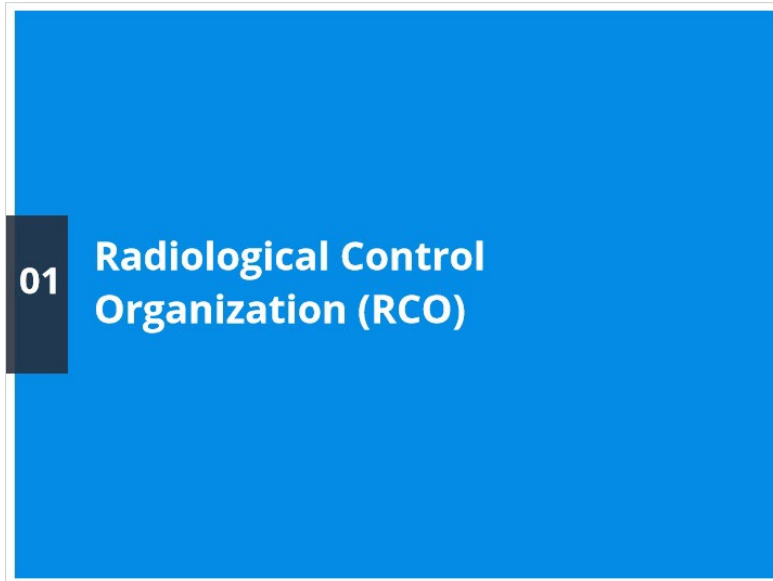
#### Main Menu

This Radiological Worker training will discuss the following topics:

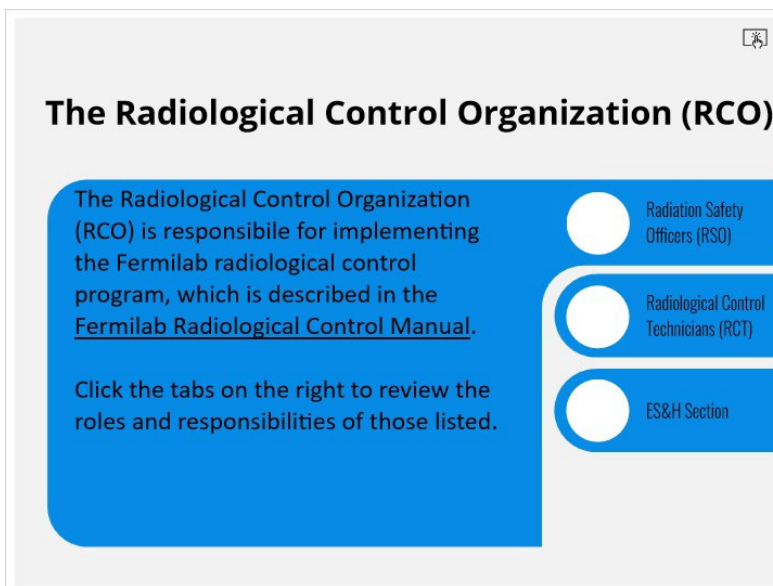
- ❖ Radiological Control Organization (RCO)
- ❖ Fundamentals
- ❖ Radiological Units & Measurements
- ❖ Background Radiation
- ❖ Biological Effects
- ❖ Dose Limits, Dosimetry & Records
- ❖ Keeping Exposures ALARA
- ❖ Prenatal Radiation Exposure
- ❖ Fermilab Prenatal Policy
- ❖ Medical Radiation Exposure
- ❖ Radiological Postings
- ❖ Contamination Control
- ❖ Radiological Work Permits
- ❖ Fermilab Radioactivity Class System
- ❖ Radioactive Material Surveying & Labeling
- ❖ Storage of Radioactive Material
- ❖ Transport of Radioactive Materials
- ❖ Moratorium on Metals Recycling
- ❖ Radioactive Source Control
- ❖ Radioactive Waste Management
- ❖ Radiological Emergencies

## 2. Radiological Control Organization

### 2.1 Radiological Control Organization



### 2.2 The Radiological Control Organization (RCO)



## ESH&Q Section (Slide Layer)

**The Radiological Control Organization (RCO)**

**ESH&Q Section**  
The ESH&Q Section conducts all lab-wide aspects of the radiological control program including:

- Radiation Safety Officer responsibilities for assigned areas
- Dosimetry program
- Radioactive waste
- Radioactive source program
- Instrument maintenance and calibration
- Interlocks
- Radiation physics science
- Shielding assessments

Radiation Safety Officers (RSO)

Radiological Control Technicians (RCT)

ESH&Q Section

## RCT (Slide Layer)

**The Radiological Control Organization (RCO)**

**Radiological Control Technicians (RCTs)**

- Assist RSOs in the conduct of daily activities
- RCTs are your primary point of contact in the field

Radiation Safety Officers (RSO)

Radiological Control Technicians (RCT)

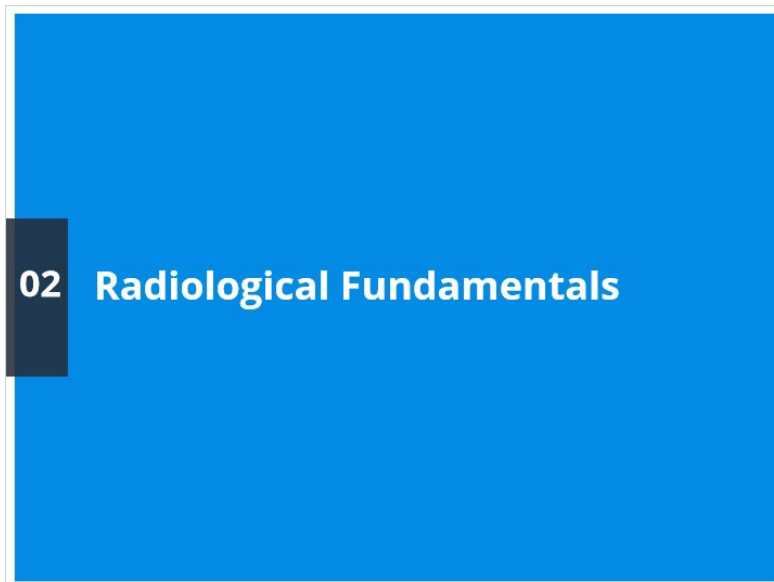
ESH&Q Section

## RSO (Slide Layer)



## 3. Radiological Fundamentals

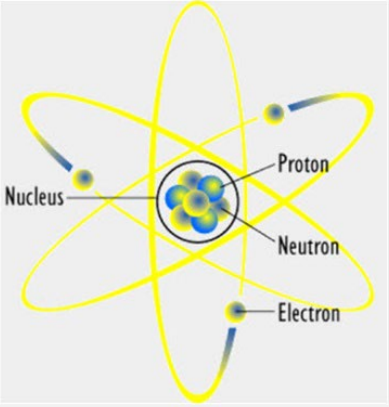
### 3.1 Radiological Fundamentals



### 3.2 Atomic Structure

#### Atomic Structure

Click the labeled buttons on the right to see the corresponding definition.



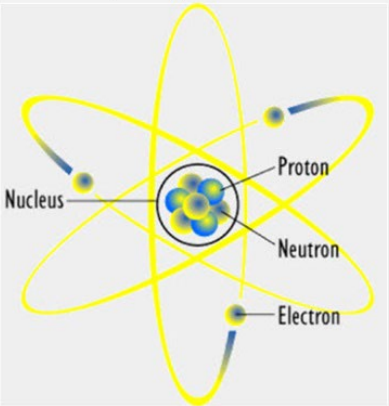
The diagram shows a central nucleus composed of blue protons and yellow neutrons. Three yellow elliptical orbits surround the nucleus, with small blue spheres representing electrons. Labels with leader lines point to the Nucleus, Proton, Neutron, and Electron.

- Atom
- Nucleus
- Electrons

#### Atom (Slide Layer)

#### Atomic Structure

Click the labeled buttons on the right to see the corresponding definition.



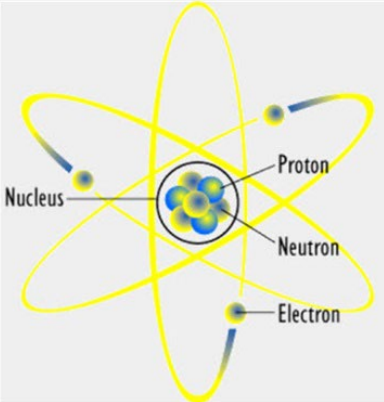
The diagram shows a central nucleus composed of blue protons and yellow neutrons. Three yellow elliptical orbits surround the nucleus, with small blue spheres representing electrons. Labels with leader lines point to the Nucleus, Proton, Neutron, and Electron.

- Atom  
The basic unit of matter.
- Nucleus
- Electrons

## Nucleus (Slide Layer)

**Atomic Structure**

Click the labeled buttons on the right to see the corresponding definition.



The diagram shows a central nucleus composed of blue protons and yellow neutrons. Three yellow elliptical orbits surround the nucleus, with small blue spheres representing electrons. Labels with leader lines point to the Nucleus, Proton, Neutron, and Electron.

**Atom**

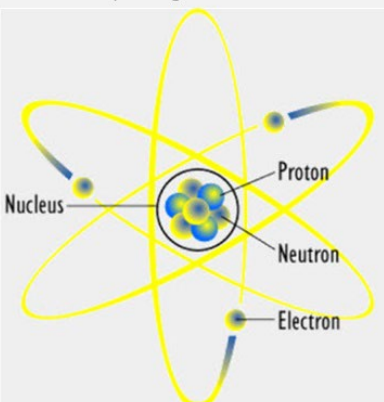
**Nucleus**  
The central portion of the atom which contains the protons and neutrons.

**Electrons**

## Electrons (Slide Layer)

**Atomic Structure**

Click the labeled buttons on the right to see the corresponding definition.



The diagram shows a central nucleus composed of blue protons and yellow neutrons. Three yellow elliptical orbits surround the nucleus, with small blue spheres representing electrons. Labels with leader lines point to the Nucleus, Proton, Neutron, and Electron.

**Atom**

**Nucleus**

**Electrons**  
Particles in orbit around the nucleus.

### 3.3 Definitions

**Definitions**

Radiation

Ions

Ionizing Radiation

Radioactive Decay

Half-life

Radioactive Material

Radio-activation

Let's review some of the fundamental radiological definitions that are important to understand. Click on the buttons on each side of this box to reveal definitions.

You must review each definition before you can advance in this training.

### Radiation (Slide Layer)

**Definitions**

Radiation

Ions

Ionizing Radiation

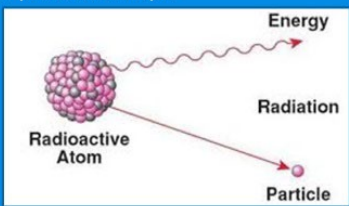
Radioactive Decay

Half-life

Radioactive Material

Radio-activation

**Radiation**  
Radiation is energy in the form of particles or rays.



The diagram shows a cluster of pink spheres labeled "Radioactive Atom". A wavy red arrow labeled "Energy" points away from the atom. A straight red arrow labeled "Particle" points away from the atom, ending in a small pink sphere.



## Ion (Slide Layer)

**Definitions**

**ions**  
Atoms or molecules with a different number of proton than electrons, giving them a net electrical charge.

Radiation      Half-life  
Ions      Radioactive Material  
Ionizing Radiation      Radio-activation  
Radioactive Decay

## Radioactive Decay (Slide Layer)

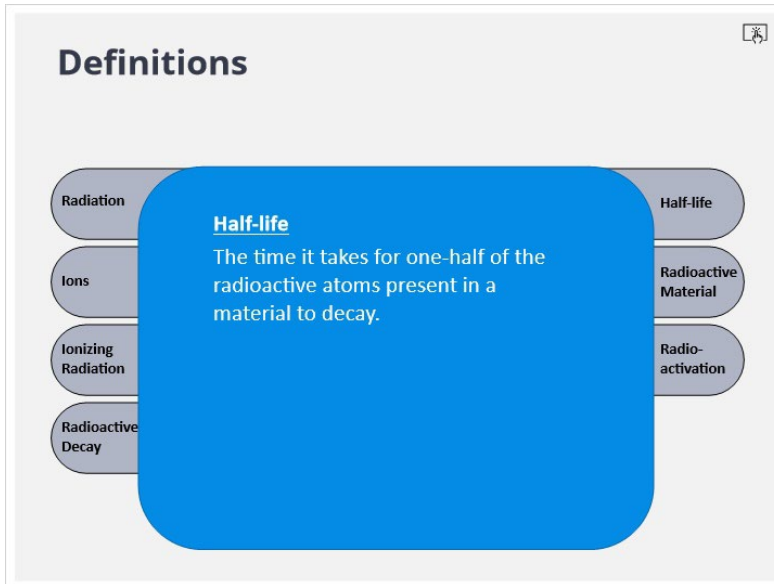
**Definitions**

**Radioactive Decay**  
Release of excess energy from an unstable atom. It is the result of the atom's reconfiguration of its protons, neutrons, or electrons.

Radiation      Half-life  
Ions      Radioactive Material  
Ionizing Radiation      Radio-activation  
Radioactive Decay

## Half-life (Slide Layer)

**Definitions**



A slide layer titled "Definitions" with a central blue rounded rectangle containing the definition of "Half-life". The rectangle is surrounded by eight grey rounded rectangles, each containing a related term: "Radiation", "Half-life", "Radioactive Material", "Radio-activation", "Radioactive Decay", "Ionizing Radiation", "Ions", and "Radioactive Decay".

**Half-life**  
The time it takes for one-half of the radioactive atoms present in a material to decay.

Radiation

Half-life

Radioactive Material

Radio-activation

Radioactive Decay

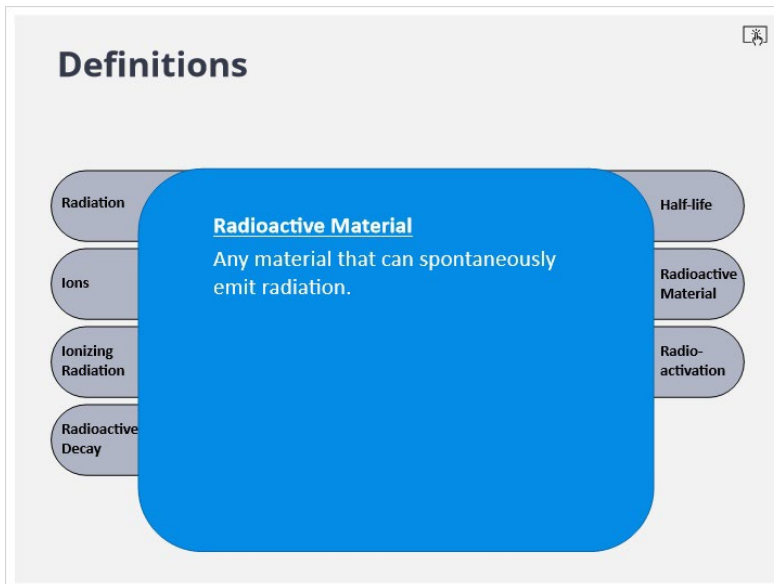
Ionizing Radiation

Ions

Radioactive Decay

## Radioactive Material (Slide Layer)

**Definitions**



A slide layer titled "Definitions" with a central blue rounded rectangle containing the definition of "Radioactive Material". The rectangle is surrounded by eight grey rounded rectangles, each containing a related term: "Radiation", "Half-life", "Radioactive Material", "Radio-activation", "Radioactive Decay", "Ionizing Radiation", "Ions", and "Radioactive Decay".

**Radioactive Material**  
Any material that can spontaneously emit radiation.

Radiation

Half-life

Radioactive Material

Radio-activation

Radioactive Decay

Ionizing Radiation

Ions

Radioactive Decay

## Radioactivation (Slide Layer)

**Definitions**

**Radiation**

**Ions**

**Ionizing Radiation**

**Radioactive Decay**

**Half-life**

**Radioactive Material**

**Radio-activation**

**Radioactivation**  
Any material, equipment or system component determined to be made radioactive by exposure to particle beams or beam spray. All material that is or has been inside a beamline enclosure has the potential to be radioactivated.

## Ionizing Radiation (Slide Layer)

**Definitions**

**Radiation**

**Ions**

**Ionizing Radiation**

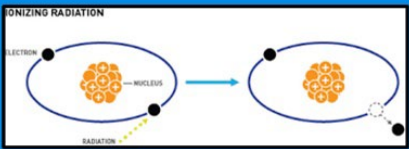
**Radioactive Decay**

**Half-life**

**Radioactive Material**

**Radio-activation**

**Ionizing Radiation**  
Radiation that can produce ions when passing through material. This is the type of radiation we are concerned within this course.




The diagram, titled "IONIZING RADIATION", illustrates the process of ionization. On the left, a central nucleus (represented by a cluster of orange spheres) is surrounded by a blue elliptical electron shell containing two black dots representing electrons. One electron is labeled "ELECTRON". A yellow arrow labeled "RADIATION" points from the left towards the nucleus. On the right, the nucleus remains, but one electron has been ejected from the shell, leaving a gap. A blue arrow points from the left atom to the right atom, indicating the transition. The ejected electron is shown as a small black dot moving away from the atom.

### 3.6 Types of Ionizing Radiation

#### Types of Ionizing Radiation

Click the buttons on the right to review the different types of ionizing radiation.

You must review all the types before you advance in the training.



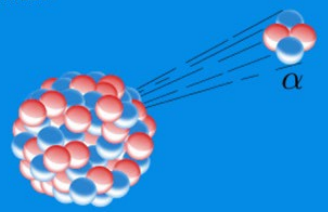
The slide features a blue rounded rectangle containing instructional text. To the right of the text is a vertical column of five circular buttons. From top to bottom, the buttons contain: the Greek letter alpha ( $\alpha$ ), the Greek letter beta ( $\beta$ ), the Greek letter gamma ( $\gamma$ ), a stylized atomic symbol, and a symbol representing a neutron or similar particle.

#### Alpha Particles (Slide Layer)

#### Types of Ionizing Radiation

Alpha Particles

Alpha particles are made by radioactive sources. They are not generally produced at Fermilab.



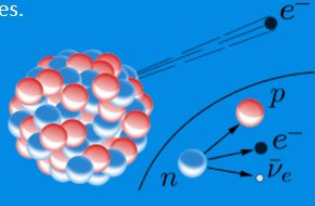
The slide features a blue rounded rectangle containing text and a diagram. The diagram shows a large nucleus on the left, composed of red and blue spheres. Four lines radiate from the nucleus to a smaller alpha particle on the right, which is also composed of red and blue spheres and labeled with the Greek letter alpha ( $\alpha$ ). To the right of the text and diagram is a vertical column of five circular buttons, identical to the ones in the previous slide.

## Beta Particles (Slide Layer)

### Types of Ionizing Radiation

Beta Particles

Beta particles are mainly found in beamline enclosures and workshop storage areas due to beam interaction with material or components. They are made by radioactive sources.





The diagram shows a nucleus composed of red and blue spheres. An arrow points from a blue sphere (neutron) to a red sphere (proton) and an electron ( $e^-$ ). Another arrow points from a blue sphere to an electron ( $e^-$ ) and an anti-neutrino ( $\bar{\nu}_e$ ).

$\alpha$

$\beta$

$\gamma$



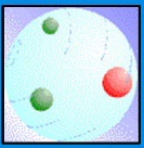


## Neutrons (Slide Layer)

### Types of Ionizing Radiation

Neutrons

Neutrons are made by radioactive sources. They are produced by beam interactions during operation. They may be associated with any posted area in and around the enclosure while the beam is operating.




The diagram shows a sphere containing two green spheres and one red sphere, representing the quark structure of a neutron.


*The quark structure of the neutron. Green represents 2 Down quarks. Red represents 1 Up quark.*

$\alpha$

$\beta$

$\gamma$



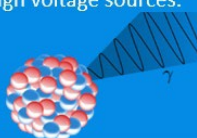


## Gamma ray and X-rays (Slide Layer)

### Types of Ionizing Radiation

Gamma Rays and X-rays (photons)

Gamma rays and X-rays are made by radioactive sources. They are a major source of radiation exposure at Fermilab. They are mainly found in beamline enclosures due to beam interaction with material or components. They can also be found in RF cavities and other high voltage sources.








A diagram showing a nucleus composed of red and blue spheres. A cone of radiation, labeled with the Greek letter gamma ( $\gamma$ ), is shown emanating from the nucleus.

$\alpha$

$\beta$

$\gamma$

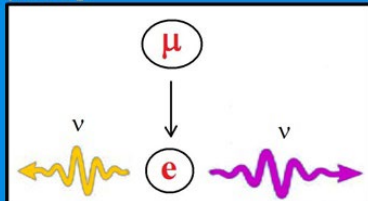


## Muons (Slide Layer)

### Types of Ionizing Radiation

Muons

Muons are found at high energy accelerators, such as Fermilab, only when the proton beam is operating.








A diagram illustrating muon decay. A muon ( $\mu$ ) is shown at the top, with a downward arrow pointing to an electron ( $e$ ). From the electron, two wavy lines representing neutrinos ( $\nu$ ) are shown, one pointing left and one pointing right.

*A muon decaying into an electron and 2 neutrinos.*

$\alpha$

$\beta$

$\gamma$

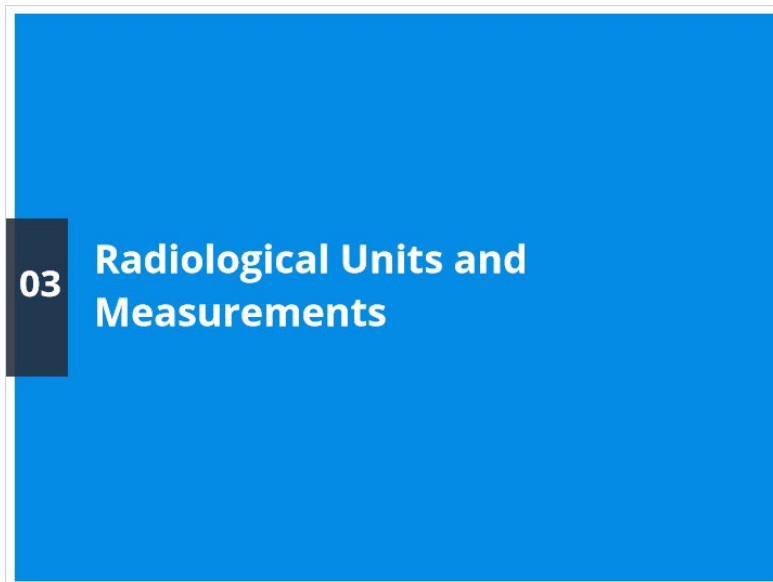


### 3.7 Sources and Types of Radiation at Fermilab

Sources and Types of Radiation at Fermilab					
Sources	Alpha	Beta	Muon	Gamma Rays & X-Rays	Neutrons
Accelerators		X	X	X	X
RF Cavities, Klystrons, Septa, Separators				X	X
Activation Products		X		X	
Radioactive Sources	X	X		X	X

## 4. Radiological Units and Measurement

### 4.1 Radiological Units & Measurements



## 4.2 Radiological Units and Measurements

### Radiological Units and Measurements

Conventional radiological units are required to be used in the U.S. This system differs from the International System of Units (SI) that are used in other countries. If you have questions about radiological units used at Fermilab please contact your assigned RSO.

#### Conventional and SI Unit Conversions

	SI Units*	Common Units
<b>Radioactivity</b>	becquerel (Bq)	curie (Ci)
<b>Absorbed Dose</b>	gray (Gy)	rad
<b>Effective Dose</b>	sievert (Sv)	rem
<b>Exposure</b>	coulomb/kilogram (C/kg)	roentgen (R)

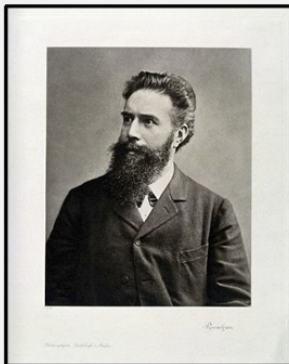
\* SI Units: International System of Units

Note: In the table above the common units and SI units in each row are not equivalent in value, i.e., 1 curie does not equal 1 becquerel, but they both measure the same parameter

## 4.3 Roentgen (R)

### Roentgen (R)

A Roentgen is a measure of radiation exposure in the air.



Wilhelm Conrad Roentgen

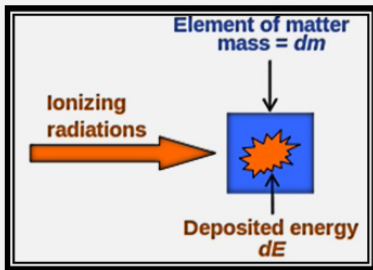
- Roentgens only apply to gamma and X-rays.
- A Roentgen does not describe biological effects of radiation to humans.
- Many instruments at Fermilab read out in Roentgen or milliRoentgen (mR) such as Log Survey Meters and Wallflowers.



## 4.4 Radiation Absorbed Dose (rad)

### Radiation Absorbed Dose (rad)

A rad is the amount of radiation energy absorbed by a material

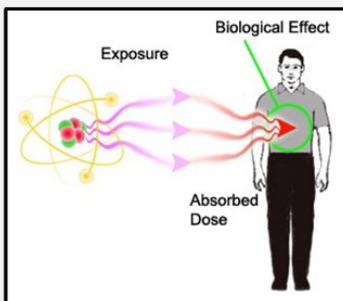


- 1 rad = 100 erg/gram
- A rad applies to all types of radiation and all types of materials
- A rad does not account for potential effect on the human body due to different types of radiation

## 4.5 Roentgen Equivalent Man (rem)

### Roentgen Equivalent Man (rem)

A rem is the amount of radiation dose delivered to humans. It is also known as "equivalent dose".



- Rem describes the biological effect on humans by taking into account the effect on the human body due to different types of radiation. Weighting factors are assigned to different types of radiation to classify their biological hazards.
- Rem applies to all types of radiation.
- Rem is used as a legal unit for exposure reports

## 4.6 Radiological Units and Measurements Cont.

### Radiological Units and Measurements

The units of measurement we have discussed are all too large for daily use. Therefore, we refer to them in smaller units as seen here.

1000 milliRoentgen = 1 Roentgen

1000 millirad = 1 rad

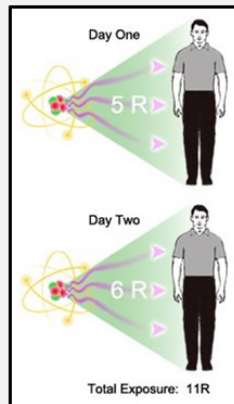
1000 millirem = 1 rem

## 4.7 Dose Rate and Exposure Rate

### Dose Rate and Exposure Rate

Dose rates and exposure rates are measured over a given period of time.

- Dose rate is typically measured in mrem/hr
- Exposure rate is measured in mR/hr
- Dose rate and exposure rate are common units for measuring gamma and X-rays emitted by radioactive materials at Fermilab

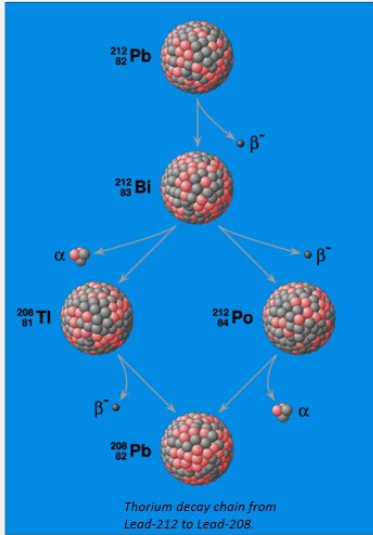


## 4.8 Radioactivity

### Radioactivity

Radioactivity is defined as the number of disintegrations (decays) over a given period of time.

It is typically correlated with a measurement of counts per minute (cpm) on a Frisker.



## 4.9 Mathematical Examples

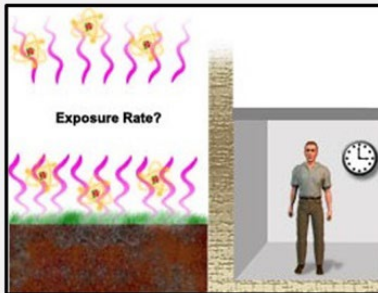
### Mathematical Examples

After working in a radiation field of 5 mR/hr, what would you expect your pocket dosimeter to read after 4 hours?

[Click here for answer](#)

The survey meter readout on your instrument indicates 30 counts per minute (cpm). If you are on the x10 scale, what is the actual count rate?

[Click here for answer](#)



## Question 1 Answer (Slide Layer)

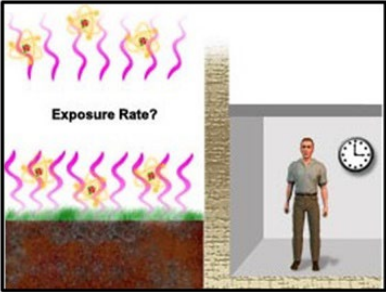
**Mathematical Examples**

After working in a radiation field of 5 mR/hr, what would you expect your pocket dosimeter to read after 4 hours?

[Click here for answer](#)      $5\text{mR/hr} \times 4\text{ hr} = 20\text{ mR}$

The survey meter readout on your instrument indicates 30 counts per minute (cpm). If you are on the x10 scale, what is the actual count rate?

[Click here for answer](#)



The diagram shows a person standing in a room. To the left, there are several yellow radiation symbols with wavy lines. A clock is on the wall to the right. The text 'Exposure Rate?' is written above the person.

## Question 2 Answer (Slide Layer)

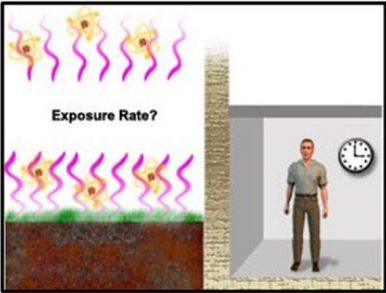
**Mathematical Examples**

After working in a radiation field of 5 mR/hr, what would you expect your pocket dosimeter to read after 4 hours?

[Click here for answer](#)

The survey meter readout on your instrument indicates 30 counts per minute (cpm). If you are on the x10 scale, what is the actual count rate?

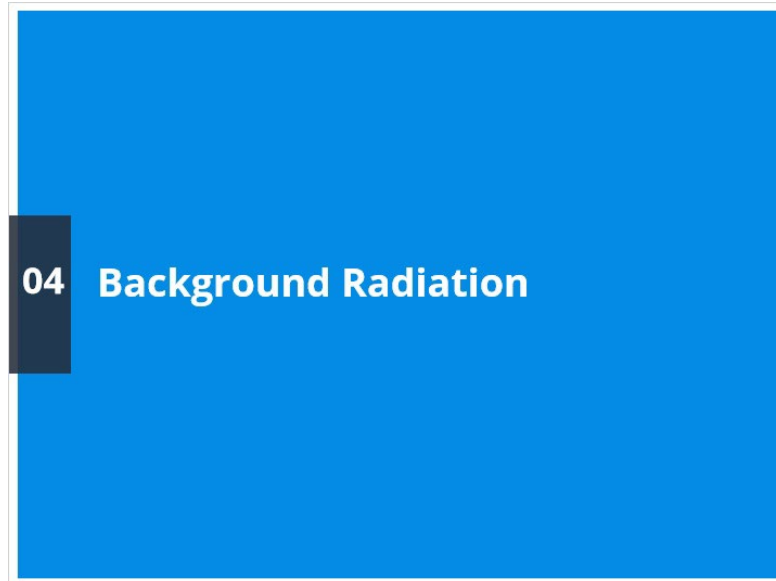
[Click here for answer](#)      $30\text{ cpm} \times 10 = 300\text{ cpm}$



The diagram shows a person standing in a room. To the left, there are several yellow radiation symbols with wavy lines. A clock is on the wall to the right. The text 'Exposure Rate?' is written above the person.

## 5. Background Radiation

### 5.1 Background Radiation



### 5.2 Average Annual Background Dose

**Average Annual Background Dose**

The diagram shows a person standing in a grassy field. Four sources of radiation are indicated with pink wavy arrows: 'Cosmic Radiation' from the sky, 'Radioactivity in the Body' from the person's torso, 'Radon' from the ground, and 'Terrestrial Sources' from the ground.

The average annual background dose in the United States is **620 mrem per year**.


Typical occupational radiation dose received at Fermilab is much lower than radiation dose received from background radiation.

### 5.3 Sources of Background Radiation

#### Sources of Background Radiation

Click the buttons on the right to review the different sources of background radiation.

You must review all the types before you advance in the training.





#### Medical (Slide Layer)

#### Sources of Background Radiation

Medical

48% of background dose is from medical sources including both diagnostic and therapeutic procedures.





## Cosmic Rays (Slide Layer)

**Sources of Background Radiation**

Cosmic Rays

Background radiation comes from interactions of cosmic rays from outer space with the earth's atmosphere.





## Internal Radioactivity (Slide Layer)

**Sources of Background Radiation**

Internal Radioactivity

There are low levels of naturally occurring radioactive elements in the air you breathe, the water you drink and the food you eat.




## Radon (Slide Layer)

### Sources of Background Radiation

Radon

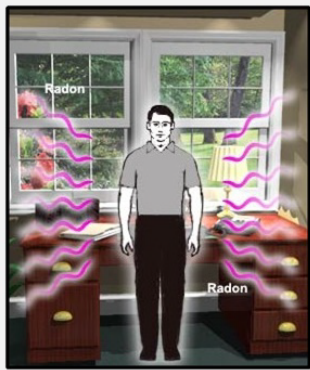
Radon gas originates from radium in the soil and building materials

86  
Rn  
(222)



## 5.4 Background Radiation - Radon

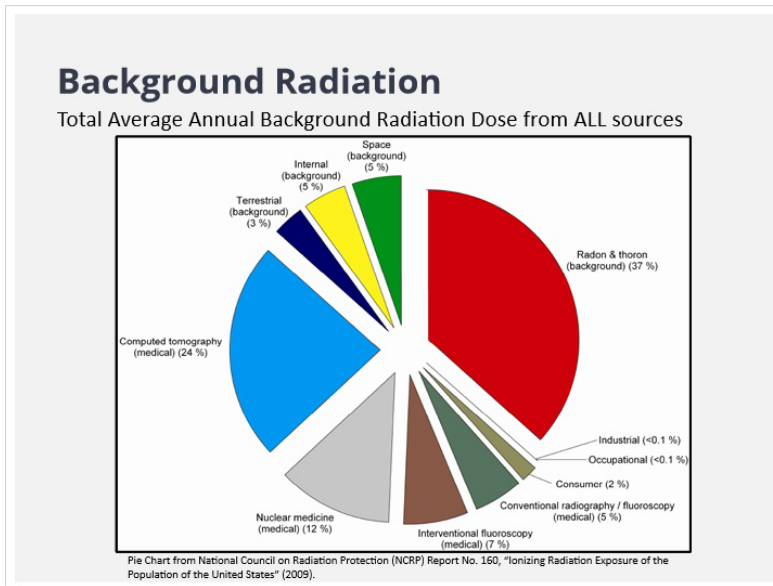
### Background Radiation - Radon



- Approximately 37% of background dose is from indoor radon (230 mrem per year)
- Radon gas originates from radium in the soil and building materials.
- Radon can also be found here at Fermilab and is typically discovered during personal frisking. It can be attracted to plastic hard hats and clothing by static electricity.



## 5.5 Background Radiation Chart



## 5.6 Background Radiation

### Background Radiation

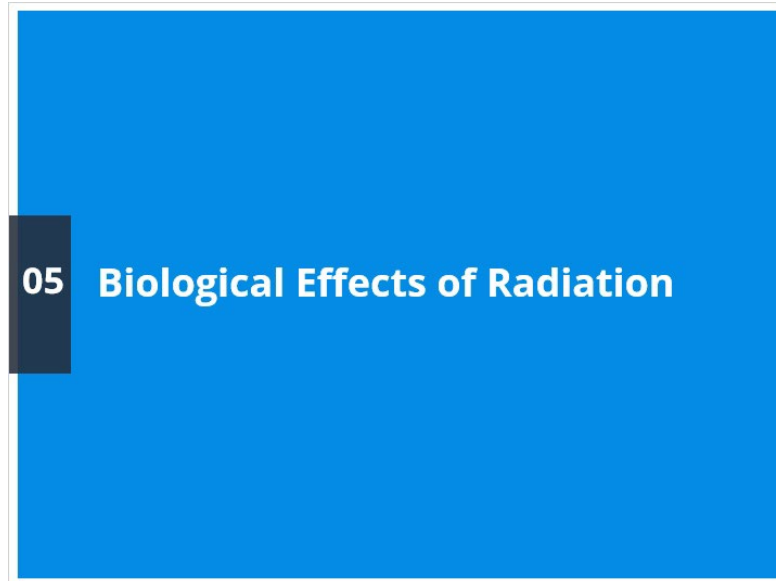
Typical Background Exposures from Various Sources of Man-Made Background Radiation.

Man-Made Background Radiation Source	Typical Dose (mrem)
Head/Neck X-ray	20
Chest X-ray	10
Lumbar Spinal X-ray	130
Heart Stress Test ( <sup>99m</sup> Tc, 34 milliCurie total)	1,000
CT Scan	1,000 - 2,500 depending on type of scan
Airport Body Scanner (backscatter machine)	0.01
Airplane Flight	0.6 millirem per hour of flying

Information in the table above may be found at [http://www.radiationanswers.org/radiation-blog/Airport\\_xray\\_scanners.html](http://www.radiationanswers.org/radiation-blog/Airport_xray_scanners.html) and <http://www.iem-inc.com/toolsexpo.html>.

## 6. Biological Effects of Radiation


### 6.1 Biological Effects




### 6.2 Biological Effects of Radiation are Based on Data Collected by:

**Biological Effects of Radiation are Based on Data Collected by:**

- Early radiation workers
- Survivors of atomic bombs
- Radiation therapy patients
- Radiation accidents involving radioactive sources such as:
  - Industrial radiography over exposures
  - Abandoned/broken Cobalt-60 teletherapy sources



Early Radiation Workers – “Radium Girls”



Radiation Therapy Patient

### 6.3 Factors Influencing Biological Effect

**Factors Influencing Biological Effect**

Let's review some of the factors that influence the biological effects of radiation. Click on the buttons on each side of this box to learn more.

You must review each definition before you can advance in this training.

Buttons: Total Dose, Dose Rate, Type of Radiation, Area of Body Exposed, Location of Exposure, Cell Sensitivity, Individual Sensitivity.

#### Total Dose (Slide Layer)

**Factors Influencing Biological Effect**

Total Dose

The greater the dose, the more severe the biological effect.

Buttons: Total Dose, Dose Rate, Type of Radiation, Area of Body Exposed, Location of Exposure, Cell Sensitivity, Individual Sensitivity.

## Dose Rate (Slide Layer)

**Factors Influencing Biological Effect**

**Total Dose**

**Dose Rate**

**Type of Radiation**

**Area of Body Exposed**

**Location of Exposure**

**Cell Sensitivity**

**Individual Sensitivity**

**Dose Rate**

The faster the dose is received, the less time the cell has to repair itself and the more severe the effect.

## Type of Radiation (Slide Layer)

**Factors Influencing Biological Effect**

**Total Dose**

**Dose Rate**

**Type of Radiation**

**Area of Body Exposed**

**Location of Exposure**

**Cell Sensitivity**

**Individual Sensitivity**

**Type of Radiation**

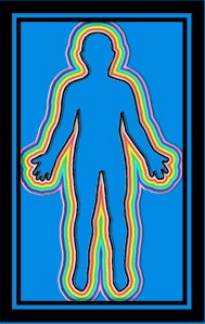
Externally, neutrons are more damaging than betas or gammas. Alpha particles are not an external hazard because they cannot penetrate the outer layer of skin. Alpha particles are an internal exposure hazard if inhaled or ingested.

## Area Exposed (Slide Layer)

**Factors Influencing Biological Effect**

**Area of Body Exposed**

The larger the area exposed, the greater the effect.



The diagram shows a human silhouette with a blue rectangular area highlighting the torso. The silhouette is outlined with a thick black border and a multi-colored inner border (yellow, green, blue, red).

**Factors influencing biological effect:**

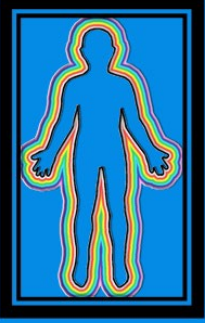
- Total Dose
- Dose Rate
- Type of Radiation
- Area of Body Exposed
- Location of Exposure
- Cell Sensitivity
- Individual Sensitivity

## Location of Exposure (Slide Layer)

**Factors Influencing Biological Effect**

**Location of Exposure**

The torso of the body contains critical organs, so an exposure to the torso has a greater effect than an exposure to the hands or feet.



The diagram shows a human silhouette with a blue rectangular area highlighting the torso. The silhouette is outlined with a thick black border and a multi-colored inner border (yellow, green, blue, red).

**Factors influencing biological effect:**

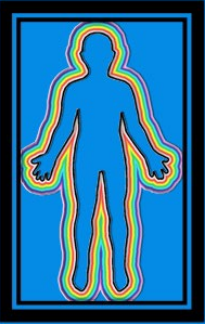
- Total Dose
- Dose Rate
- Type of Radiation
- Area of Body Exposed
- Location of Exposure
- Cell Sensitivity
- Individual Sensitivity

## Cell Sensitivity (Slide Layer)

Factors Influencing Biological Effect

**Cell Sensitivity**

Some types of cells are more sensitive than others such as hair follicles and the GI tract.



The diagram shows a human silhouette with a highlighted internal area representing cell sensitivity. The highlighted area is a blue shape with a black border, containing a yellow and red outline of a human figure. This area is centered on the torso and extends slightly to the arms and legs.

Factors influencing biological effect:

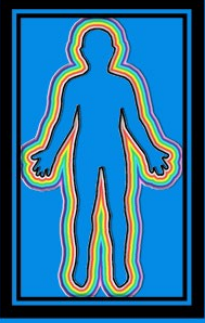
- Total Dose
- Dose Rate
- Type of Radiation
- Area of Body Exposed
- Location of Exposure
- Cell Sensitivity
- Individual Sensitivity

## Individual Sensitivity (Slide Layer)

Factors Influencing Biological Effect

**Individual Sensitivity**

Some individuals/age groups are more sensitive than others.



The diagram shows a human silhouette with a highlighted internal area representing individual sensitivity. The highlighted area is a blue shape with a black border, containing a yellow and red outline of a human figure. This area is centered on the torso and extends slightly to the arms and legs.

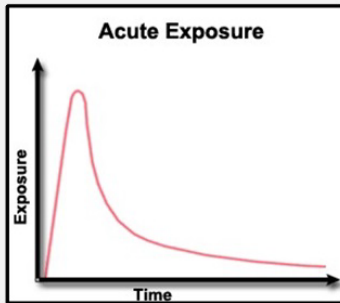
Factors influencing biological effect:

- Total Dose
- Dose Rate
- Type of Radiation
- Area of Body Exposed
- Location of Exposure
- Cell Sensitivity
- Individual Sensitivity

## 6.5 Acute Dose

### Acute Dose

An Acute Dose is a large amount of dose received in a short period of time.



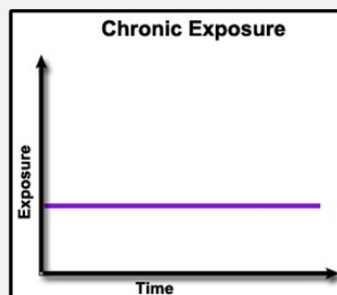
- Probability of an acute dose at Fermilab is extremely remote.
- No biological effects to humans seen at doses <10,000 mrem.
- If the dose is large enough, radiation sickness develops - symptoms shown in organs or systems with rapidly dividing cells (bone marrow, gastrointestinal tract). Severity depends on dose.

## 6.7 Chronic Dose

### Chronic Dose

An Chronic Dose is small amount of dose received over a long period of time, such as background radiation and occupational doses received at Fermilab.

- There are no detectable physical changes, but chronic exposure could affect the DNA of the cell.
- The human body handles chronic doses better than acute doses.



## 6.8 Chronic Dose Cont.

### Chronic Dose

A Chronic Dose is small amount of dose received over a long period of time, such as background radiation and occupational doses received at Fermilab.

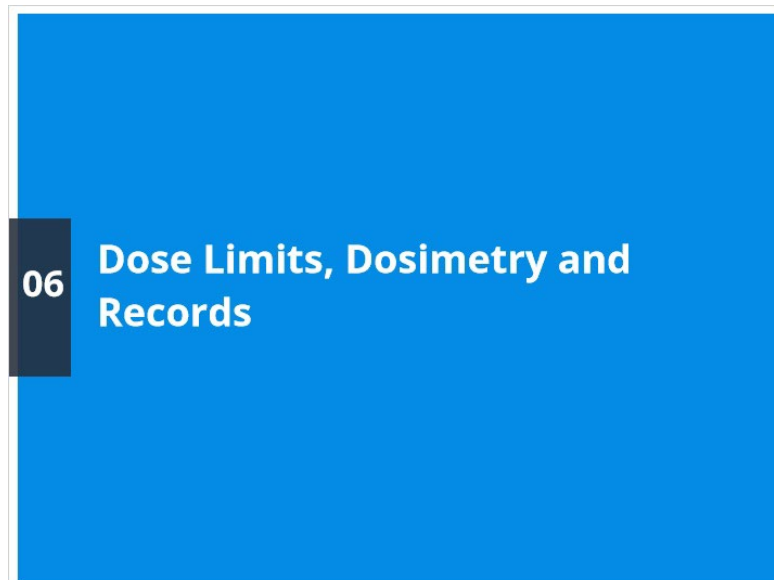


● **Somatic Effects:** Seen in a person who receives a chronic dose. Examples are cancer and cataracts. There is an extremely low chance of somatic effects occurring as a result of occupational doses received at Fermilab.

● **Genetic Effects:** Seen in future generations due to damage in reproductive cells. There is an extremely low chance of genetic effects occurring as a result of occupational doses received at Fermilab.

## 7. Dose Limits, Dosimetry and Records

### 7.1 Dose Limits, Dosimetry and Records





## 7.2 Dose Limits

### Dose Limits

DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	
Lens of the Eye	
Extremities	
Skin	
Declared Pregnant worker	
Minors & Students under 18	

Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

### Declared Pregnant Worker (Slide Layer)

### Dose Limits

DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	
Lens of the Eye	
Extremities	
Skin	
Declared Pregnant worker	500 mrem during gestation period
Minors & Students under 18	

Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

## Whole Body (Slide Layer)

**Dose Limits**

DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	5,000 mrem/yr
Lens of the Eye	
Extremities	
Skin	
Declared Pregnant worker	
Minors & Students under 18	

Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

## Lens of the Eye (Slide Layer)

**Dose Limits**


DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	
Lens of the Eye	15,000 mrem/yr
Extremities	
Skin	
Declared Pregnant worker	
Minors & Students under 18	

Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

## Extremities (Slide Layer)



### Dose Limits


DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	
Lens of the Eye	
Extremities	50,000 mrem/yr
Skin	
Declared Pregnant worker	
Minors & Students under 18	

Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

## Skin (Slide Layer)



### Dose Limits

DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	
Lens of the Eye	
Extremities	
Skin	50,000 mrem/yr
Declared Pregnant worker	
Minors & Students under 18	

Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

## Minors and students (Slide Layer)

### Dose Limits

DOE Legal Dose Limits  
Click the white boxes to right to reveal the dose

Whole Body	
Lens of the Eye	
Extremities	
Skin	
Declared Pregnant worker	
Minors & Students under 18	100 mrem/yr


Fermilab's Administrative Dose Limit is 1,500 mrem/yr

95% of permanent Fermilab workers receive < 100 mrem/yr

## 7.5 Dosimetry Devices - Badge

### Dosimetry Devices

#### Dosimetry Badge



- The dosimetry badge is a legal record of radiation exposure
- The Fermilab dosimetry badge measures beta, gamma, and neutron
- Badges are sent off-site for processing
- Do not open or tamper with dosimetry badges

## 7.6 Dosimetry Devices - Finger Ring

### Dosimetry Devices

#### Finger Ring

- Finger rings are worn if there is a chance for significant dose to extremities
- Finger rings are assigned to individuals by assigned RSOs
- Finger rings should be worn so that the top of the ring is closest to the source of radiation



## 7.7 Dosimetry Devices

### Dosimetry Devices

#### Pocket Dosimeter



- Direct reading pocket dosimeters are used to keep track of exposure during work
- Pocket dosimeters measure gamma exposure in R.
- A pocket dosimeter should be worn next to dosimetry badge
- A pocket dosimeter should be zeroed when it reads over 50% of full scale
- The scale is horizontal, not vertical. Read the pocket dosimeter on the horizontal scale
- A pocket dosimeter is the backup for the dosimetry badge in case the badge is lost

## 7.8 Dosimetry Devices - Digidose

### Dosimetry Devices

#### Digidose



- A digidose is a small electronic dosimeter used for high dose jobs
- A digidose measures the gamma dose
- The digidose beeps once for each accumulated mrem of dose
- The digidose will be specified by the assigned RSO when it is required
- Not entered on GetDose

## 7.9 Policies for ALL Dosimetry Devices

### Policies for ALL Dosimetry Devices

- A dosimetry device should only be worn by the person to whom it is issued.
- A dosimetry device is to be worn at all times when required by signs, RWP, or radiological control personnel
- Do not take dosimetry devices off-site.



## 7.10 Policies for ALL Dosimetry Devices cont.

### Policies for ALL Dosimetry Devices

If you are in an area controlled for radiological purposes and notice that your dosimetry badge, pocket dosimeter, Digidose, etc. is lost, off-scale, damaged, or contaminated:

- Place your work activities in a safe condition. For example, do not leave power tools operating
- Alert others in the vicinity. Their dosimetry may also be lost, off-scale, damaged, or contaminated
- Immediately leave the area
- Notify the assigned RSO via the Main Control Room

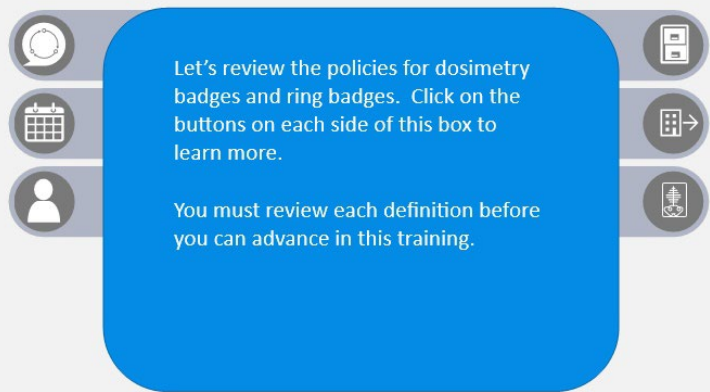


## 7.11 Policies for Dosimetry Badges and Ring Badges

### Policies for Dosimetry Badges and Ring Badges

Let's review the policies for dosimetry badges and ring badges. Click on the buttons on each side of this box to learn more.

You must review each definition before you can advance in this training.



## Return for processing (Slide Layer)

**Policies for Dosimetry Badges and Ring Badges**

Dosimetry badges and finger ring badges should be returned for processing as scheduled or upon request.

This slide features a light gray background with a title at the top left and a small icon at the top right. A central blue rounded rectangle contains the text. On the left side, there are three circular icons: a clock, a calendar, and a person. On the right side, there are three circular icons: a document, a grid with an arrow, and a hand holding a device.

## Turn in (Slide Layer)

**Policies for Dosimetry Badges and Ring Badges**

Dosimetry badges and finger ring badges should be turned in the first working day of January, April, July, and October.

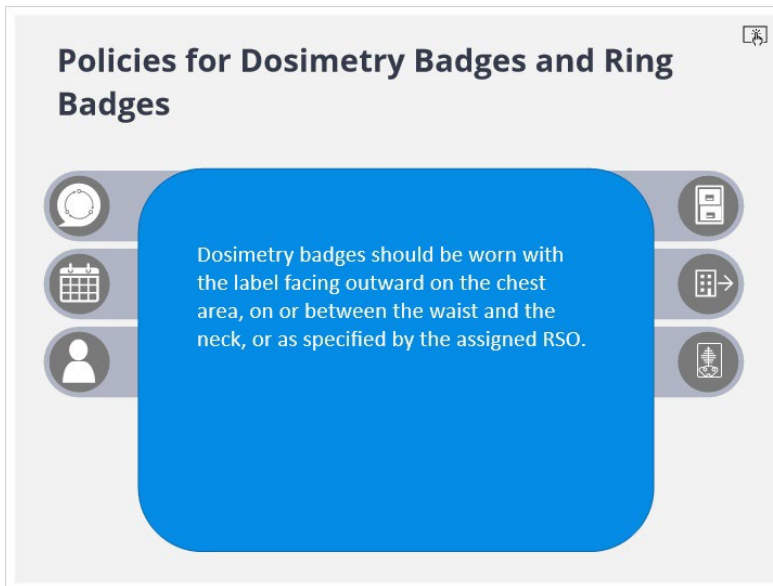
This slide features a light gray background with a title at the top left and a small icon at the top right. A central blue rounded rectangle contains the text. On the left side, there are three circular icons: a clock, a calendar, and a person. On the right side, there are three circular icons: a document, a grid with an arrow, and a hand holding a device.



## Wear facing forward (Slide Layer)

**Policies for Dosimetry Badges and Ring Badges**

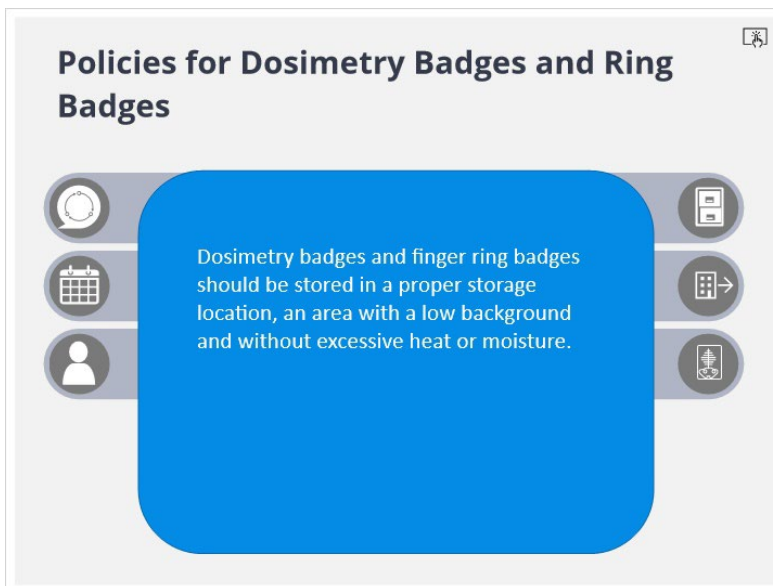
Dosimetry badges should be worn with the label facing outward on the chest area, on or between the waist and the neck, or as specified by the assigned RSO.

A slide layer titled "Policies for Dosimetry Badges and Ring Badges" with a blue rounded rectangle containing text. The slide is surrounded by a grey border with icons: a speech bubble, a calendar, a person, a document, a grid with an arrow, and a hand holding a device. A small icon in the top right corner indicates a slide layer.

## Store in proper location (Slide Layer)

**Policies for Dosimetry Badges and Ring Badges**

Dosimetry badges and finger ring badges should be stored in a proper storage location, an area with a low background and without excessive heat or moisture.

A slide layer titled "Policies for Dosimetry Badges and Ring Badges" with a blue rounded rectangle containing text. The slide is surrounded by a grey border with icons: a speech bubble, a calendar, a person, a document, a grid with an arrow, and a hand holding a device. A small icon in the top right corner indicates a slide layer.

## Do not wear off-site (Slide Layer)

**Policies for Dosimetry Badges and Ring Badges**

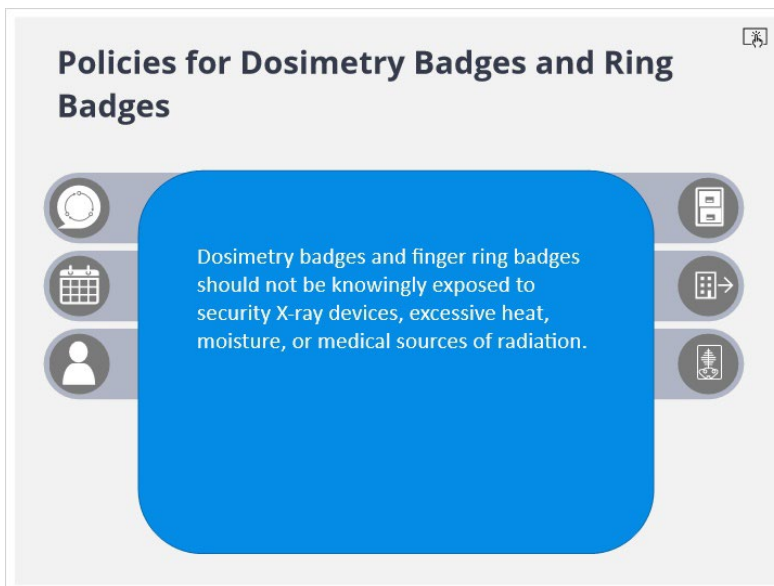
Dosimetry badges and finger ring badges should not be worn off-site unless specifically authorized by the Senior Radiation Safety Officer.

A slide layer with a light gray background. At the top left is the title "Policies for Dosimetry Badges and Ring Badges" in bold black text. In the top right corner is a small square icon with a magnifying glass. A central blue rounded rectangle contains the text "Dosimetry badges and finger ring badges should not be worn off-site unless specifically authorized by the Senior Radiation Safety Officer." On the left side, there are three circular icons: a clock, a calendar, and a person silhouette. On the right side, there are three circular icons: a document with a checkmark, a document with a right-pointing arrow, and a radiation symbol.

## Do not expose (Slide Layer)


**Policies for Dosimetry Badges and Ring Badges**

Dosimetry badges and finger ring badges should not be knowingly exposed to security X-ray devices, excessive heat, moisture, or medical sources of radiation.

A slide layer with a light gray background. At the top left is the title "Policies for Dosimetry Badges and Ring Badges" in bold black text. In the top right corner is a small square icon with a magnifying glass. A central blue rounded rectangle contains the text "Dosimetry badges and finger ring badges should not be knowingly exposed to security X-ray devices, excessive heat, moisture, or medical sources of radiation." On the left side, there are three circular icons: a clock, a calendar, and a person silhouette. On the right side, there are three circular icons: a document with a checkmark, a document with a right-pointing arrow, and a radiation symbol.

## 7.14 Policies for Pocket Dosimeters and Digidoses


### Policies for Pocket Dosimeters and Digidoses



- When required, a pocket dosimeter shall be worn next to one's dosimetry badge
- Return the device when it is due for calibration
- The pocket dosimeter is due on the last day of the month indicated by the sticker.
- Don't start a job if your pocket dosimeter reading is over half-way of full scale. Zero it first
- Enter the dose weekly on GetDose

## 7.15 Policies for Pocket Dosimeters and Digidoses

### Policies for Pocket Dosimeters and Digidoses



Click the buttons on the right to read the policies for pocket dosimeters and digidoses.

- Obtained from stockroom
- User responsible for recording
- Digidoses/RSO

## User responsibility (Slide Layer)

**Policies for Pocket Dosimeters and Digidoses**

The user is responsible for recording the dose from a pocket dosimeter.

- Obtained from stockroom
- User responsible for recording
- Digidoses/RSO

This slide features a light gray background with a small icon in the top right corner. The main title is in bold black text. A large blue rounded rectangle contains the primary text. To the right, three blue horizontal bars with white circular markers contain the bullet points.

## stockroom (Slide Layer)

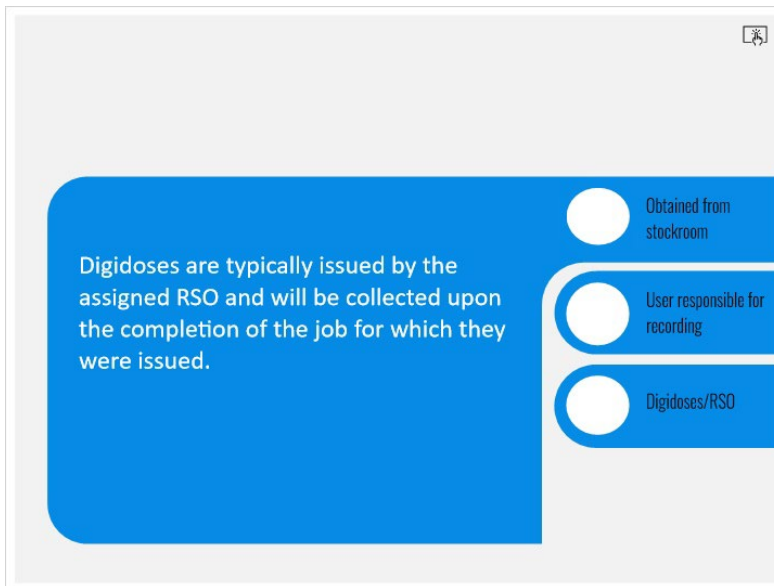
**Policies for Pocket Dosimeters and Digidoses**

Pocket dosimeters can be obtained from the stockroom.

- Obtained from stockroom
- User responsible for recording
- Digidoses/RSO

This slide features a light gray background with a small icon in the top right corner. The main title is in bold black text. A large blue rounded rectangle contains the primary text. To the right, three blue horizontal bars with white circular markers contain the bullet points.

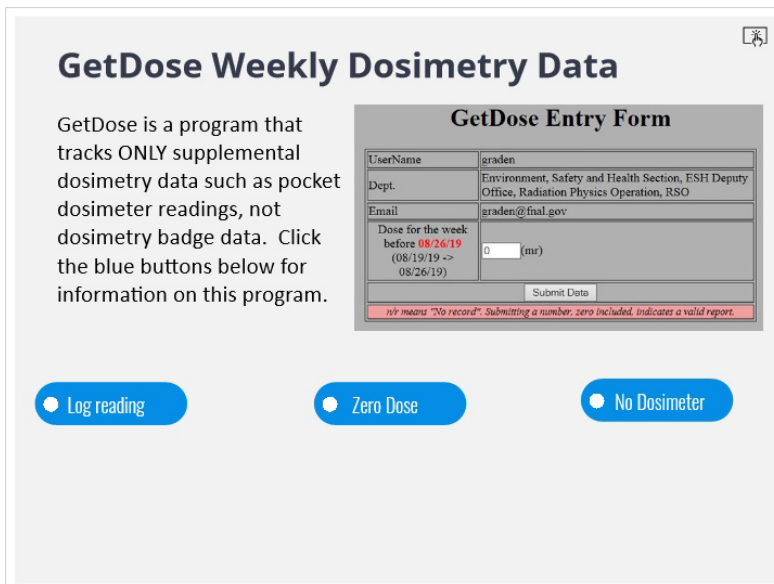
## RSO (Slide Layer)



Digidoses are typically issued by the assigned RSO and will be collected upon the completion of the job for which they were issued.

- Obtained from stockroom
- User responsible for recording
- Digidoses/RSO

## 7.16 GetDose Weekly Dosimetry Data



### GetDose Weekly Dosimetry Data

GetDose is a program that tracks ONLY supplemental dosimetry data such as pocket dosimeter readings, not dosimetry badge data. Click the blue buttons below for information on this program.

#### GetDose Entry Form

UserName	graden
Dept.	Environment, Safety and Health Section, ESH Deputy Office, Radiation Physics Operation, RSO
Email	graden@fnal.gov
Dose for the week before 08/26/19 (08/19/19 -> 08/26/19)	0 (mR)
Submit Data	
<small>*0 means "No record". Submitting a number, zero included, indicates a valid report.</small>	

Log reading     Zero Dose     No Dosimeter

## Log reading (Slide Layer)

### GetDose Weekly Dosimetry Data

GetDose is a program that tracks ONLY supplemental dosimetry data such as pocket dosimeter readings, not dosimetry badge data. Click the blue buttons below for information on this program.

GetDose Entry Form	
UserName	graden
Dept.	Environment, Safety and Health Section, ESH Deputy Office, Radiation Physics Operation, RSO
Email	graden@fnal.gov
Dose for the week before 08/26/19 (08/19/19 -> 08/26/19)	0 (mr)
Submit Data	
<i>nr means "No record". Submitting a number, zero included, indicates a valid report.</i>	

[Log reading](#)   [Zero Dose](#)   [No Dosimeter](#)

If you are a radiological worker, you will receive an email each week that requests you to log your pocket dosimeter or other supplemental dosimeter reading into this database.

## Zero dose (Slide Layer)

### GetDose Weekly Dosimetry Data

GetDose is a program that tracks ONLY supplemental dosimetry data such as pocket dosimeter readings, not dosimetry badge data. Click the blue buttons below for information on this program.

GetDose Entry Form	
UserName	graden
Dept.	Environment, Safety and Health Section, ESH Deputy Office, Radiation Physics Operation, RSO
Email	graden@fnal.gov
Dose for the week before 08/26/19 (08/19/19 -> 08/26/19)	0 (mr)
Submit Data	
<i>nr means "No record". Submitting a number, zero included, indicates a valid report.</i>	

[Log reading](#)   [Zero Dose](#)   [No Dosimeter](#)

If you wear a pocket dosimeter and get zero dose, it is important to record a zero for that week.

## no dosimeter (Slide Layer)

### GetDose Weekly Dosimetry Data

GetDose is a program that tracks ONLY supplemental dosimetry data such as pocket dosimeter readings, not dosimetry badge data. Click the blue buttons below for information on this program.

#### GetDose Entry Form

UserName	graden
Dept.	Environment, Safety and Health Section, ESH Deputy Office, Radiation Physics Operation, RSO
Email	graden@fnal.gov
Dose for the week before 08/26/19 (08/19/19 -> 08/26/19)	0 (mSv)
<input type="button" value="Submit Data"/>	
<small>n/r means "No record". Submitting a number, zero included, indicates a valid report.</small>	

Log reading

Zero Dose

No Dosimeter

If you do not wear a pocket dosimeter, you may enter a zero, leave GetDose Entry form as is with "n/r", or delete the email message.

## 7.17 Dose Records – Obtaining Dose Reports

### Dose Records – Obtaining Dose Reports

Each worker is responsible to contact his/her assigned RSO or the Dosimetry Program Manager if he/she is monitored for radiation exposure elsewhere.

- Annual summaries are sent to badge holders
- Dose reports are generated on a quarterly basis
- A current dose report can be obtained by submitting a **written** request to the ES&H Section Dosimetry Program Manager

## 7.18 ALERT List

### ALERT List

Click the blue buttons below for information about the ALERT program.

● Purpose      ● Quarterly ALERT      ● Minimizing Dose

## Annual ALERT (Slide Layer)

### ALERT List

Click the blue buttons below for information about the ALERT program.

● Purpose      ● Quarterly ALERT      ● Minimizing Dose

The Fermilab ALERT List is used to keep workers' annual radiation dose below the Fermilab administrative limit of 1,500 mrem/year.



## Quarterly ALERT (Slide Layer)

### ALERT List

Click the blue buttons below for information about the ALERT program.

● Purpose      ● Quarterly ALERT      ● Minimizing Dose

An individual will be placed on the ALERT List if their whole body dose is >350 mrem in a quarter.

## Minimizing Dose (Slide Layer)

### ALERT List

Click the blue buttons below for information about the ALERT program.

● Purpose      ● Quarterly ALERT      ● Minimizing Dose

The individual and his/her supervisor will be instructed on techniques to minimize dose and a more rigid monitoring system will be imposed.

## 8. Keeping Exposures ALARA

### 8.1 Keeping Exposures ALARA



### 8.2 ALARA Concept

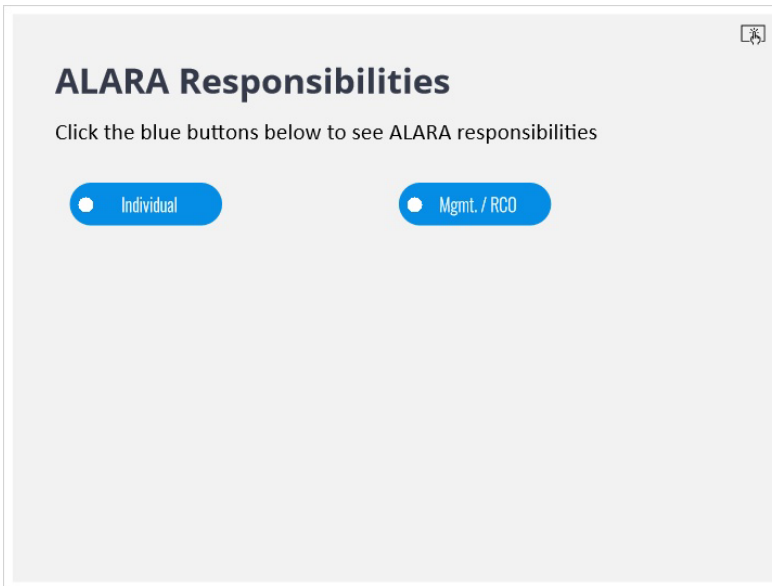
**ALARA Concept**

Keep your radiation exposure ALARA.

ALARA stands for As Low As Reasonably Achievable. ALARA is not a dose limit but a process.

As  
Low  
As  
Reasonably  
Achievable

### 8.3 ALARA Responsibilities



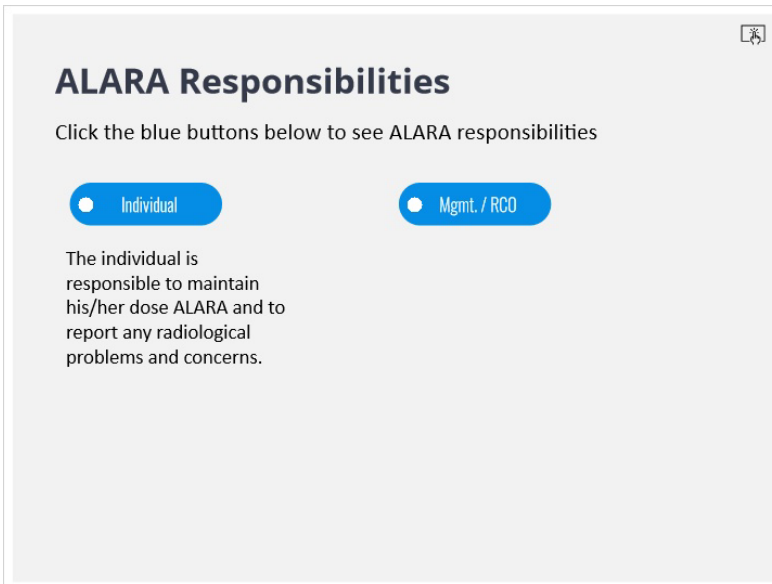
ALARA Responsibilities

Click the blue buttons below to see ALARA responsibilities

Individual Mgmt. / RCO

This slide features a light gray background with a title 'ALARA Responsibilities' in bold black text. Below the title is a subtitle 'Click the blue buttons below to see ALARA responsibilities'. At the bottom, there are two blue rounded rectangular buttons with white text: 'Individual' on the left and 'Mgmt. / RCO' on the right. A small icon is visible in the top right corner.

#### Individual (Slide Layer)



ALARA Responsibilities

Click the blue buttons below to see ALARA responsibilities

Individual Mgmt. / RCO

The individual is responsible to maintain his/her dose ALARA and to report any radiological problems and concerns.

This slide is similar to the previous one but includes additional text. It has the same title 'ALARA Responsibilities' and subtitle 'Click the blue buttons below to see ALARA responsibilities'. The buttons 'Individual' and 'Mgmt. / RCO' are present. Below the buttons, there is a paragraph: 'The individual is responsible to maintain his/her dose ALARA and to report any radiological problems and concerns.' A small icon is visible in the top right corner.

## Management/RCO (Slide Layer)

### ALARA Responsibilities

Click the blue buttons below to see ALARA responsibilities

**Individual**      **Mgmt. / RCO**

Management and the Radiological Control Organization (RCO) Responsibilities are as follows:

- Provide resources and assistance
- Review work plans and procedures
- Plan tasks
- Perform dose estimates for individuals and groups
- Conduct radiological surveys and monitoring
- Ensure personnel receive appropriate training

## 8.4 External Dose Reductions

### External Dose Reductions

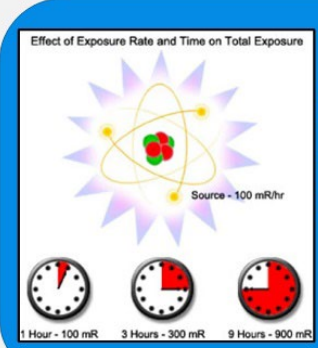
Use time, distance, and shielding methods to minimize your exposure to radiation.

The diagram consists of three panels, each with an illustration and a text box. The first panel, labeled 'Time', shows a person running away from a radiation source with wavy lines representing radiation. The second panel, labeled 'Distance', shows a person standing further away from a radiation source. The third panel, labeled 'Shielding', shows a person standing behind a large rectangular shield between themselves and a radiation source.

**Time**      **Distance**      **Shielding**

## 8.5 Minimize Time

**Minimize Time**



Effect of Exposure Rate and Time on Total Exposure

Source - 100 mR/hr

1 Hour - 100 mR    3 Hours - 300 mR    9 Hours - 900 mR

Click the buttons on the right to learn more about minimizing your time spent around radiation.

- Document icon
- Wrench icon
- Group of people icon
- Close icon
- Help icon

### Procure equipment (Slide Layer)

**Minimize Time**

Procure the necessary equipment prior to starting work.



- Document icon
- Wrench icon
- Group of people icon
- Close icon
- Help icon

## Pre-plan (Slide Layer)

Minimize Time

Pre-plan the job.



A slide titled "Minimize Time" with the text "Pre-plan the job." and an icon of a document with a pencil. The slide is part of a presentation with navigation icons on the right side.

## Never Loiter (Slide Layer)

Minimize Time

Never loiter in an area controlled for radiological purposes.

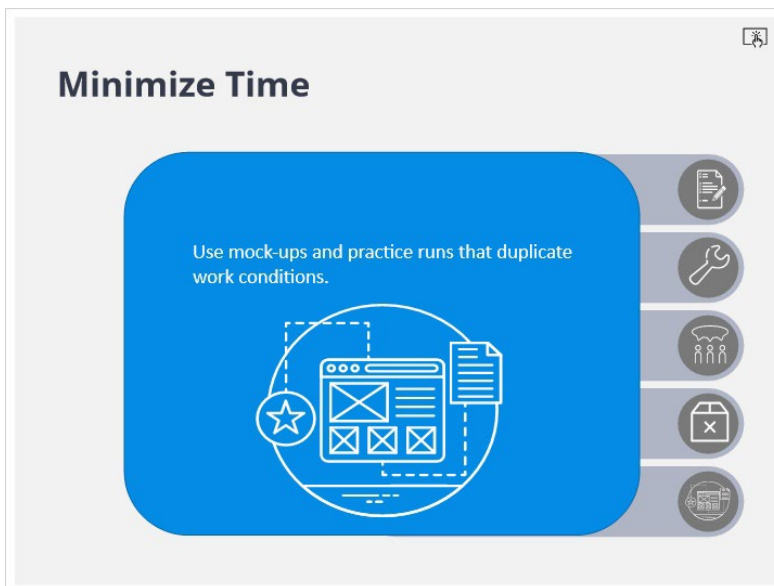


A slide titled "Minimize Time" with the text "Never loiter in an area controlled for radiological purposes." and an icon of three people under a cloud. The slide is part of a presentation with navigation icons on the right side.

## Remove (Slide Layer)



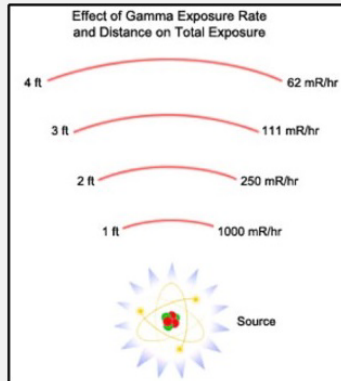
## Mock-ups (Slide Layer)



## 8.6 Maximize Distance

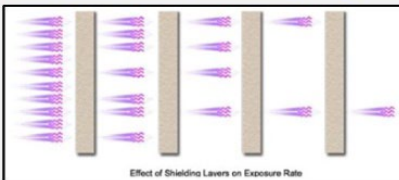
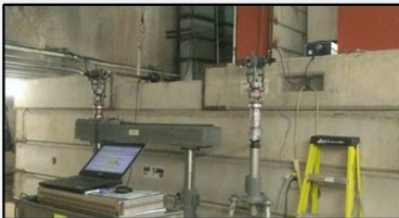
### Maximize Distance

- Be familiar with radiological conditions in the area. Stay as far away as possible from the source of radiation, moving to lower dose rate areas during delays.
- Use tools with long handles or other remote handling devices when possible.



## 8.7 Use of Shielding

### Use of Shielding



- Take advantage of permanent shielding such as non-radioactive equipment or structures.
- If the job warrants, temporary shielding can be installed; consult with the assigned RSO.



## 8.9 Internal Dose Reduction

Internal Dose Reduction

Internal exposure occurs as a result of radioactive material entering the body. Click the buttons on the right learn about the different routes of entry.

1

2

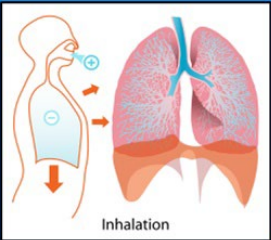
3

4

### Inhalation (Slide Layer)

Internal Dose Reduction

Inhalation



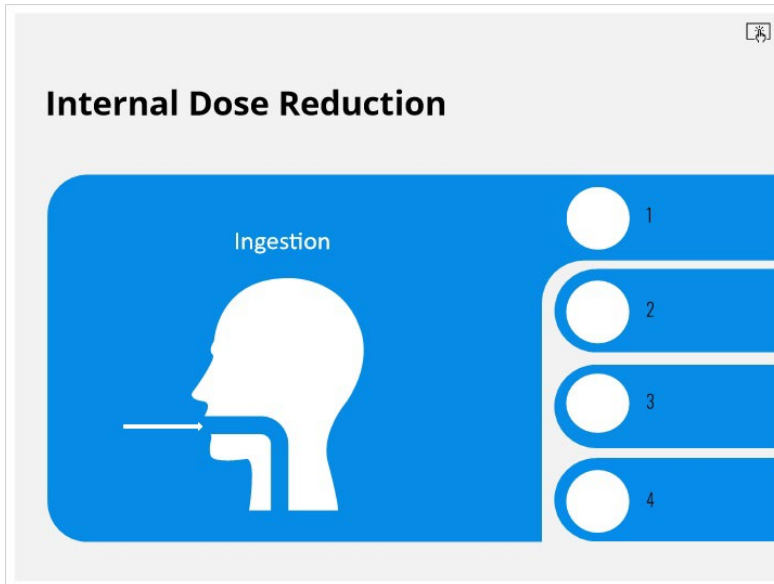
1

2

3

4

## Ingestion (Slide Layer)




## Absorption (Slide Layer)



## Wounds (Slide Layer)

Internal Dose Reduction

Open wounds or cuts



- 1
- 2
- 3
- 4


### 8.10 Internal Dose Reduction Cont.

Internal Dose Reduction

Click the buttons on the right to learn how to prevent radioactive material from entering the body.


- No eating or drinking
- Comply with requirements
- Bandage wounds
- Wear PPE

## No eating or drinking (Slide Layer)




### Internal Dose Reduction

Do not eat, drink, smoke, chew, or apply cosmetics in any radiological area.




- No eating or drinking
- Comply with requirements
- Bandage wounds
- Wear PPE

## Comply (Slide Layer)



### Internal Dose Reduction

Comply with the requirements of all work documents.




- No eating or drinking
- Comply with requirements
- Bandage wounds
- Wear PPE

## Bandage wounds (Slide Layer)

**Internal Dose Reduction**

Bandage wounds, cuts, rashes, and abrasions before entering any area where contamination may be present.




- No eating or drinking
- Comply with requirements
- Bandage wounds
- Wear PPE

## PPE (Slide Layer)

**Internal Dose Reduction**

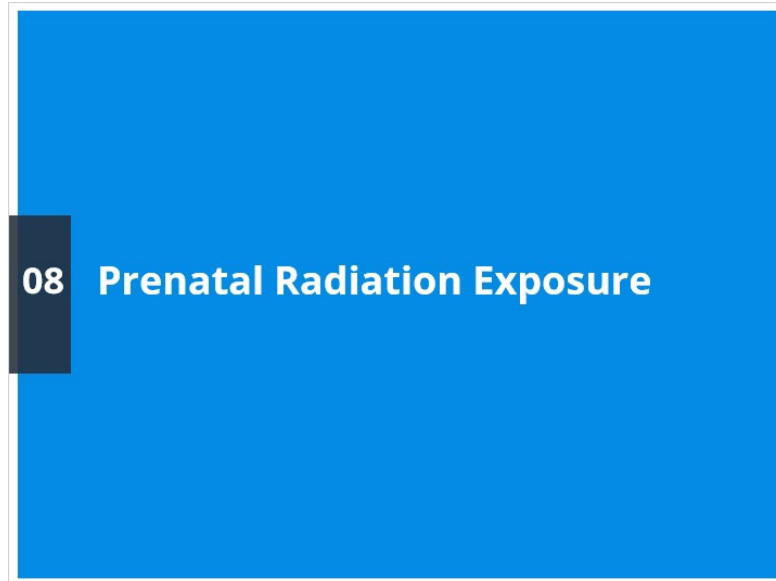
Wear coveralls, gloves, respirators and eye protection.



- No eating or drinking
- Comply with requirements
- Bandage wounds
- Wear PPE

## 9. Prenatal Radiation Exposure


### 9.1 Prenatal Radiation Exposure



### 9.2 Potential Biological Effects of Prenatal Radiation Exposure

**Potential Biological Effects of Prenatal Radiation Exposure**


- In studies of children exposed in utero to radiation from atomic bombs, few effects were observed at doses <15,000 mrem.
- At very high doses of >15,000 mrem, low birth weights and mental retardation were observed in some infants.
- An increased chance of childhood cancer has been suggested, but not proven at very high radiation doses.

A black silhouette of a pregnant woman standing, set against a pink square background. The woman is facing left, and her belly is prominent.

### 9.3 DOE Embryo/Fetal Dose Limits


#### DOE Embryo/Fetal Dose Limits

- The dose limit for entire gestation period is 500 mrem.
- At present occupational dose limits, the risk from radiation dose is minimal compared to general risks of pregnancy.
- DOE dose limits are set as an additional measure of protection.

A black silhouette of a pregnant woman with a white circle on her abdomen containing a black silhouette of a fetus.

### 9.4 Fermilab's Prenatal Policy

#### Fermilab's Prenatal Policy

A black silhouette of a pregnant woman with a white circle on her abdomen containing a black silhouette of a fetus.

- Fermilab's Prenatal Policy applies only to Fermilab employees. Pregnant users, visitors, and subcontractors should contact their home institution/employer.
- All women routinely being monitored for radiation exposure shall receive appropriate information concerning prenatal radiation exposure.

## 9.5 If A Women knows or Suspects She is Pregnant

### Fermilab's Prenatal Policy

If a woman knows or suspects that she is pregnant, she may:

- Choose not to make a pregnant radiological worker declaration. Under this option, the usual occupational exposure limits will apply.
- Voluntarily notify the Medical Office, assigned RSO, or ES&H Section Dosimetry Program Manager in writing as soon as possible. Under this option, she would then become a Declared Pregnant Worker. An assigned RSO will conduct an evaluation of her work area and assigned tasks and lower dose limits will apply.



## 9.6 Fermilab's Prenatal Policy Cont.

### Fermilab's Prenatal Policy

Declared Pregnant Workers

Non-Fermilab employees (users, visitors, subcontractors, etc.) who declare their pregnancy to their employer may contact their assigned RSO at Fermilab to discuss ALARA considerations for their current Fermilab work environment.

Click the buttons on the right to view the options for Declared Pregnant Workers employed by Fermilab.

Temporary Assignment

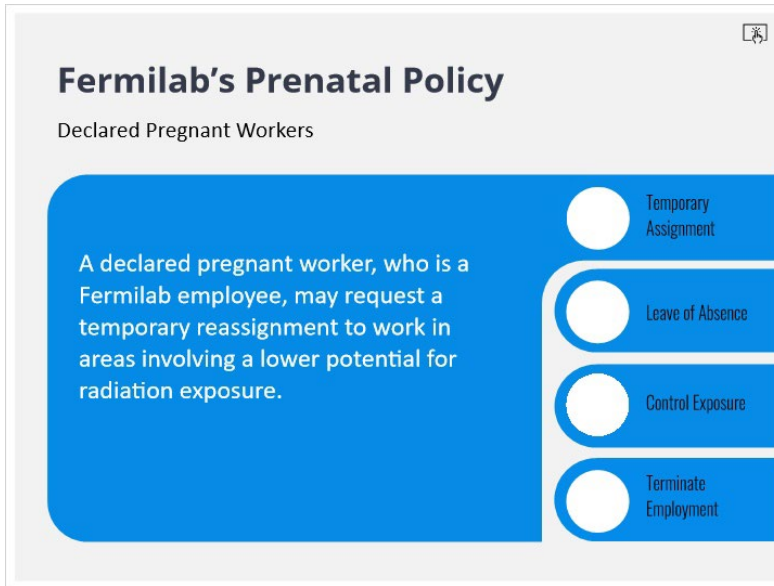
Leave of Absence

Control Exposure

Terminate Employment



## Temporary Assignment (Slide Layer)



**Fermilab's Prenatal Policy**

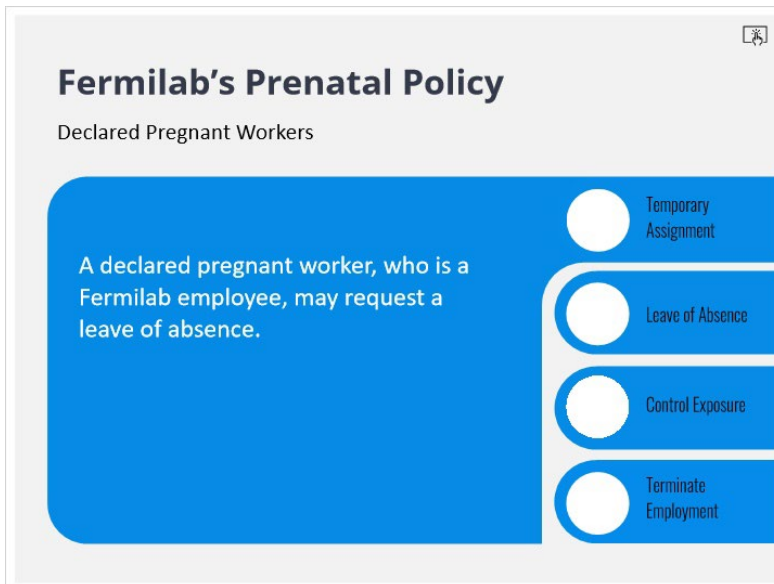
Declared Pregnant Workers

A declared pregnant worker, who is a Fermilab employee, may request a temporary reassignment to work in areas involving a lower potential for radiation exposure.

- Temporary Assignment
- Leave of Absence
- Control Exposure
- Terminate Employment

This slide layer features a light gray background with a title and subtitle at the top. A large blue rounded rectangle on the left contains the main text. To the right, a vertical stack of four blue buttons with white circular icons is visible. The top button is highlighted, indicating the current slide's topic.

## Leave of Absence (Slide Layer)



**Fermilab's Prenatal Policy**

Declared Pregnant Workers

A declared pregnant worker, who is a Fermilab employee, may request a leave of absence.

- Temporary Assignment
- Leave of Absence
- Control Exposure
- Terminate Employment

This slide layer is identical in layout to the first one, but the second button in the vertical stack, labeled 'Leave of Absence', is highlighted with a white circle, indicating it is the active slide.

## Control Exposure (Slide Layer)

**Fermilab's Prenatal Policy**  
Declared Pregnant Workers

A declared pregnant worker, who is a Fermilab employee, may continue with the same job assignment and control her exposure such that the embryo/fetus dose limits are not exceeded.

- Temporary Assignment
- Leave of Absence
- Control Exposure
- Terminate Employment

This slide layer features a light gray background with a small icon in the top right corner. The title 'Fermilab's Prenatal Policy' is in bold, followed by the subtitle 'Declared Pregnant Workers'. A large blue rounded rectangle on the left contains the policy text. To the right, a vertical list of four options is presented, each with a white circle and a blue bar extending to the right.

## Terminate employment (Slide Layer)

**Fermilab's Prenatal Policy**  
Declared Pregnant Workers

A declared pregnant worker, who is a Fermilab employee, may terminate employment at Fermilab.

- Temporary Assignment
- Leave of Absence
- Control Exposure
- Terminate Employment

This slide layer features a light gray background with a small icon in the top right corner. The title 'Fermilab's Prenatal Policy' is in bold, followed by the subtitle 'Declared Pregnant Workers'. A large blue rounded rectangle on the left contains the policy text. To the right, a vertical list of four options is presented, each with a white circle and a blue bar extending to the right.

## 9.7 Fermilab's Prenatal Policy Cont.

**Fermilab's Prenatal Policy**

Declared Pregnant Workers

Click the buttons on the right to learn more about Fermilab's policy for Declared Pregnant Workers.

- Dose < 50 mrem
- Fetal Monitoring Badges
- If dose > 500/mrem
- Declaration Revocation

### Dose < 50 (Slide Layer)

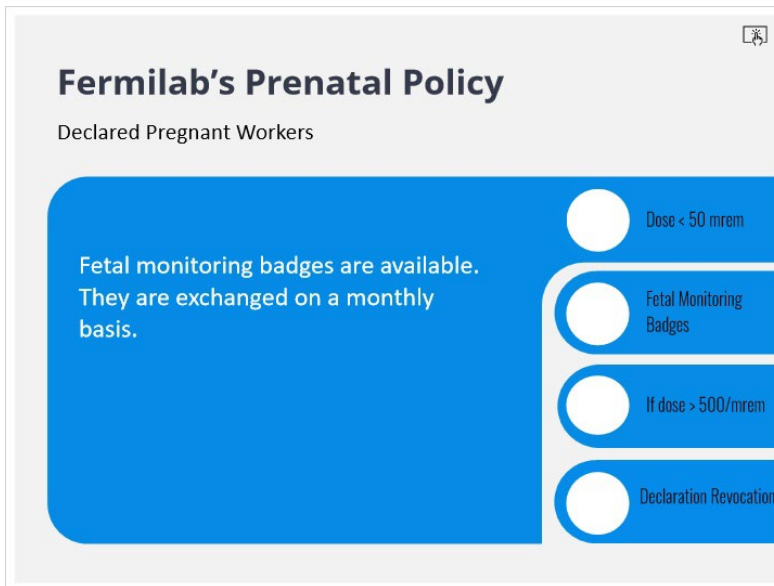
**Fermilab's Prenatal Policy**

Declared Pregnant Workers

Efforts will be made to maintain dose to the fetus to <50 mrem/month.

- Dose < 50 mrem
- Fetal Monitoring Badges
- If dose > 500/mrem
- Declaration Revocation

## Fetal Monitoring (Slide Layer)



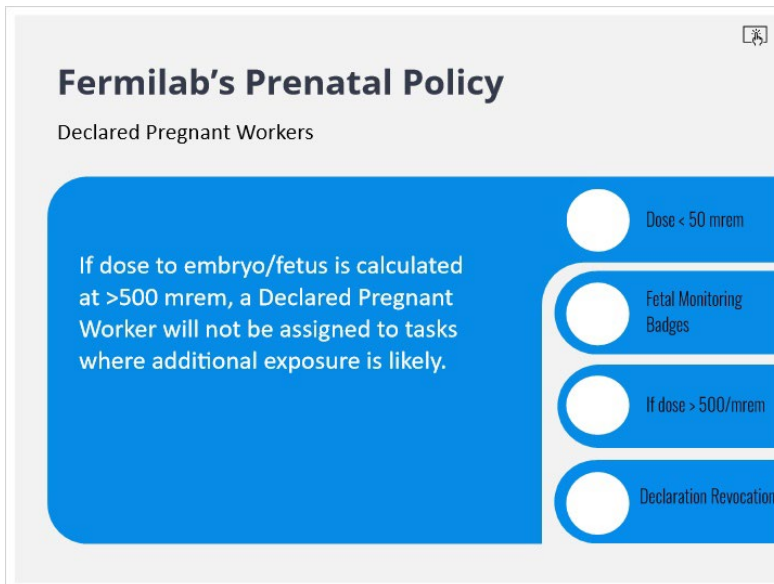
**Fermilab's Prenatal Policy**  
Declared Pregnant Workers

Fetal monitoring badges are available. They are exchanged on a monthly basis.

- Dose < 50 mrem
- Fetal Monitoring Badges
- If dose > 500/mrem
- Declaration Revocation

This slide features a light gray background with a blue rounded rectangle on the left containing text. To the right, a vertical stack of four blue rounded rectangles contains a white circle icon and text. A small icon is in the top right corner.

## Dose > 500 (Slide Layer)



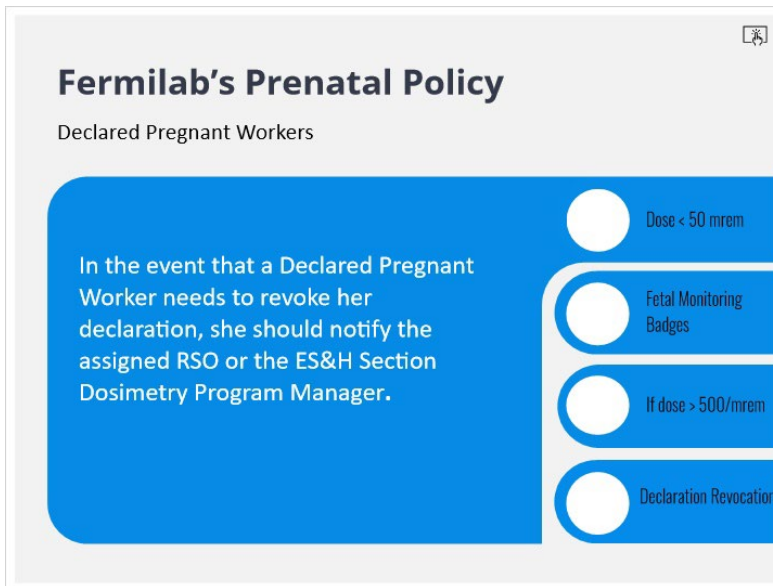
**Fermilab's Prenatal Policy**  
Declared Pregnant Workers

If dose to embryo/fetus is calculated at >500 mrem, a Declared Pregnant Worker will not be assigned to tasks where additional exposure is likely.

- Dose < 50 mrem
- Fetal Monitoring Badges
- If dose > 500/mrem
- Declaration Revocation

This slide features a light gray background with a blue rounded rectangle on the left containing text. To the right, a vertical stack of four blue rounded rectangles contains a white circle icon and text. A small icon is in the top right corner.

## Declaration Revocation (Slide Layer)



**Fermilab's Prenatal Policy**  
Declared Pregnant Workers


In the event that a Declared Pregnant Worker needs to revoke her declaration, she should notify the assigned RSO or the ES&H Section Dosimetry Program Manager.

- Dose < 50 mrem
- Fetal Monitoring Badges
- If dose > 500/mrem
- Declaration Revocation

The slide features a light gray background with a blue rounded rectangle containing the main text. To the right, a vertical stack of four blue rounded rectangles, each with a white circle on the left, lists the policy details. A small icon is visible in the top right corner of the slide frame.

## 10. Medical Radiation Exposures

### 10.1 Medical Radiation Exposure




**09 Medical Radiation Exposure**

The slide has a solid blue background. On the left side, there is a dark blue vertical bar containing the number '09' in white. To the right of this bar, the text 'Medical Radiation Exposure' is written in white, bold font.

## 10.2 Medical Exposures

**Medical Exposures**

Click the buttons on each side of this box to learn about medical radiation exposures.



The image shows a medical CT scanner in a clinical setting. The scanner is a large, white, circular machine with a patient lying on a table inside. The room has a blue wall and a window.

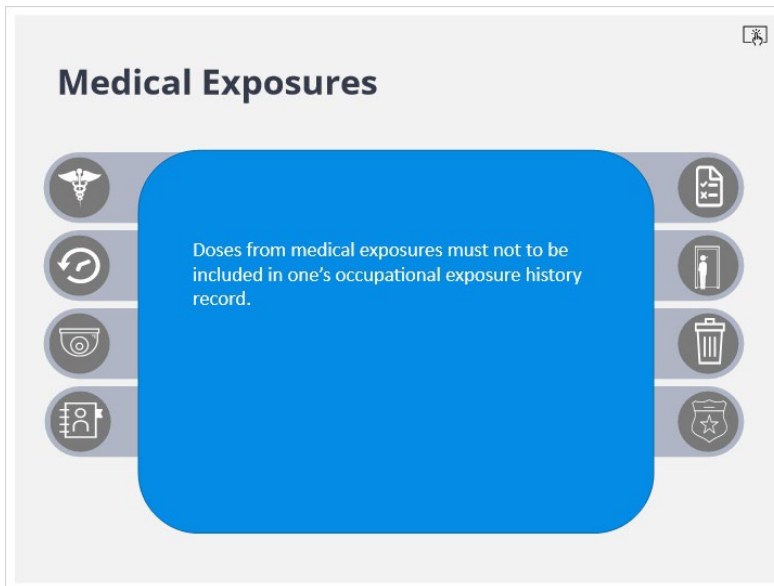
### Inform medical (Slide Layer)

**Medical Exposures**

Although it is not required, a radiological worker who undergoes a medical procedure involving radioactive materials is **highly encouraged** to inform the Medical Office, the assigned RSO, or the ES&H Section Dosimetry Program Manager for the following reasons:

- To ensure that the individual does not wear his/her dosimetry badge
- To minimize exposures to co-workers
- To provide instructions for handling radioactive bodily fluids

## Not included in history (Slide Layer)

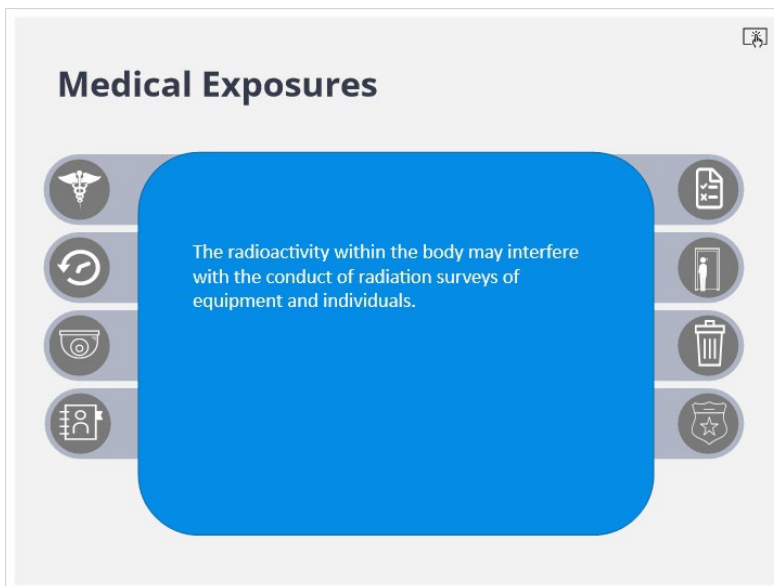


**Medical Exposures**

Doses from medical exposures must not be included in one's occupational exposure history record.

The slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with various icons: a caduceus, a document with a checkmark, a refresh arrow, a person silhouette, a target, a trash can, a calendar, and a shield with a star. A small icon in the top right corner indicates a locked slide layer.

## May interfere with surveys (Slide Layer)

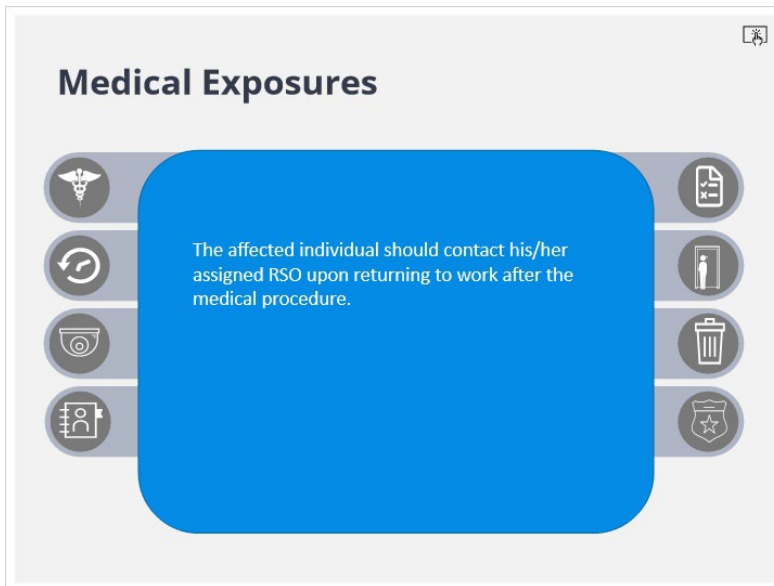


**Medical Exposures**

The radioactivity within the body may interfere with the conduct of radiation surveys of equipment and individuals.

The slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with various icons: a caduceus, a document with a checkmark, a refresh arrow, a person silhouette, a target, a trash can, a calendar, and a shield with a star. A small icon in the top right corner indicates a locked slide layer.

## Contact RSO after procedure (Slide Layer)

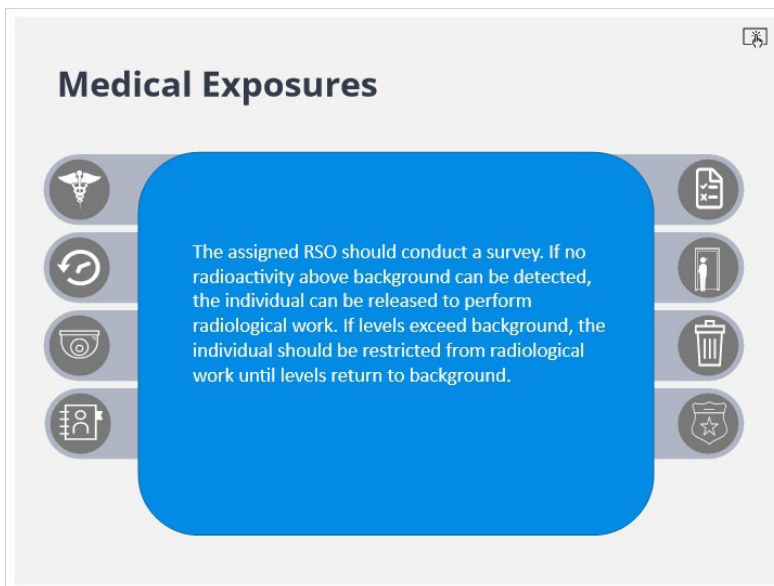


**Medical Exposures**

The affected individual should contact his/her assigned RSO upon returning to work after the medical procedure.

This slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with various icons: a caduceus, a document with a checkmark, a refresh arrow, a person silhouette, a target, a trash can, a calendar, and a shield with a star. A small icon in the top right corner indicates a locked slide.

## RSO conducts survey (Slide Layer)



**Medical Exposures**

The assigned RSO should conduct a survey. If no radioactivity above background can be detected, the individual can be released to perform radiological work. If levels exceed background, the individual should be restricted from radiological work until levels return to background.

This slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with various icons: a caduceus, a document with a checkmark, a refresh arrow, a person silhouette, a target, a trash can, a calendar, and a shield with a star. A small icon in the top right corner indicates a locked slide.



## RSO visits work area (Slide Layer)

**Medical Exposures**

The assigned RSO should visit the individual's workbench/desk area to ensure the prevailing dose rates to other personnel in the area are below 0.05 mrem/hr the majority of the workday.

## Waste materials (Slide Layer)

**Medical Exposures**

Waste materials (paper products and chewing gum) may be contaminated after use. Care must be taken to isolate these materials by placing them in temporary storage or the affected individual should take the materials home for disposal. The assigned RSO will help you make appropriate arrangements.

## Badge worn during procedure (Slide Layer)

**Medical Exposures**

If a dosimetry badge was worn during a medical procedure, the badge should be sent to the vendor for processing and an exposure investigation must be initiated.

The slide features a central blue rounded rectangle with the text. It is surrounded by a grey border containing several icons: a caduceus, a document with a checkmark, a circular arrow, a person silhouette, a target, a trash can, a calendar, and a shield with a star. A small icon in the top right corner indicates a slide layer.

## 11. Radiological Posting

### 11.1 Radiological Postings

**10 Radiological Postings**

The slide has a solid blue background. On the left side, there is a dark blue vertical bar containing the number '10' in white. To the right of this bar, the text 'Radiological Postings' is written in white.

## 11.2 General Requirements for Radiological Postings

### General Requirements for Radiological Postings

- All signs, postings, and labels have the following things in common:
  - Yellow background with black or magenta lettering
  - Standard 3-bladed propeller shaped symbol
- All access points must be posted.
- Barriers must be used when necessary and must be conspicuously posted.
- Entrance points must have signs and all radiological hazards must be noted.



## 11.3 CAUTION: Controlled Area

### CAUTION: Controlled Area



- This sign denotes any area where access is controlled to protect personnel from exposure to radiation and/or radioactive material.
- A Controlled Area is not a radiological area.
- Requirements for Entry: General Employee Radiation Training (GERT).



## 11.4 CAUTION: Radioactive Material Area

### CAUTION: Radioactive Material Area



- Any area within a Controlled Area, accessible to individuals, where items or containers of radioactive material exist and the total activity of radioactive material exceeds specified 10 CFR Part 835 values.
- A Radioactive Material Area is not a radiological area.
- Requirements for Entry: GERT; however, Radiological Worker training is required to work with the materials in the area.

## 11.5 CAUTION: Radiation Area

### CAUTION: Radiation Area

- An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose to the whole body in excess of 5 mrem in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.
- Requirements for Entry: Radiological Worker training, read and sign RWP as appropriate, and dosimetry badge, and in most cases, a dosimeter.
- Requirements to Exit: Refer to RWP instructions.



## 11.6 DANGER: High Radiation Area

### DANGER: High Radiation Area

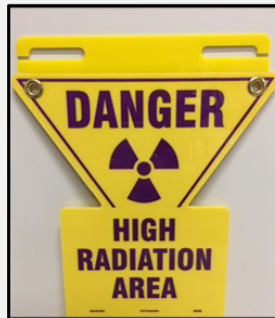
- An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose to the whole body in excess of 100 mrem in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
- Requirements for Entry: Radiological Worker training, read and sign RWP as appropriate, dosimetry badge, and pocket dosimeter.
- Requirements to Exit: Refer to RWP instructions.



## 11.7 DANGER: High Radiation Area

### DANGER: High Radiation Area

- If the work requires handling of objects where the dose to the hands can be expected to exceed 1 rem/quarter, ring badges should also be worn.
- Additional requirements will be imposed by the assigned RSO when dose rates exceed 1000 mrem/hr.




## 11.8 GRAVE DANGER: Very High Radiation Area

**GRAVE DANGER: Very High Radiation Area**

Click the buttons on the right to learn about GRAVE DANGER postings at Fermilab.

You must review all the types before you advance in the training.







### > 500 rads (Slide Layer)

**GRAVE DANGER: Very High Radiation Area**

An area, accessible to individuals, in which radiation levels could result in a person receiving an absorbed dose in excess of 500 rads in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates.






## Entry requirements (Slide Layer)

**GRAVE DANGER: Very High Radiation Area**

Requirements for Entry:



- Radiological Worker training
- worker signature on RWP or written authorization by the assigned RSO to enter the area
- dosimetry badge
- supplemental dosimeters
- and survey meters or dose rate indicating device available at the work area



## Access points (Slide Layer)

**GRAVE DANGER: Very High Radiation Area**



Access points will be secured by control devices, locks, etc..



## Requirements to exit (Slide Layer)

**GRAVE DANGER: Very High Radiation Area**



Requirements to Exit: Post-job briefing, dosimetry records completed, and whole body frisking as applicable. Refer to RWP instructions.



## rare at Fermi (Slide Layer)

**GRAVE DANGER: Very High Radiation Area**

Access to such areas is extremely rare at Fermilab.





### **11.9 CAUTION: Contamination Area**

#### **CAUTION: Contamination Area**

Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Chapter 2, Table 2-2 of the FRCM, but do not exceed 100 times those values.



### **11.10 DANGER: High Contamination Area**

#### **DANGER: High Contamination Area**

Any area, accessible to individuals, where removable contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Chapter 2, Table 2-2 of the FRCM.



## 11.11 CAUTION: Airborne Radioactivity Area

### CAUTION: Airborne Radioactivity Area

Any area, accessible to individuals where:

- The concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the Derived Air Concentration (DAC) values listed in Appendix A or Appendix C of 10 CFR 835
- An individual in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week.



## 11.13 Requirements for Entry/Exit to/from Contamination, High Contamination, and Airborne Radioactivity Areas

### Requirements for Entry/Exit to/from Contamination, High Contamination, and Airborne Radioactivity Areas

Click the blue buttons below for entry and exit requirements.

• Entry

• Exit

## Entry (Slide Layer)

**Requirements for Entry/Exit to/from Contamination, High Contamination, and Airborne Radioactivity Areas**

Click the blue buttons below for entry and exit requirements.

**Entry**      **Exit**

- Radiological Worker training
- Worker signature on RWP
- Dosimetry badge and supplemental dosimetry as required by RWP
- Protective equipment/ clothing required by the RWP
- Pre-job briefing as required

## exit (Slide Layer)

**Requirements for Entry/Exit to/from Contamination, High Contamination, and Airborne Radioactivity Areas**

Click the blue buttons below for entry and exit requirements.

**Entry**      **Exit**



Whole body frisk before removal of protective clothing as specified by RWP, Radiological Control personnel or as posted.

## 11.14 Responsibilities of the Worker

**Responsibilities of the Worker**

Click the buttons on the right to learn about the responsibilities of the worker.


You must review all the responsibilities before you advance in the training.



### Report to RSO (Slide Layer)

**Responsibilities of the Worker**

Report to the assigned RSO any unusual situation you identify, or any situation where radiological controls are not adequate or are not being followed.



## Read signs (Slide Layer)

Responsibilities of the Worker

Read all signs before entering area.

This slide features a light gray background with a title 'Responsibilities of the Worker' in the top left. A large blue rounded rectangle contains the text 'Read all signs before entering area.' To the right of this rectangle is a vertical toolbar with five circular icons: a person reading, a circular arrow, a list with a checkmark, a square with a diagonal line, and a megaphone. A small square icon with a lock symbol is in the top right corner.

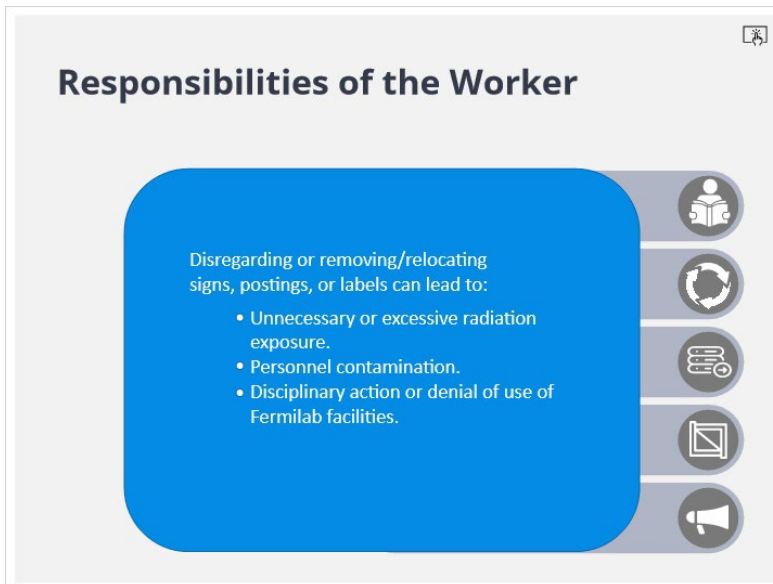
## Comply with info (Slide Layer)

Responsibilities of the Worker

Comply with all information on signs, postings, and labels. Do not remove or relocate them.

This slide features a light gray background with a title 'Responsibilities of the Worker' in the top left. A large blue rounded rectangle contains the text 'Comply with all information on signs, postings, and labels. Do not remove or relocate them.' To the right of this rectangle is a vertical toolbar with five circular icons: a person reading, a circular arrow, a list with a checkmark, a square with a diagonal line, and a megaphone. A small square icon with a lock symbol is in the top right corner.

## Disregarding (Slide Layer)



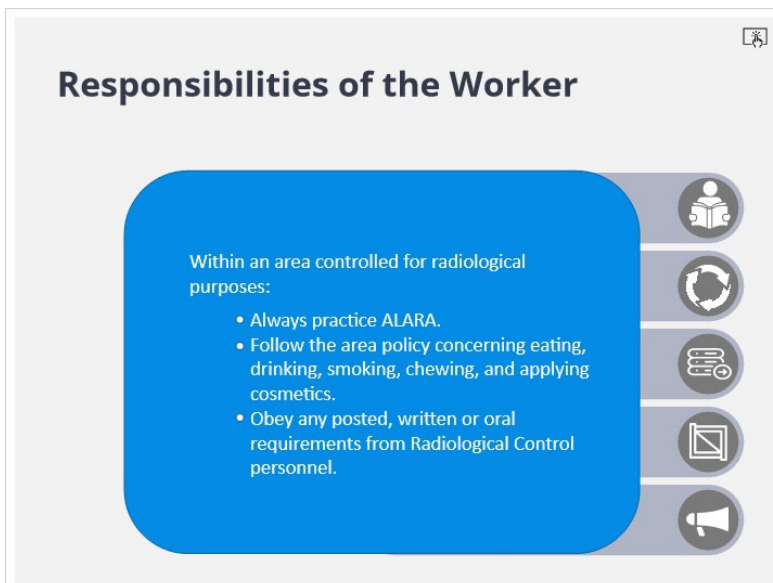
**Responsibilities of the Worker**

Disregarding or removing/relocating signs, postings, or labels can lead to:

- Unnecessary or excessive radiation exposure.
- Personnel contamination.
- Disciplinary action or denial of use of Fermilab facilities.

The slide features a vertical toolbar on the right with five icons: a person reading, a circular arrow, a document with a checkmark, a square with a diagonal line, and a megaphone.

## Within a controlled area (Slide Layer)



**Responsibilities of the Worker**

Within an area controlled for radiological purposes:

- Always practice ALARA.
- Follow the area policy concerning eating, drinking, smoking, chewing, and applying cosmetics.
- Obey any posted, written or oral requirements from Radiological Control personnel.

The slide features a vertical toolbar on the right with five icons: a person reading, a circular arrow, a document with a checkmark, a square with a diagonal line, and a megaphone.

## 12. Contamination Control

### 12.1 Contamination Control




### 12.2 Radioactive Contamination

**Radioactive Contamination**

Radioactive Contamination is defined as the deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

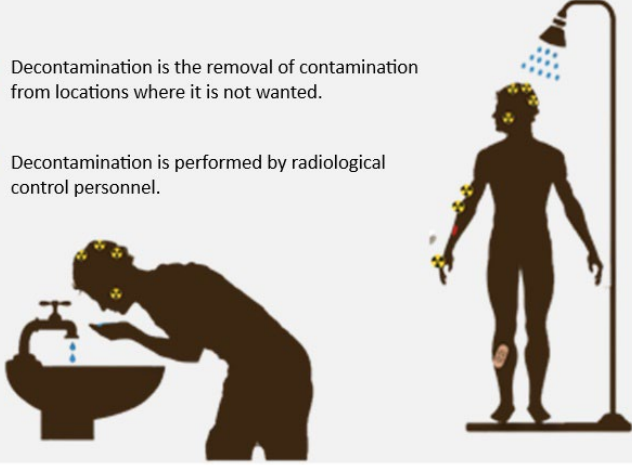
- Loose surface contamination can be transferred by contact with other surfaces.
- Radioactive contamination is commonly found in beamline enclosures.
- Proper use of protective clothing helps to control the hazard.



## 12.4 Decontamination

### Decontamination

- Decontamination is the removal of contamination from locations where it is not wanted.
- Decontamination is performed by radiological control personnel.




The illustration shows two scenarios of decontamination. On the left, a silhouette of a person is bent over a sink, washing their hands. On the right, a silhouette of a person stands under a showerhead, with water spraying over their head and body. Yellow starburst symbols are scattered on the person's head and arms in both scenes, representing radioactive contamination.

## 12.5 Sources of Radioactive Contamination

### Sources of Radioactive Contamination

Click on the buttons on the right to learn about sources of radioactive contamination.



- Leaks in systems w/ radioactive liquid
- Debris from beamline enclosure
- Operations on activated materials
- Leaks from radioactive sources

The slide features a central photograph of a laboratory or industrial environment filled with various pieces of equipment, including a large cylindrical tank and several smaller containers. To the right of the photo are four blue buttons, each with a white circle and text describing a source of contamination. The buttons are arranged vertically and are currently inactive.



## Leaks in systems with radioactive Liquid (Slide Layer)

**Sources of Radioactive Contamination**

Leaks or breaks in systems containing radioactive liquids (e.g. vacuum pumps or water systems).

- Leaks in systems w/ radioactive liquid
- Debris from beamline enclosure
- Operations on activated materials
- Leaks from radioactive sources

## Debris from beamline enclosure (Slide Layer)

**Sources of Radioactive Contamination**

Dust, debris, grease, dirt, and oil within or from a beam/beamline enclosure because it may have become activated.

- Leaks in systems w/ radioactive liquid
- Debris from beamline enclosure
- Operations on activated materials
- Leaks from radioactive sources

## Operations on activated materials (Slide Layer)

**Sources of Radioactive Contamination**

Certain operations, such as grinding, cutting, or welding on Class 3 or higher activated materials.

- Leaks in systems w/ radioactive liquid
- Debris from beamline enclosure
- Operations on activated materials
- Leaks from radioactive sources

## Leaks from radioactive sources (Slide Layer)

**Sources of Radioactive Contamination**


Leakage of or damage to radioactive sources.

- Leaks in systems w/ radioactive liquid
- Debris from beamline enclosure
- Operations on activated materials
- Leaks from radioactive sources

## 12.7 Contamination Control

Contamination Control

Click on the buttons on the right to learn about contamination control.



- Understand and Comply with work controls
- Use good work practices
- Identify and report radiological leaks

### Understand and comply (Slide Layer)

Contamination Control

Understand and comply with the radiological work controls, including:

- Protective clothing,
- Respiratory equipment,
- Containment devices,
- Frisking requirements when working in a posted Contamination Area

- Understand and Comply with work controls
- Use good work practices
- Identify and report radiological leaks

## Good work practices (Slide Layer)

**Contamination Control**

Use good work practices such as good housekeeping and cleaning up after jobs.

- Understand and Comply with work controls
- Use good work practices
- Identify and report radiological leaks

This slide features a light gray background with a blue rounded rectangle on the left containing the main text. To the right, three blue horizontal bars with white circular icons on the left contain the list items. A small icon is in the top right corner.

## Identify and report leaks (Slide Layer)

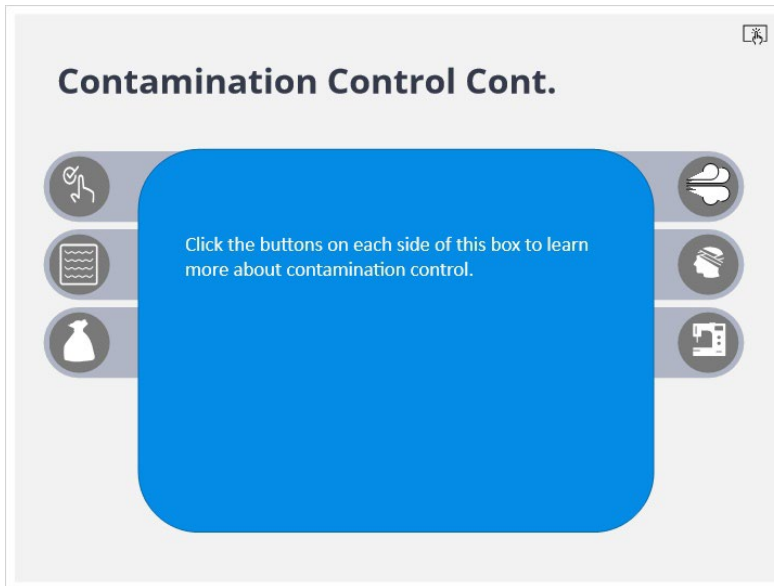
**Contamination Control**

Identify and report leaks in radiological systems before they become a serious problem.

- Understand and Comply with work controls
- Use good work practices
- Identify and report radiological leaks

This slide features a light gray background with a blue rounded rectangle on the left containing the main text. To the right, three blue horizontal bars with white circular icons on the left contain the list items. A small icon is in the top right corner.

## 12.8 Contamination Control Cont.



### Avoid unnecessary contact (Slide Layer)



## Place tools in bag (Slide Layer)

Contamination Control Cont.

Place contaminated tools, equipment, etc. inside bags when work is finished.



## Avoid stirring up (Slide Layer)

Contamination Control Cont.

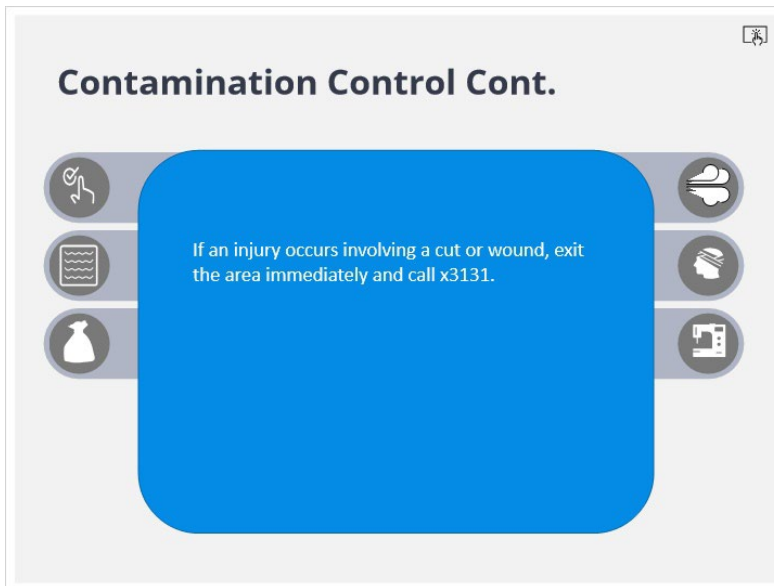
Avoid stirring up contamination because it could become airborne.



## Avoid injury (Slide Layer)

Contamination Control Cont.

If an injury occurs involving a cut or wound, exit the area immediately and call x3131.

A slide layer titled "Contamination Control Cont." with a central blue rounded rectangle containing the text "If an injury occurs involving a cut or wound, exit the area immediately and call x3131." The slide is surrounded by a grey border with six circular icons: a person falling, a person with a cut, a person with a headache, a person with a cough, a person with a stomach ache, and a person with a fever.

## No machining (Slide Layer)

Contamination Control Cont.

No machining of radioactive material is allowed without prior assigned RSO approval.

A slide layer titled "Contamination Control Cont." with a central blue rounded rectangle containing the text "No machining of radioactive material is allowed without prior assigned RSO approval." The slide is surrounded by a grey border with six circular icons: a person falling, a person with a cut, a person with a headache, a person with a cough, a person with a stomach ache, and a person with a fever.

## Perform before removing (Slide Layer)


### Contamination Control Cont.

Make sure that required contamination surveys are performed before removing items from posted Contamination areas.

## 12.10 Source Reduction

### Source Reduction

- Minimize the production of contamination and reduce the levels of contamination prior to work.
- Final clean up of beamline enclosures at the end of a shut down.
- Magnets are wiped down, floors are cleaned, and other general cleaning is done to minimize the amount of dust and debris that may be activated once the beam is running again.





## 12.11 Selecting and Putting on Protective Clothing

Selecting and Putting on Protective Clothing


Click the buttons on the right to learn about selecting and putting on protective clothing.

- RSD/RCT will provide instructions
- Check for tears
- No order for donning
- Supplemental dosimeters

### RSD/RCT will provide instructions (Slide Layer)

Selecting and Putting on Protective Clothing

Specified in the applicable RWP or the assigned RSO or the RCT assigned to cover the job will provide instructions.




- RSD/RCT will provide instructions
- Check for tears
- No order for donning
- Supplemental dosimeters

## Check for tears (Slide Layer)

Selecting and Putting on Protective Clothing


Check clothing for rips and tears. Replace if necessary.



- RSO/RCT will provide instructions
- Check for tears
- No order for donning
- Supplemental dosimeters

## No order (Slide Layer)


Selecting and Putting on Protective Clothing



There is no particular order for putting on protective clothing.


- RSO/RCT will provide instructions
- Check for tears
- No order for donning
- Supplemental dosimeters

## Supplemental dosimeters (Slide Layer)




### Selecting and Putting on Protective Clothing

Dosimetry badges and supplemental pocket or electronic dosimeters should be placed on the outside of the protective clothing so that you can access them.









- RSO/RCT will provide instructions
- Check for tears
- No order for donning
- Supplemental dosimeters






## 12.12 Conducting a Whole-Body Frisk



### Conducting a Whole Body Frisk

Click the buttons on each side of this box to learn about conducting a whole body frisk.

## Verify (Slide Layer)

### Conducting a Whole Body Frisk

Before you begin, verify that:

- the frisker is turned on
- the frisker appears to be functioning properly
- the frisker is within calibration
- the frisker set to the proper scale (x1 scale)
- audio output can be heard




The slide features a central blue rounded rectangle containing a list of verification steps and a small inset photograph. The photograph shows a hand pointing at a control panel with various buttons and a small display. The slide is framed by a light gray border with several circular icons on the left and right sides, including a person, a hand, a clock, and a person with a checkmark.

## If not functioning (Slide Layer)

### Conducting a Whole Body Frisk

If the instrument does not appear to be functioning properly or is not in calibration, contact your assigned RSO.



The slide features a central blue rounded rectangle containing a text instruction. The slide is framed by a light gray border with several circular icons on the left and right sides, including a person, a hand, a clock, and a person with a checkmark. A small icon in the top right corner of the slide area indicates a warning or error.

## Frisk Gloved Hand (Slide Layer)

**Conducting a Whole Body Frisk**

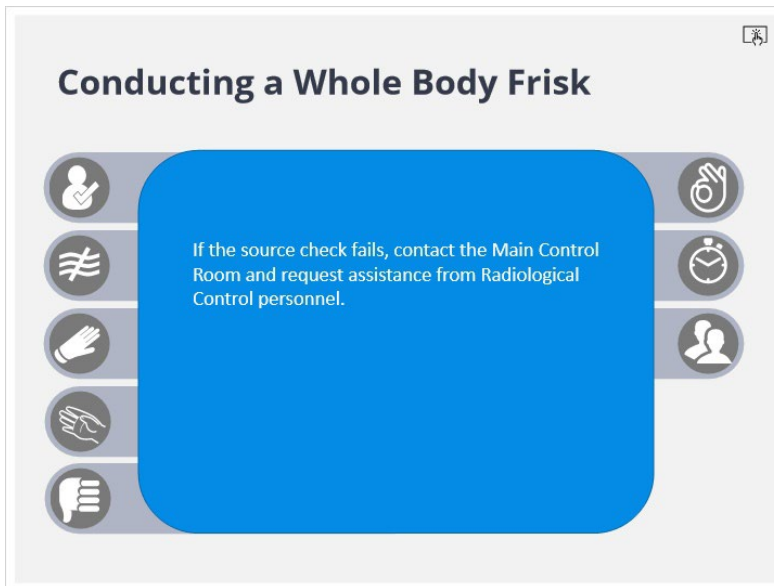
Frisk your gloved hands before picking up the probe. If your gloves are contaminated, remove gloves and all other protective clothing and dispose of it properly.

## Frisk bare hand (Slide Layer)

**Conducting a Whole Body Frisk**

Frisk your bare hands. After frisking your bare hands, source check the instrument.

## IF check fails (Slide Layer)

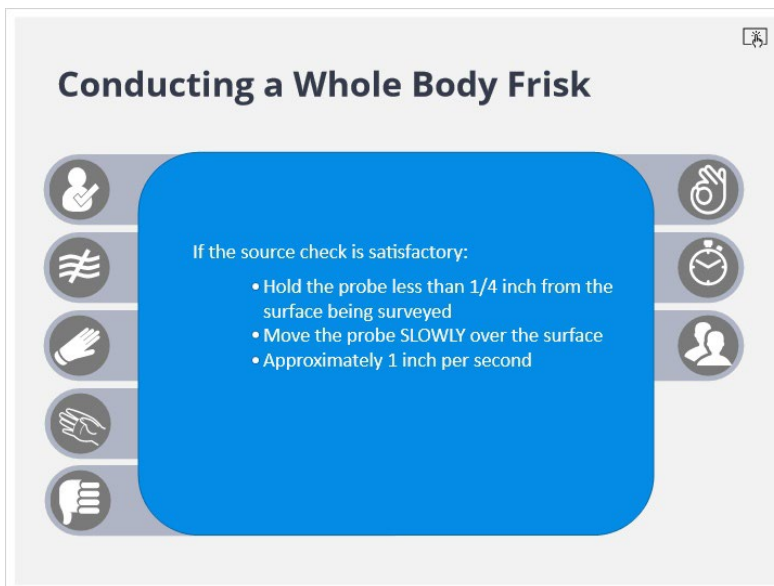


**Conducting a Whole Body Frisk**

If the source check fails, contact the Main Control Room and request assistance from Radiological Control personnel.

The slide features a central blue rounded rectangle containing the text. It is flanked by two vertical columns of five circular icons each. The left column icons, from top to bottom, are: a person with a checkmark, a crossed-out symbol, a hand, a hand with a checkmark, and a hand with a checkmark. The right column icons, from top to bottom, are: a hand with a checkmark, a clock, a person, a person, and a person. A small square icon with a checkmark is in the top right corner.

## If check is satisfactory (Slide Layer)



**Conducting a Whole Body Frisk**

If the source check is satisfactory:

- Hold the probe less than 1/4 inch from the surface being surveyed
- Move the probe SLOWLY over the surface
- Approximately 1 inch per second

The slide features a central blue rounded rectangle containing the text and a bulleted list. It is flanked by two vertical columns of five circular icons each, identical to the first slide. A small square icon with a checkmark is in the top right corner.

## Takes 3-5 minutes (Slide Layer)

Conducting a Whole Body Frisk

A whole body frisk should take AT LEAST 3 to 5 minutes.



The slide features a central blue rounded rectangle containing the text. To the right of this rectangle is a photograph of a yellow metal cart with a white electronic device on top, connected to various cables and a wall-mounted unit. The slide is framed by a light gray border with a small icon in the top right corner. On the left and right sides of the slide, there are vertical columns of six circular icons each, representing different aspects of the process or equipment.

## Working with others (Slide Layer)

Conducting a Whole Body Frisk

If you are working with another person, help each other by surveying each other's shoe bottoms.

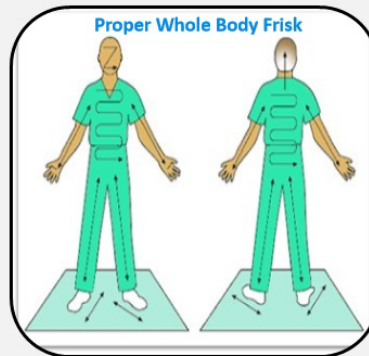
The slide features a central blue rounded rectangle containing the text. The slide is framed by a light gray border with a small icon in the top right corner. On the left and right sides of the slide, there are vertical columns of six circular icons each, representing different aspects of the process or equipment.

## 12.14 Conducting a Whole Body Frisk Cont.

### Conducting a Whole Body Frisk

Perform a whole body frisk in order shown on the right pausing at places that may have come in contact with contamination. If the count rate increases during frisking, pause over the area to provide adequate time for the instrument to respond.

1. Dosimetry & keys
2. Head
3. Neck and shoulders
4. Arms
5. Chest and abdomen
6. Back, hips, seat of pants
7. Legs
8. Shoe tops
9. Shoe bottoms
10. Personal belongings including hard hat, if applicable



## 12.15 Conducting a Whole Body Frisk Cont.

### Conducting a Whole Body Frisk

- If you are performing a frisk after removing your protective clothing and the Frisker reads equal to or greater than 100 cpm above background, you are contaminated.
- Minimize your movements to reduce the spread of contamination, and call or have someone call X3131.
- If during the frisk of your personal belongings, the Frisker reads equal to or greater than 50 cpm above background, contact your assigned RSO for further instructions.






## 12.17 Other Frisking Considerations

### Other Frisking Considerations

Click the buttons on each side of this box to learn about other frisking conditions.



The image shows a medical device, likely a defibrillator or ECG monitor, with a yellow top and white front panel. The number '86' is printed on the front. It is connected to several cables. In the background, a red 'FIRE' sign is visible.

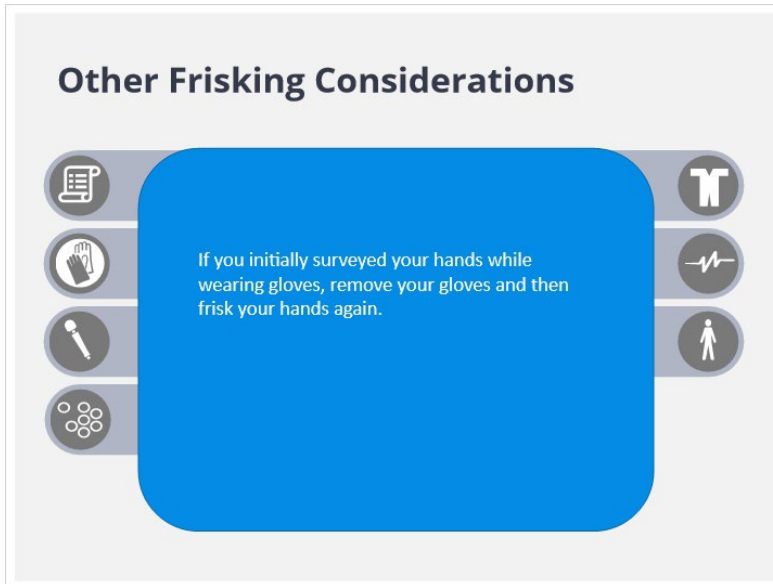
## Follow posted instructions (Slide Layer)

### Other Frisking Considerations

If you are not required to perform a whole body frisk at the exit, follow the posted instructions.

## Remove gloves (Slide Layer)

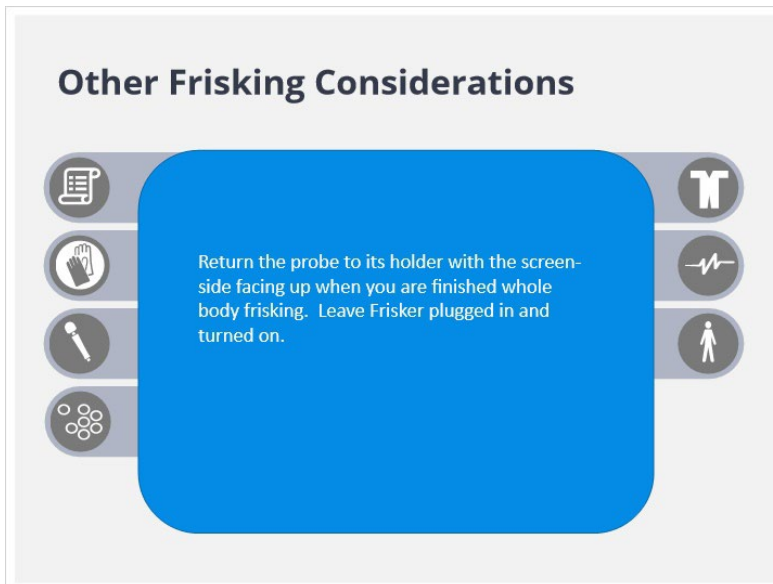
**Other Frisking Considerations**



If you initially surveyed your hands while wearing gloves, remove your gloves and then frisk your hands again.

## Return probe (Slide Layer)

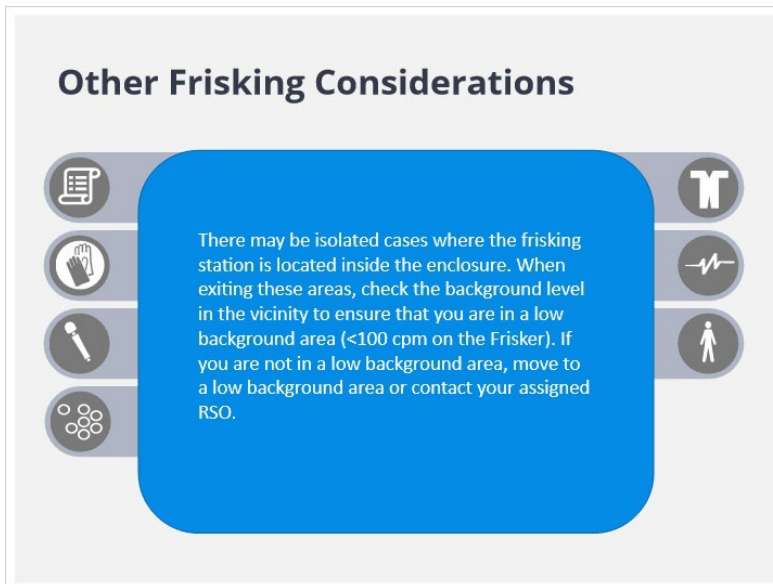
**Other Frisking Considerations**



Return the probe to its holder with the screen-side facing up when you are finished whole body frisking. Leave Frisker plugged in and turned on.

## Isolated cases (Slide Layer)

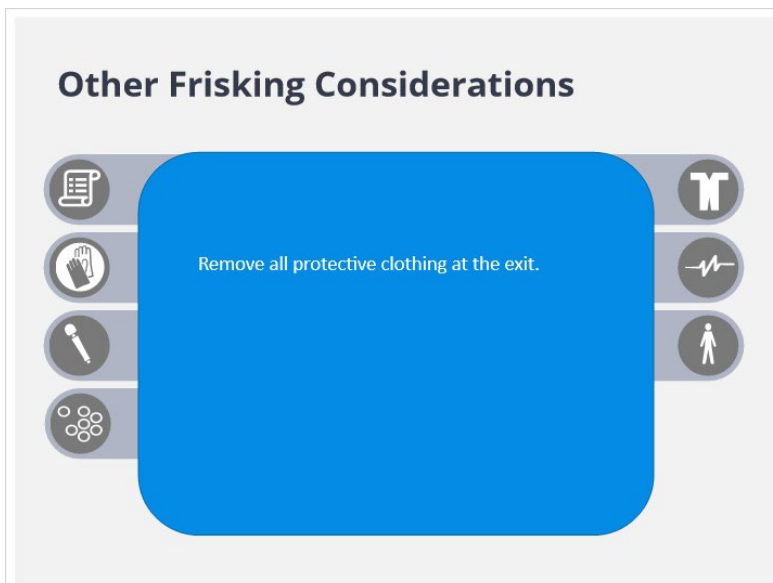
### Other Frisking Considerations



There may be isolated cases where the frisking station is located inside the enclosure. When exiting these areas, check the background level in the vicinity to ensure that you are in a low background area (<100 cpm on the Frisker). If you are not in a low background area, move to a low background area or contact your assigned RSO.

## Remove protective clothing (Slide Layer)

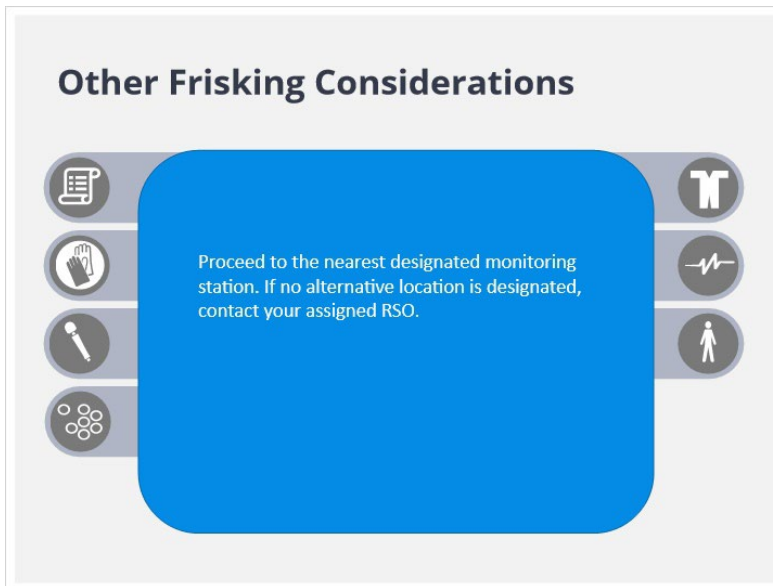
### Other Frisking Considerations



Remove all protective clothing at the exit.

## Proceed to monitoring station (Slide Layer)

### Other Frisking Considerations



Proceed to the nearest designated monitoring station. If no alternative location is designated, contact your assigned RSO.

This slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with seven circular icons: a checklist, gloves, a pipette, bubbles, a T-shirt, a pulse line, and a person silhouette.

## Conduct frisk (Slide Layer)

### Other Frisking Considerations



Conduct your frisk.

This slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with seven circular icons: a checklist, gloves, a pipette, bubbles, a T-shirt, a pulse line, and a person silhouette.

## 12.18 Disposal of Protective Clothing

**Disposal of Protective Clothing**


Click the buttons on the right to learn about the disposal of protective clothing.

- If there is no contamination
- Clothing exceeds 50 cpm
- Whole body frisk

### If there is no contamination (Slide Layer)

**Disposal of Protective Clothing**

If clothing has no contamination, dispose of it in the regular trash.



- If there is no contamination
- Clothing exceeds 50 cpm
- Whole body frisk

## Clothing exceeds 50 cpm (Slide Layer)

**Disposal of Protective Clothing**

If any portion of the protective clothing exceeds 50 cpm above background, remove it in a manner that will minimize the spread of contamination and prevent you from becoming contaminated.

In this case, all of your protective clothing needs to be disposed of in a radioactive waste container unless instructed otherwise.

- If there is no contamination
- Clothing exceeds 50 cpm
- Whole body frisk



## Whole body frisk (Slide Layer)

**Disposal of Protective Clothing**

You will be required to perform a whole body frisk upon its removal.

- If there is no contamination
- Clothing exceeds 50 cpm
- Whole body frisk



## 12.19 Frisking Procedure When No Protective Clothing is Worn

### Frisking Procedure When No Protective Clothing is Worn



- Instrument checks are the same as for a frisk when wearing protective clothing.
- At a minimum, frisk your hands and shoe bottoms.
- Frisk other areas of your body which may have come in contact with surfaces while inside the enclosure.
- Frisk your hard hat, if applicable.

## 13. Radiological Work Permits

### 13.1 Radiological Work Permits (RWPs)

## 12 Radiological Work Permits (RWPs)

## 13.2 Radiological Work Permits (RWPs)

### Radiological Work Permits (RWPs)

The purpose of an RWP is to:

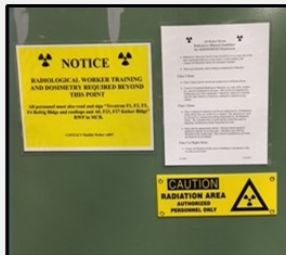
- To inform workers of radiological conditions in the area.
- To inform workers of entry requirements into the areas.
- Be posted at the area access point or where keys are obtained.



## 13.3 Radiological Work Permits (RWPs) Cont.

### Radiological Work Permits (RWPs)

Circumstances Requiring an RWP include:



- Entry and work in certain posted radiological areas.
- Handling of materials with removable contamination exceeding the specified limits.



# 13.4 Information Included in RWPs

## Information Included in RWPs

**Information on a RWP includes:**

- Unique identifying number
- Work location
- Permit type
- General RWP: Routine or repetitive activities in areas with well characterized and stable radiological conditions
- Job Specific RWP: Non-routine work or work in areas with changing radiological conditions
- Date of issue and expiration
- Description of work
- Access type
- Work area conditions

[Click to see more](#)

Click the RWP above to see a larger version of it.

## Large RWP (Slide Layer)

**Fermilab** Division: AD

**Radiological Work Permit No. AD-18-101**

**MI Collimator** RWP State

Access Name: \_\_\_\_\_

Expiration Date: Dec 31, 2018

Permit Type: Job-Specific

Issue Date: Sep 18, 2018

Issue Time: 10:18 AM

Expiration Date: Dec 31, 2018

---

**Description of Work**  
Reposition and repair of the collimators 301, 302, 307 and 308 per attached ALARA plan(s).

**Basic Work Area Conditions**  
Poor lighting - bring supplemental lighting

**Time Limits**  
None

**Dosimetry Requirements**  
 None Required  
 Dosimetry Badge  
 Pocket Dosimeter  
 Ring Badge  
 See Special Requirements

**Portable Survey Instruments**  
 None Required  
 LSM  
 Ludlum 14C  
 E140N/Portable Frisker  
 Minimeter  
 Telelector  
 Bicon Analyst  
 See Special Requirements

**SPECIAL REQUIREMENTS**  
This is a long term work and will consist of multiple ALARA plans. Please follow job specific ALARA plan for each step. Work steps of collective dose as per each ALARA plan. RSO or designee approval required before processing if work is stopped. Radiation Safety group (RTSG) will conduct radiation surveys as necessary, will provide supplemental dosimetry as needed and provide instructions for placement. RCT (s) will be tracking the dose for every person that works on the collimator and make sure the quarterly limit will not be exceeded without RSO approval. Take precautions to prevent the spread of contamination. PPE may be waived based on contamination survey results, however, specific steps might require additional PPE - wear PPE as directed by the RCT. All activated components are assumed to be contaminated.

Prepared By: Nino Chelidze

RSO Authorization  
*N. Chelidze*

**Access Type**  
 Controlled Access  
 Supervised Access  
 Open Access  
 Other - Secured Area  
 N/A

**Area Posting**  
1. High Radiation Area  
2. Potential Contamination Area  
3.

**Work Documents**  
see attached job plan(s)  
HA when applicable

**Basic Training Requirements**  
None

**Other Training Requirements**  
None


**Minimum Personal Protective Equipment**  
 None Required  
 Gloves  
 Shoe covers  
 Labcoats  
 Coveralls  
 Hood  
 Eye Protection  
 Respiratory Protection  
 See attached instructions  
 See special requirements

**Additional Instructions**  
 Notify ESH&Q Prior to Work  
 Rad Tech Coverage Required  
 Review Survey Map  
 Pre-Job Briefing  
 Personal Frisk on Exit  
 Survey & Label Materials on Exit  
 Post-Job De-Briefing  
 No Eating, Drinking, Smoking  
 See Special Requirements

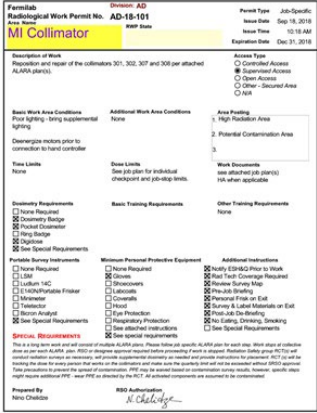
[Back to page](#)

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## More information (Slide Layer)



### Information Included in RWPs



**Information on an RWP includes:**

- Time limits and dose limits
- Work documents
- Dosimetry requirements
- Training requirements for entry
- Portable survey instrumentation
- Protective clothing and equipment requirements
- Additional instructions
- Survey maps showing specific area dose rates, locations of "hot spots", and levels of contamination in the vicinity
- Special requirements including, in some instances, protective measures against other hazards
- Authorizing signatures

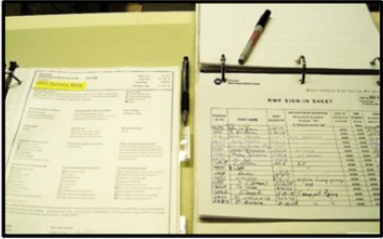
[Go Back](#)

Click the RWP above to see a larger version of it.

## 13.6 Worker Responsibilities

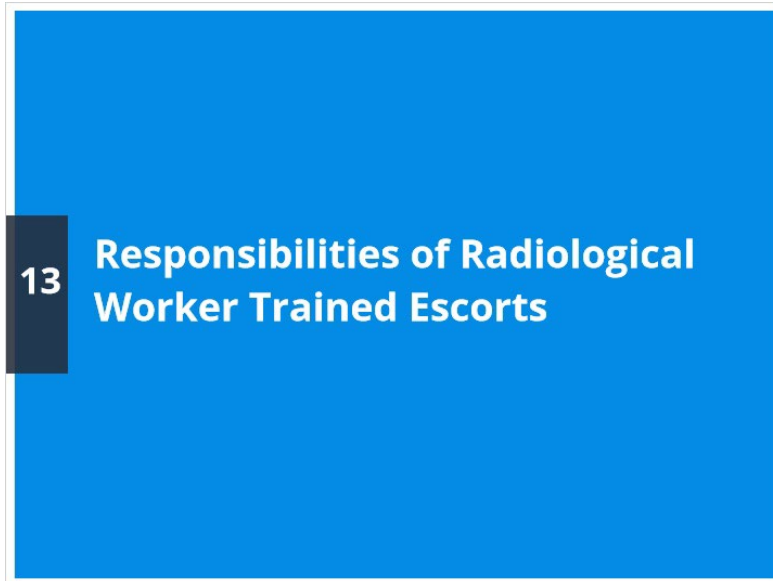
### Worker Responsibilities

- Read and sign the RWP. This indicates one has read and understands the requirements of the RWP.
- Obey the instructions on the RWP.
- If you do not understand any part of the RWP, contact your supervisor or assigned RSO.



## 14. Responsibilities of Radiological Worker Trained Escorts

### 14.1 Radiological Work Permits (RWPs)



### 14.2 Responsibilities of Radiological Worker Trained Escorts



## Radiation Safety Briefing (Slide Layer)

**Responsibilities of Radiological Worker Trained Escorts**

As provided by the RSO, attend radiation safety briefing with the untrained individual(s) and sign the radiation safety briefing form to acknowledge that they are the designated escort for the named individual(s)

Safety Briefing

Inform

Continuous Supervision

Review Requirements

Ensure Requirements

Assist with frisk

Provide badges / cards

## Provide continuous supervision (Slide Layer)

**Responsibilities of Radiological Worker Trained Escorts**

Provide continuous supervision of untrained individual(s) and limit the work to stay within the scope of the work plan

Safety Briefing

Inform

Continuous Supervision

Review Requirements

Ensure Requirements

Assist with frisk

Provide badges / cards

## Provide Badges/Cards (Slide Layer)

**Responsibilities of Radiological Worker Trained Escorts**

Provide dosimetry badges and pocket dosimeters/pocket dosimeter cards to untrained individual(s).

- Safety Briefing
- Inform
- Review Requirements
- Assist with frisk
- Provide badges / cards
- Ensure Requirements
- Continuous Supervision
- Inform

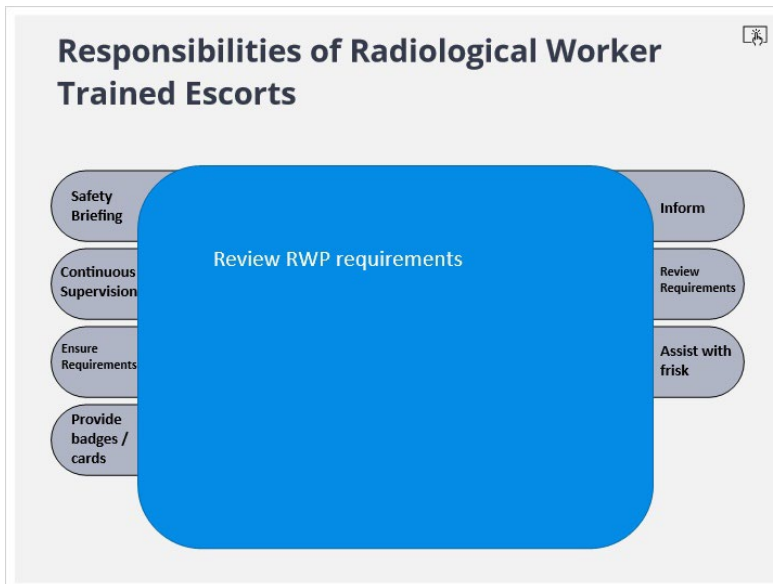
## Inform about postings (Slide Layer)

**Responsibilities of Radiological Worker Trained Escorts**

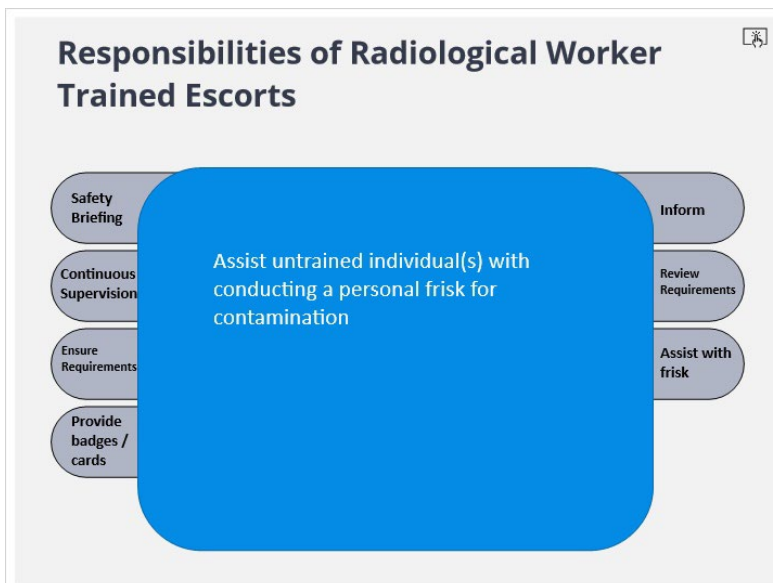
Inform untrained individual(s) of area radiological conditions including radiological postings and dose rates.

- Safety Briefing
- Inform
- Review Requirements
- Assist with frisk
- Provide badges / cards
- Ensure Requirements
- Continuous Supervision
- Inform

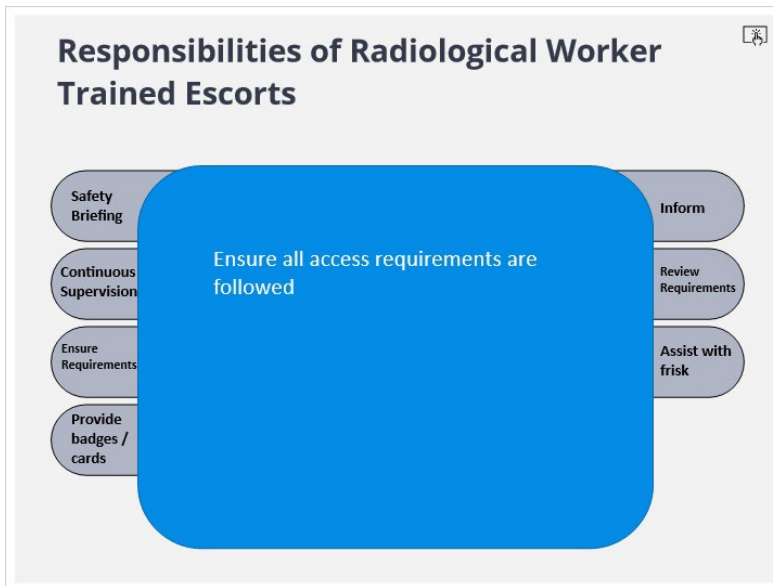
## Review Requirements (Slide Layer)



## Assist with frisk (Slide Layer)

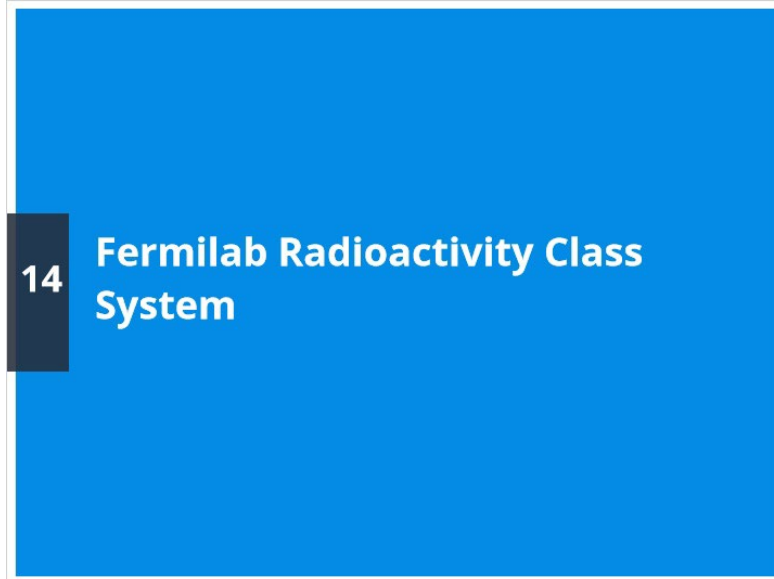


## Ensure Requirements (Slide Layer)



## 15. Fermilab Radioactivity Class System


### 15.1 Fermilab Radioactivity Class System



### 15.2 Fermilab Radioactivity Class System

**Fermilab Radioactivity Class System**

- Activated material is classified by external exposure rate.
- The appropriate class label needs to be affixed when an item is removed from an enclosure or when it is disassembled.
- Check items when practical and, if warranted, reclassify. Remove labels when item is no longer radioactive. Questions should be directed to your assigned RSO.



The image shows three items related to the Fermilab Radioactivity Class System. At the top is a yellow rectangular label for 'CLASS 1' with the text 'CAUTION RADIOACTIVE MATERIAL' and a radiation symbol. Below it is a similar yellow label for 'CLASS 2'. At the bottom is a photograph of a metal container with a yellow 'CLASS 2' label affixed to it.



## 15.3 Radioactivity Class Labels

Class Label	Exposure Rate (mR/hr @ 1 ft.)	
	At Least	Less Than
CAUTION: RADIOACTIVE MATERIAL CLASS 1	<ul style="list-style-type: none"><li>50 cpm above background* on a Frisker OR</li><li>2000 cpm above background* on a Bicon Analyst**, if background is 2000-3000 cpm OR</li><li>Count rate* is equal to or greater than twice the mean background rate in a low background area (&lt; 2000 cpm)</li></ul>	1 mR/hr
CAUTION: RADIOACTIVE MATERIAL CLASS 2	1	10 mR/hr
CAUTION: RADIOACTIVE MATERIAL CLASS 3	10	100 mR/hr
DANGER: RADIOACTIVE MATERIAL CLASS 4	100	1000 mR/hr (= 1 R/hr)
DANGER: HIGHLY RADIOACTIVE MATERIAL CLASS 5	1 R/hr	—

## 16. Radioactive Material Surveying and Labeling

### 16.1 Radioactive Material Surveying and Labeling



## 16.2 Radioactive Material Surveying & Labeling

Radioactive Material Surveying & Labeling

Survey all items coming out of radiological areas.  
Frisk yourself first, then the materials.



The image shows a hand holding a survey instrument probe over a piece of equipment. The equipment has a dial and a meter, and the number '124' is visible on its front panel. The background is a plain wall.

### Verify (Slide Layer)

Radioactive Material Surveying & Labeling

Verify that the survey instrument is on, appears to be functioning properly, and is not obviously damaged.




The image shows a hand touching the survey instrument probe. The probe is connected to a device, and the hand is positioned to check the instrument's status. The background is a plain wall.

## Set to proper scale (Slide Layer)

Radioactive Material Surveying & Labeling

Set to the proper scale (x1) and ensure that the audio output can be heard.



The image shows a close-up of a Geiger counter's control panel. A hand is turning a black knob labeled 'X1 X10 X100'. To the left of the knob is a red light and the number '124'. To the right is a circular scale with a needle. The device is labeled 'MODEL 177-4'.

## Verify calibration (Slide Layer)

Radioactive Material Surveying & Labeling

Verify that the instrument is within its calibration period.




The image shows a hand pointing to a white calibration label on a Geiger counter. The label has a radiation symbol and some text, including 'CALIBRATION'. The device is a handheld unit with a probe.

## Check background level (Slide Layer)

**Radioactive Material Surveying & Labeling**

Check background levels to ensure that you are in a low background area. If the background count rate is greater than 100 cpm on a Frisker, contact the assigned RSO.



The image shows a close-up of a radiation detector's control panel. A hand is pointing to the needle on a circular scale. The scale has markings from 0 to 100. The needle is positioned at approximately 20. The panel also features a red emergency stop button, a power switch, and a digital display showing '124'. The device is labeled '124'.

## Frisk your hand (Slide Layer)

**Radioactive Material Surveying & Labeling**

Frisk your hands before picking up the probe.



The image shows a hand being held over a radiation detector probe. The probe is a handheld device with a rectangular head and a handle. The hand is positioned just above the probe's head. The detector is labeled '124'.

## Response check (Slide Layer)

**Radioactive Material Surveying & Labeling**

Perform a response check by using the radioactive source mounted on the instrument.



The slide features a central blue rounded rectangle containing a photograph of a person's hand holding a handheld radiation detector against a piece of equipment. The equipment has a dial and a small display. The slide is framed by a light gray border with a series of navigation icons on the left and right sides, including a person with a checkmark, a square with an arrow, a target, a square with dots, a hand, a refresh arrow, a cross, a U-shaped arrow, and a radiation symbol.

## Source check fails (Slide Layer)

**Radioactive Material Surveying & Labeling**

If the source check fails, contact the Main Control Room and request assistance from Radiological Control personnel.



The slide features a central blue rounded rectangle containing a photograph of a radiation warning sign. The sign is white with black text and a radiation symbol. The text on the sign reads: "CHECK SOURCE MUST READ", "90 to 130 CPM", "Over Background", and "In a Background of  $\leq 100$ ". The slide is framed by a light gray border with a series of navigation icons on the left and right sides, including a person with a checkmark, a square with an arrow, a target, a square with dots, a hand, a refresh arrow, a cross, a U-shaped arrow, and a radiation symbol.

## Hold the probe (Slide Layer)

**Radioactive Material Surveying & Labeling**

Hold the probe less than 1/4 inch from the surface being surveyed.

Move the probe SLOWLY (no faster than 1 inch per second) over the item to allow the detector to respond.

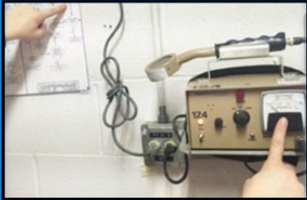
All accessible surfaces need to be surveyed.

## Reads over 50 (Slide Layer)

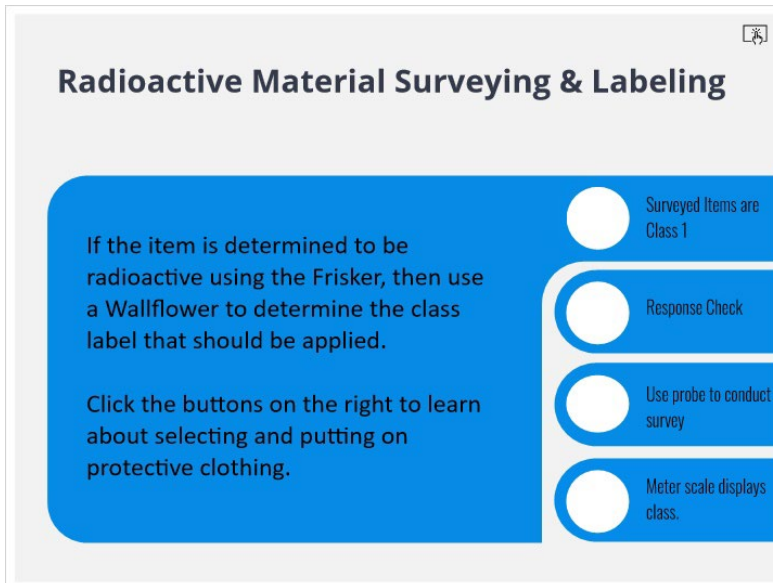
**Radioactive Material Surveying & Labeling**

If the Frisker reads more than 50 cpm above the background level at any time during your survey, the item is considered to be radioactive. It's important to note that one does not need final reading on Frisker.

Always assume the instrument reading is correct.



## 16.4 Radioactive Material Surveying & Labeling



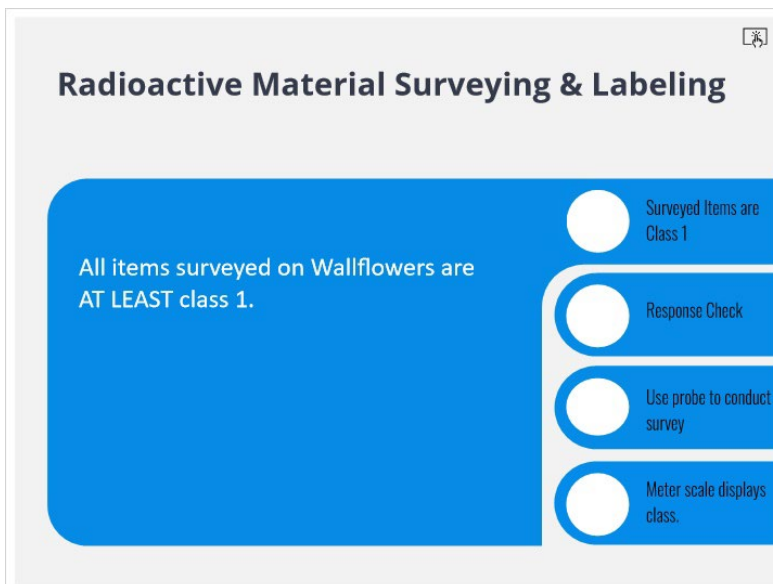
**Radioactive Material Surveying & Labeling**

If the item is determined to be radioactive using the Frisker, then use a Wallflower to determine the class label that should be applied.

Click the buttons on the right to learn about selecting and putting on protective clothing.

- Surveyed Items are Class 1
- Response Check
- Use probe to conduct survey
- Meter scale displays class.

### Items surveys (Slide Layer)



**Radioactive Material Surveying & Labeling**

All items surveyed on Wallflowers are AT LEAST class 1.

- Surveyed Items are Class 1
- Response Check
- Use probe to conduct survey
- Meter scale displays class.

## Response check (Slide Layer)

**Radioactive Material Surveying & Labeling**

Perform a response check by using the radioactive source mounted on the instrument.



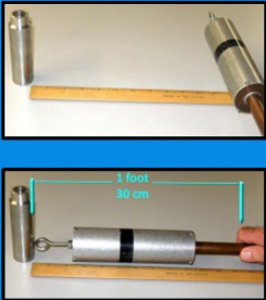
Black Band centered on top of Source Check

- Surveyed Items are Class 1
- Response Check
- Use probe to conduct survey
- Meter scale displays class.

## Use probe to conduct survey (Slide Layer)

**Radioactive Material Surveying & Labeling**

Use the probe in a vertical position at a distance of 1 foot to conduct survey. Survey the spot on the item which has the highest reading from the Frisker survey. Use the probed sideways (at 90 degrees).




- Surveyed Items are Class 1
- Response Check
- Use probe to conduct survey
- Meter scale displays class.



## Meter scale displays class (Slide Layer)

### Radioactive Material Surveying & Labeling

The meter scale displays Class 1, Class 2, and Class 3. The needle will indicate the correct Class label to affix to the item being surveyed.




- Surveyed Items are Class 1
- Response Check
- Use probe to conduct survey
- Meter scale displays class.

## 16.5 Radioactive Material Surveying & Labeling Cont.

### Radioactive Material Surveying & Labeling

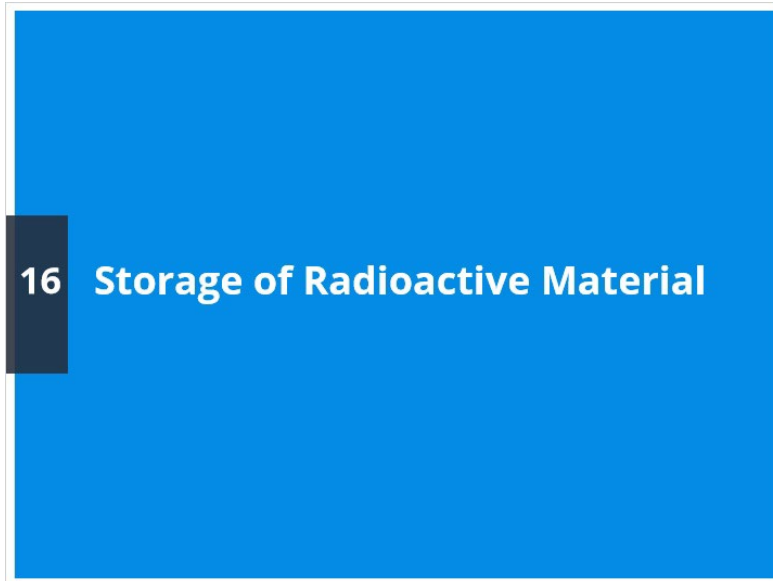
If the item is determined to be radioactive using the Frisker, then use a Wallflower to determine the class label that should be applied.

- Complete all information on the label:
  - Date
  - Exposure rate at 1 foot (30cm)
  - Your Fermilab ID number
- If any material is determined to be Class 2 or greater, contact the assigned RSO or RCT for additional instructions.



## 17. Storage of Radioactive Material

### 17.1 Storage of Radioactive Material




### 17.2 Storage of Radioactive Material Cont.



## Determine value (Slide Layer)

### Storage of Radioactive Material

Determine "value" of material to be stored. Consider future usefulness of material when determining value. Disposal or decontamination is the preferred alternative to storage.




Navigation icons: Home, Back, Forward, Search, Refresh, and a small icon in the top right corner.

## Store in designated areas (Slide Layer)

### Storage of Radioactive Material

Radioactive materials should only be stored in designated areas which have been approved by the assigned Radiation Safety Officer (RSO).




Navigation icons: Home, Back, Forward, Search, Refresh, and a small icon in the top right corner.

## Items must be surveyed (Slide Layer)

Storage of Radioactive Material

Prior to long-term storage, all items must be surveyed.



The slide features a central blue rounded rectangle containing the text and a photograph. The photograph shows a person in a white protective suit and a yellow hard hat standing next to several blue metal shelving units in a storage facility. The slide is surrounded by a grey border with a navigation menu on the left and right sides, and a small icon in the top right corner.

## Store in a manner (Slide Layer)

Storage of Radioactive Material

Store in a manner that reduces combustible loading.




The slide features a central blue rounded rectangle containing the text and an aerial photograph. The photograph shows a large industrial or storage facility with many buildings and parking lots. The slide is surrounded by a grey border with a navigation menu on the left and right sides, and a small icon in the top right corner.

## Outdoor storage (Slide Layer)

Storage of Radioactive Material

Outdoor storage of radioactive material requires assigned RSO approval.



Navigation icons: Home, Back, Forward, Search, Refresh, Print, Close.

## Not stored off-site (Slide Layer)

Storage of Radioactive Material

Radioactive material shall not be stored off-site.



Navigation icons: Home, Back, Forward, Search, Refresh, Print, Close.

## Not stored in housing (Slide Layer)

### Storage of Radioactive Material

Radioactive material shall not be stored in any on-site housing, eating and drinking areas, or office areas.



## 18. Transport of Radioactive Material

### 18.1 Transport of Radioactive Material

# 17 Transport of Radioactive Material

## 18.2 Transport of Radioactive Material

**Transport of Radioactive Material**

Click the buttons on each side of this box to learn about transporting radioactive material at Fermilab.



The image shows a silver pickup truck from a front-quarter perspective. The license plate is white with black text and the number '641-43429'. The truck is parked on a paved surface.

### Ensure (Slide Layer)

**Transport of Radioactive Material**

Ensure that radioactive materials have been properly labeled before transport.

## Confirm the receiver (Slide Layer)

Transport of Radioactive Material

Confirm that the receiver is allowed to receive the materials.

This slide features a central blue rounded rectangle containing the text 'Confirm that the receiver is allowed to receive the materials.' The slide is framed by a light gray border with a title 'Transport of Radioactive Material' at the top. On the left and right sides, there are vertical columns of circular icons: a checkmark, a speech bubble, a car, two arrows, and a back arrow on the left; and a document, a document with an 'x', a document with a magnifying glass, a person icon, and a truck icon on the right. A small icon in the top right corner indicates a slide layer.

## Do not transport in private vehicles (Slide Layer)

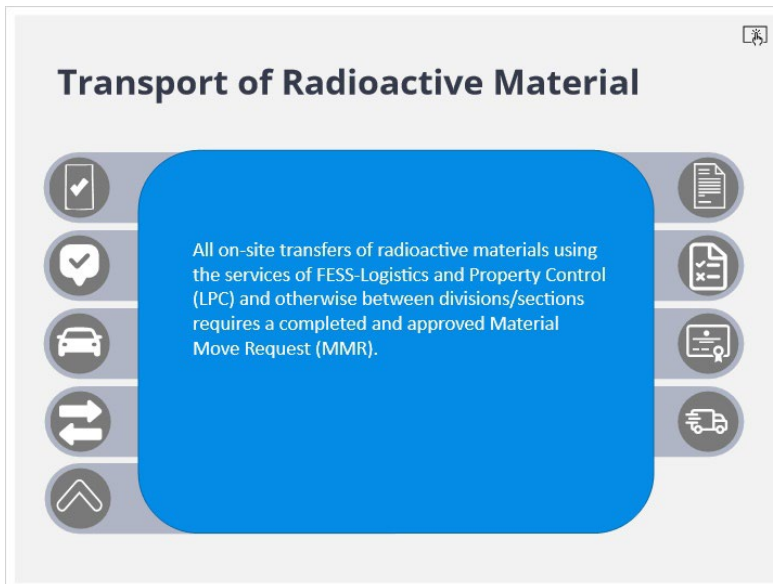
Transport of Radioactive Material

Do not transport radioactive material in private vehicles. Radioactive materials must be transported in government vehicles. Radioactive materials cannot be transported in Fermilab taxis.

This slide features a central blue rounded rectangle containing the text 'Do not transport radioactive material in private vehicles. Radioactive materials must be transported in government vehicles. Radioactive materials cannot be transported in Fermilab taxis.' Below the text is a photograph of a white van with a red prohibition sign (a circle with a diagonal slash) overlaid on it. The slide is framed by a light gray border with a title 'Transport of Radioactive Material' at the top. On the left and right sides, there are vertical columns of circular icons: a checkmark, a speech bubble, a car, two arrows, and a back arrow on the left; and a document, a document with an 'x', a document with a magnifying glass, a person icon, and a truck icon on the right. A small icon in the top right corner indicates a slide layer.



## On-site transfers (Slide Layer)

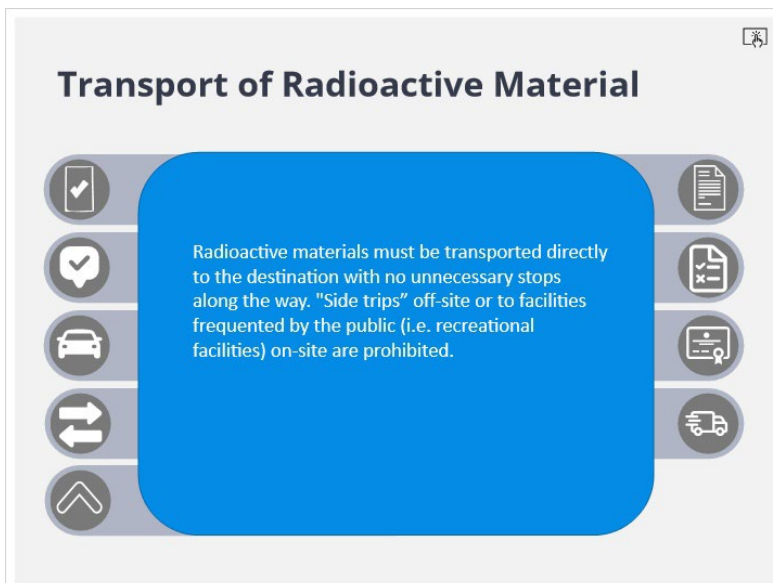


**Transport of Radioactive Material**

All on-site transfers of radioactive materials using the services of FESS-Logistics and Property Control (LPC) and otherwise between divisions/sections requires a completed and approved Material Move Request (MMR).

The slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with navigation icons: a checkmark, a speech bubble, a car, two arrows, a back arrow, a document, a document with a checkmark, a document with a magnifying glass, and a truck.

## Transport Directly (Slide Layer)



**Transport of Radioactive Material**

Radioactive materials must be transported directly to the destination with no unnecessary stops along the way. "Side trips" off-site or to facilities frequented by the public (i.e. recreational facilities) on-site are prohibited.

The slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with navigation icons: a checkmark, a speech bubble, a car, two arrows, a back arrow, a document, a document with a checkmark, a document with a magnifying glass, and a truck.

## MMR (Slide Layer)

### Transport of Radioactive Material

A Material Move Request must be completed when:

- Radioactive material is transported on-site between divisions/sections. FESS-LPC services are used to transport radioactive material.
- Radioactive material labeled Class 3 or higher is transported on-site (even if it remains within the same division/section). RCTs supervise transport of Class 3 or higher radioactive materials.
- Any radioactive material is transported off-site.

## Radiation Survey (Slide Layer)

### Transport of Radioactive Material


If the possibility exists that the material is radioactive, a radiation survey must be performed.



## Trained personnel (Slide Layer)

**Transport of Radioactive Material**

Only specially trained personnel can perform these surveys. Contact your assigned RSO if you have material which needs to be surveyed.



The slide features a central blue rounded rectangle containing text and an image of a Geiger counter. The text reads: "Only specially trained personnel can perform these surveys. Contact your assigned RSO if you have material which needs to be surveyed." The image shows a yellow and black Geiger counter with a circular dial and various cables. The slide is framed by a light gray border with a navigation menu on the left and right sides, and a small icon in the top right corner.

## Shipped Offsite (Slide Layer)

**Transport of Radioactive Material**

If the material is radioactive and is being shipped off-site, contact the ES&H Section Hazard Control Technology Team so that it can be packaged appropriately for transportation.



The slide features a central blue rounded rectangle containing text and an image of a truck. The text reads: "If the material is radioactive and is being shipped off-site, contact the ES&H Section Hazard Control Technology Team so that it can be packaged appropriately for transportation." The image shows a white truck with a large, dark, wrapped object on its flatbed. The slide is framed by a light gray border with a navigation menu on the left and right sides, and a small icon in the top right corner.

## 19. Moratorium on Metals Recycling

### 19.1 Moratorium on Metals Recycling



### 19.2 Moratorium on Metals Recycling

## Moratorium on Metals Recycling

All metals offered for recycling must be checked for radioactivity in accordance with Fermilab release criteria. All metals found to be radioactive must be disposed of as radioactive waste.


If the metals are found **not** to be radioactive, they may be offered for recycling. These metals must be physically segregated into two groups before FESS will pick them up:

Group 1

Group 2

Click the blue buttons above to see information about the groups.  
You must view both to advance in the training.

## Group 1 (Slide Layer)



### Moratorium on Metals Recycling

All metals offered for recycling must be checked for radioactivity in accordance with Fermilab release criteria. All metals found to be radioactive must be disposed of as radioactive waste.


If the metals are found **not** to be radioactive, they may be offered for recycling. These metals must be physically segregated into two groups before FESS will pick them up:

**Group 1**

Items that **did not** originate from a radiological area before being offered for recycling. FESS will proceed to recycle these items.

**Group 2**

## Group 2 (Slide Layer)



### Moratorium on Metals Recycling

All metals offered for recycling must be checked for radioactivity in accordance with Fermilab release criteria. All metals found to be radioactive must be disposed of as radioactive waste.

If the metals are found **not** to be radioactive, they may be offered for recycling. These metals must be physically segregated into two groups before FESS will pick them up:

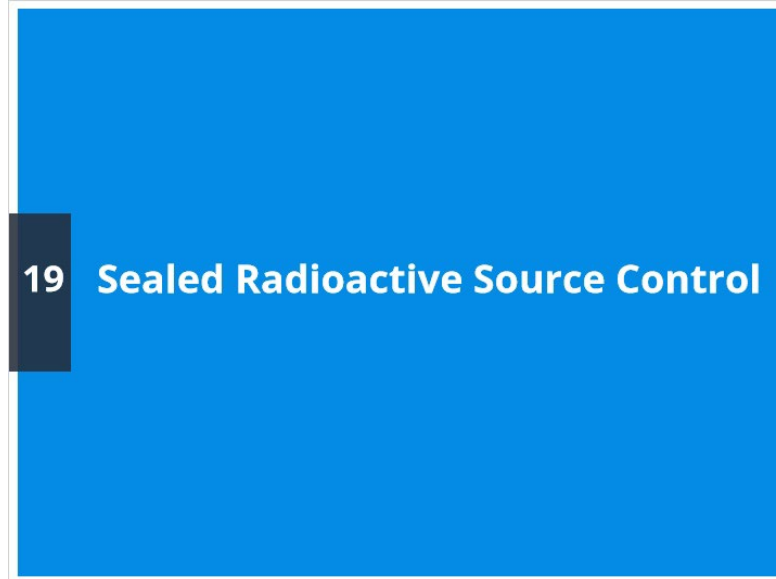
**Group 1**

**Group 2**

Items that **did** originate from a radiological area. These items will be stored pending further instructions from the DOE.

## 20. Sealed Radioactive Source Control





### 20.1 Sealed Radioactive Source Control



### 20.2 Sealed Radioactive Source Control

#### Sealed Radioactive Source Control

- Radioactive Source training is available online from the ES&H Section. Radiological Worker training is a prerequisite.
- Manufactured radioactive sources are to be used only by authorized individuals.
- Sources are not to be brought to or taken from Fermilab without advance approval from the Senior Radiation Safety Officer. This includes sources contained in instruments or equipment.



## 20.3 Typical Radioactive Source Configurations Used at Fermilab

### Typical Radioactive Source Configurations Used at Fermilab

Click the blue buttons below to view the different configurations at Fermilab.

- Wand Sources
- Beta Gun
- Disc Source
- Plastic Check Source


### Wand Sources (Slide Layer)

### Typical Radioactive Source Configurations Used at Fermilab

Click the blue buttons below to view the different configurations at Fermilab.

- Wand Sources
- Beta Gun
- Disc Source
- Plastic Check Source

**Wand Sources**




## Beta Gun (Slide Layer)

### Typical Radioactive Source Configurations Used at Fermilab

Click the blue buttons below to view the different configurations at Fermilab.

- Wand Sources
- Beta Gun**
- Disc Source
- Plastic Check Source

**Beta Gun**



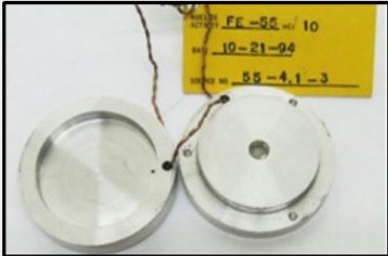
## Disc Source (Slide Layer)

### Typical Radioactive Source Configurations Used at Fermilab

Click the blue buttons below to view the different configurations at Fermilab.

- Wand Sources
- Beta Gun
- Disc Source**
- Plastic Check Source

**Disc Source**






## Plastic Check Source (Slide Layer)

### Typical Radioactive Source Configurations Used at Fermilab

Click the blue buttons below to view the different configurations at Fermilab.

- Wand Sources
- Beta Gun
- Disc Source
- Plastic Check Source**

**Plastic Check Source**



## 20.4 Sealed Radioactive Source Control - Signs

### Sealed Radioactive Source Control - Signs

Click the blue buttons below to learn about radiation caution signs.

- Radioactive Material Area**
- Radiation Area

## Radioactive Material Area (Slide Layer)

### Sealed Radioactive Source Control - Signs

Click the blue buttons below to learn about radiation caution signs.

Radioactive  
Material Area

Radiation Area

When radioactive sources are in use, the area must be posted with a "Caution, Radioactive Material" sign.



## Radiation Area (Slide Layer)

### Sealed Radioactive Source Control - Signs

Click the blue buttons below to learn about radiation caution signs.

Radioactive  
Material Area

Radiation Area

If the radioactive source creates a radiation field equal to or greater than 5 mrem/hour at 30 cm from the source, the area will be posted with a "Caution: Radiation Area" sign.





## 20.5 Sealed Radioactive Source Control Cont.

### Sealed Radioactive Source Control

Click the buttons on the right to learn more about sealed radioactive source control.

You must review all the types before you advance in the training.



### Access points (Slide Layer)

### Sealed Radioactive Source Control


All access points where radioactive sources are used and stored must be properly posted.



## When not in use (Slide Layer)

**Sealed Radioactive Source Control**


When not in use, radioactive sources shall be stored in designated locked boxes/ cabinets bearing the sign "CAUTION: RADIOACTIVE MATERIAL."



## Un-attended or unsecured (Slide Layer)

**Sealed Radioactive Source Control**


If you see a radioactive source that appears to be unattended or unsecured, contact the ES&H Section Source Physicist or your assigned RSO.



## Loose source tags (Slide Layer)

### Sealed Radioactive Source Control

If you find a source tag loose or what you think may be an unlabeled source, contact the ES&H Section Source Physicist or your assigned RSO.




## Broken source (Slide Layer)

### Sealed Radioactive Source Control

If you suspect that a source is broken or causing contamination:

- Call X3131 immediately
- If there is a chance that you may be contaminated, do not move or touch anything to the extent possible. Ask someone else to make the call
- Do not handle the source or even attempt to move it
- Keep others away from the area



## 21. Radioactive Waste Management

### 21.1 Radioactive Waste Management



### 21.2 Radioactive Waste Management

**Radioactive Waste Management**

Radioactive waste is radioactive material that is no longer useful.  
This may be:

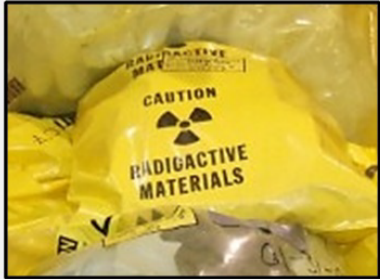
- Material that has been activated
- Items that have come in contact with radioactively contaminated material and are contaminated.



## 21.3 Radioactive Waste Management Cont.

### Radioactive Waste Management

Radioactive waste bags, radiation warning signs, and radioactive class labels shall not be thrown away in normal trash cans or dumpsters. These items are to be reused, if possible, or collected as radioactive materials in radioactive waste drums or other suitable containers whether or not they are determined to be radioactive.



## 21.4 Mixed Waste

### Mixed Waste

- Chemically hazardous or toxic waste which is also radioactive.
- Extremely difficult and expensive to dispose of.
- If the waste is radioactive and contains hazardous materials, special instructions apply.



## 21.6 Mixed Waste Cont.

### Mixed Waste

Typical hazardous materials used at Fermilab include:

- Ethyl alcohol
- Freon
- Methanol
- Acetone
- Lead
- Lead based solder
- Beryllium
- Sodium chloride



## 21.7 Waste Minimization

### Waste Minimization

The minimization of the generation of mixed waste is especially important because the disposal of such waste is very difficult.



Ways to help minimize waste include:

- Reducing or eliminating the volume of radioactive and mixed waste
- Reducing the impact on the environment and the public
- Reducing disposal costs
- Using good housekeeping techniques
- Segregating all activated and/or contaminated materials from all other hazardous and non-hazardous materials



## 21.8 Waste Minimization Cont.

### Waste Minimization

- Remove unneeded materials upon completion of the work.
- Prevent the generation of mixed waste by substituting non-hazardous materials for hazardous materials.
- Do not use hazardous materials to clean radioactive components unless the components have no removable radioactive contamination present. Except for certain special circumstances, water and KPC 820N are the only approved cleaners which may be used on radioactive materials.



## 21.10 Radioactive Waste Generator Responsibilities

### Radioactive Waste Generator Responsibilities

- Radioactive waste generators must comply with the guidelines outlined in the next several slides.
- You must contact your supervisor and/or rad waste coordinator to discuss the details of how your area handles its radioactive waste. You must contact one of these individuals prior to generating any waste.



## 21.11 Radioactive Waste Generator Responsibilities Cont.

### Radioactive Waste Generator Responsibilities

All radioactive waste generators are required to characterize waste with sufficient accuracy to permit proper identification, minimization, segregation, transportation, treatment, storage, and disposal. This responsibility cannot be delegated or deferred. Radioactive waste materials may not be left unattended for disposal at a later time.

Click the buttons on each side of this box for more information on radioactive waste generator responsibilities.

### Proper disposal (Slide Layer)

### Radioactive Waste Generator Responsibilities

Radioactive waste generators must ensure that any waste they generate, or are responsible for, is properly and promptly characterized and packaged for disposal.



## Do not generate unknown waste (Slide Layer)

**Radioactive Waste Generator Responsibilities**

Radioactive waste generators must ensure that unknown wastes are not generated. Characterizing unknown waste can be very time consuming and expensive.

## Do not generate mixed waste (Slide Layer)

**Radioactive Waste Generator Responsibilities**

Radioactive waste generators must ensure that mixed wastes are not generated if at all possible. Written approval may be required before using certain items.

## Solid materials (Slide Layer)

**Radioactive Waste Generator Responsibilities**

All dry, solid materials that are collected as radioactive waste must be surveyed to ensure that they are radioactive prior to placement in a waste disposal container.

## Water (Slide Layer)

**Radioactive Waste Generator Responsibilities**

Water collected on tunnel or enclosure floors cannot be disposed of without prior permission from the assigned RSO.

## Radioactive waste to collection areas (Slide Layer)

### Radioactive Waste Generator Responsibilities

Radioactive waste items shall promptly be taken to radioactive waste collection areas. Persons who are issued containers are generally available to open them for waste disposal during normal working hours.

## Off hours (Slide Layer)

### Radioactive Waste Generator Responsibilities

During off hours, supervisors are required to designate in advance the location (e.g., locked storage cabinet) where materials can be stored until proper radioactive waste disposal containers can be opened. When radioactive waste is placed in a designated temporary storage cabinet, the radioactive waste generator must sign the "Radioactive Waste Certification and Pickup Request Form".

## 21.12 Radioactive Waste Generator Responsibilities - Transporting Radioactive Waste

### Radioactive Waste Generator Responsibilities

#### Transporting Radioactive Waste

- Radioactive items being transported to designated collection areas should be labeled with class tape. Items may be placed in rad bags with class label taped to bag.
- Radioactive materials shall not be stored or transported in bags used for normal trash.
- Radioactive materials, including radioactive waste, must be transported in laboratory vehicles.



## 21.13 Waste Characterization

### Waste Characterization

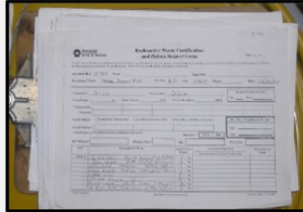
At a minimum, radioactive waste characterization must include the information listed below. This information is to be placed on an inventory sheet which is maintained for each waste container as it is being filled.

- Physical description of the waste
- Chemical characteristics of the waste and any void-filling material or absorbent
- Volume of the waste
- Weight of waste
- Radionuclide distribution, concentration, & activity in waste matrix
- Dose Rate
- Method of assay/analysis used to determine radionuclide distribution and concentration
- Packaging details
- Packaging date
- Packaging weight
- Total volume

## 21.14 Waste Characterization Cont.

### Waste Characterization

- The typical radiations emitted from dry, solid radioactive material may be detected with the Frisker.
- If the background count rate is greater than 50 cpm, it may not be possible to determine that an item is radioactive. Suspect materials should be taken to an area where the background count rate is at or below 50 cpm.
- Tritium (radioactive hydrogen) cannot be measured with available hand-held instruments.



## 21.15 Waste Characterization Cont.

### Waste Characterization

The following are waste violations/problems that have routinely occurred at Fermilab:

- Pens - especially Magnum markers
- Water and/or oil in sump pumps -there is a check valve in the pump that contains about 1/2 cup of water
- Lead seals
- Printed circuit boards - they are in many places you don't expect
- Lead solder - almost EVERY type of electrical equipment contains lead solder
- Telephone handsets - contain a lot of lead solder
- Batteries - left in flashlights or other equipment



## 21.16 Radioactive Waste Containers

Radioactive Waste Containers

Click the buttons on each side of this box to learn about radioactive waste containers.



The image shows a blue container filled with several yellow bags of radioactive waste. The bags are stacked and have a radiation warning symbol on them. The container is in a dark environment, possibly a laboratory or industrial setting.

### Locked (Slide Layer)

Radioactive Waste Containers

All radioactive waste containers must be secured so that control is maintained.



The image shows a yellow cylindrical drum, which is a common type of radioactive waste container. It has a radiation warning symbol on its side and a handle on top. The drum is standing on a floor with yellow and black hazard stripes.



## Liquids (Slide Layer)

**Radioactive Waste Containers**

No free liquids or absorbed liquids of any type are to be placed in 55-gallon radioactive drums – they are designated for dry, solid waste.

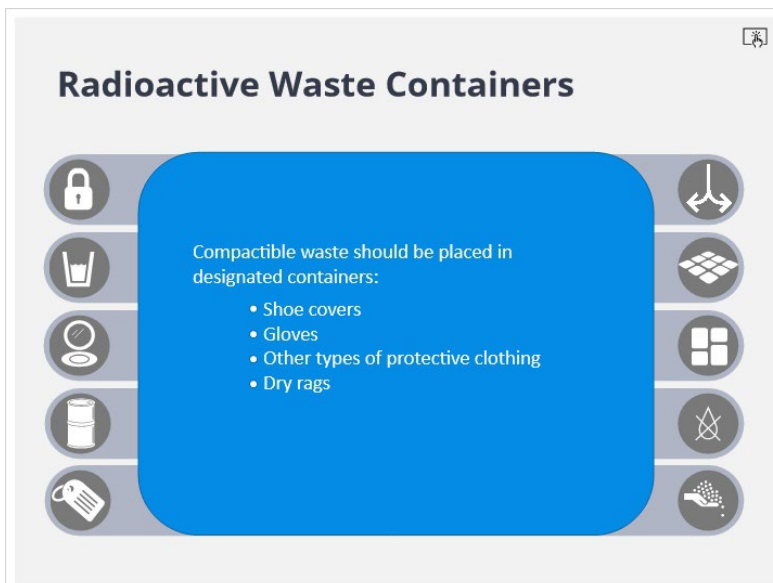


## Compactible waste (Slide Layer)

**Radioactive Waste Containers**

Compactible waste should be placed in designated containers:

- Shoe covers
- Gloves
- Other types of protective clothing
- Dry rags



## Liquid labeled (Slide Layer)

### Radioactive Waste Containers

Liquid wastes are to be collected in properly labeled and approved containers appropriate for the quantity of waste generated. The following are approved containers for such wastes:

- 55 gallon liquid drums
- 5 gallon carboys
- Polyethylene bottles
- Shipping 330 gallon totes for large quantities of tritiated water



## Oil or liquids (Slide Layer)

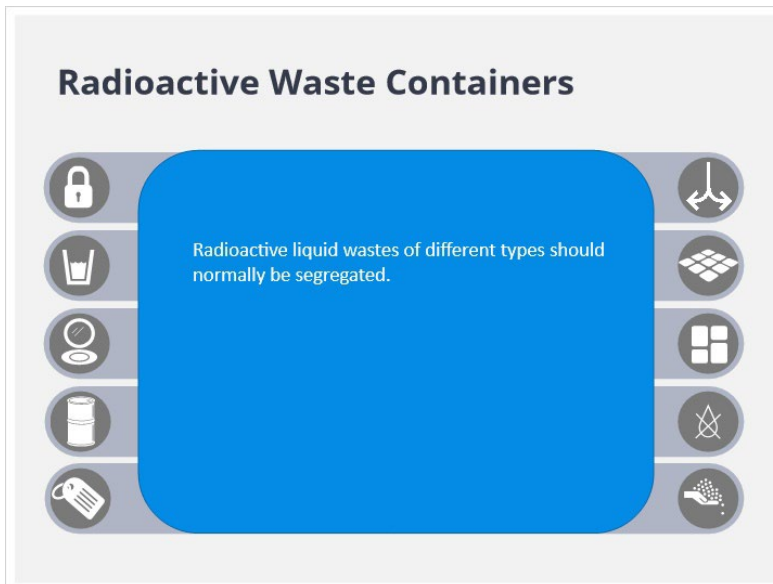
### Radioactive Waste Containers

Oil or other liquids removed from vacuum pumps and from various devices, such as septa, that have been in beam enclosures must be collected as radioactive waste. The liquids may contain tritium which is not detectable with hand-held instruments and may require special evaluation to determine if they are radioactive.

## Segregate liquids (Slide Layer)

### Radioactive Waste Containers

Radioactive liquid wastes of different types should normally be segregated.

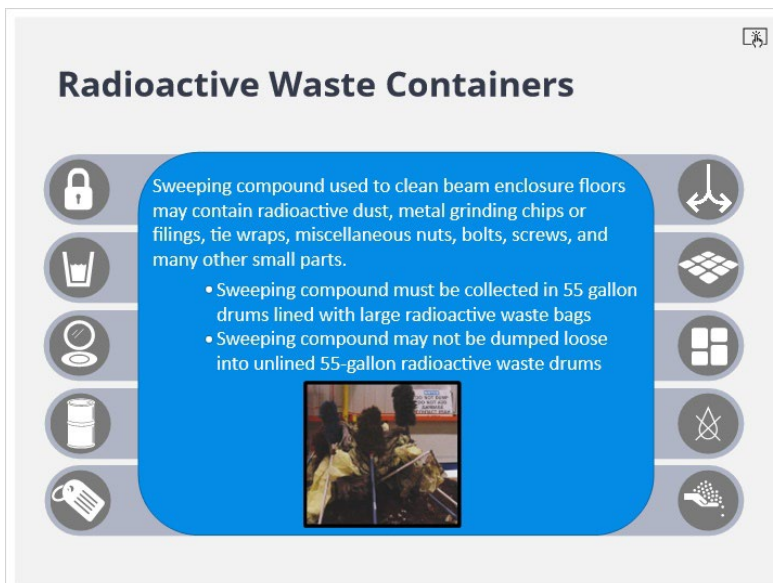



## Beam Enclosure Floor (Slide Layer)

### Radioactive Waste Containers

Sweeping compound used to clean beam enclosure floors may contain radioactive dust, metal grinding chips or filings, tie wraps, miscellaneous nuts, bolts, screws, and many other small parts.

- Sweeping compound must be collected in 55 gallon drums lined with large radioactive waste bags
- Sweeping compound may not be dumped loose into unlined 55-gallon radioactive waste drums



## Non-compactible waste (Slide Layer)

### Radioactive Waste Containers

Non-compactible waste, such as small accelerator parts and fasteners such as nuts, bolts screws, brackets etc., is to be collected in 55-gallon drums separate from compactible waste.



## Dry solids (Slide Layer)

### Radioactive Waste Containers

Approved Fermilab radioactive waste containers for dry solids are:

- Radioactive waste bags for dry compatibles
- 55 gallon drums used for dry solids. **NO LIQUIDS ALLOWED.**
- Steel boxes for scrap metal, wire cable, and other items too large for 55 gallon drums
- Bulk items too large to fit in steel boxes may be banded and placed on skids or cribbing

## Large quantities (Slide Layer)

### Radioactive Waste Containers

Large items and/or large quantities of non-compatible radioactive may be collected in steel boxes.



The slide features a central blue rounded rectangle containing the text and image. It is surrounded by a grid of icons: a padlock, a trash can, a magnifying glass, a barrel, a clipboard, a person with arrows, a diamond pattern, a square pattern, a radiation symbol, and a hand with particles. A small icon in the top right corner indicates a warning or hazard.

## 21.17 Waste Pick-Ups


### Waste Pick-Ups

Once waste is properly characterized and in the appropriate container, pick-up can be arranged if:

- Form Submitted
- Container Secured
- Surveyed/Labeled
- No Contamination

Click the blue buttons above to find out conditions that allow for pick-up.

## Form Submitted (Slide Layer)




### Waste Pick-Ups

Once waste is properly characterized and in the appropriate container, pick-up can be arranged if:

- Form Submitted
- Container Secured
- Surveyed/Labeled
- No Contamination

A completed inventory form (RW Form # 31) has been submitted through the rad waste coordinator.

## Containers Secured (Slide Layer)



### Waste Pick-Ups

Once waste is properly characterized and in the appropriate container, pick-up can be arranged if:

- Form Submitted
- Container Secured
- Surveyed/Labeled
- No Contamination

All containers are properly secured to ensure no loss of contents during transport.

## Surveyed/Labels (Slide Layer)

### Waste Pick-Ups

Once waste is properly characterized and in the appropriate container, pick-up can be arranged if:

- Form Submitted
- Container Secured
- Surveyed/Labeled
- No Contamination

The container has been surveyed and labeled as radioactive waste.

## No radioactive contamination (Slide Layer)

### Waste Pick-Ups

Once waste is properly characterized and in the appropriate container, pick-up can be arranged if:

- Form Submitted
- Container Secured
- Surveyed/Labeled
- No Contamination

There is no radioactive contamination on the external surfaces of the container which is above the limit for release to uncontrolled areas.

## 22. Radiological Emergencies

### 22.1 Radiological Emergencies

# 21 Radiological Emergencies

### 22.2 Emergency Situations

#### Emergency Situations

Emergency situations are generally handled by the assigned RSO. In all emergency situations, dial X3131 from a lab phone or 630-840-3131 from a mobile phone to report the incident to the emergency operator.



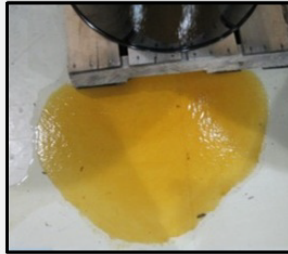


## 22.3 Area Contamination

### Area Contamination

In some instances, there may be possible area contamination where none is expected. Two potential indicators would be alarming contamination monitors and leaks, spills, or standing water around or near radioactive water systems. If you have reason to suspect this type of contamination:

- Do not enter the area
- Keep others from entering the area
- Immediately report the situation by contacting the assigned RSO via the Main Control Room



## 22.4 Elevated Radiation Levels

### Elevated Radiation Levels

Chipmunks and Scarecrows are used to monitor radiation fields due to accelerator operations. If you are working in an area and hear one of these instruments unexpectedly alarm:

- Alert others
- Immediately leave the area
- Contact the assigned RSO via the Main Control Room



## 22.5 Airborne Radioactivity

### Airborne Radioactivity

There are a few continuous air monitors on-site, primarily used in Accelerator Division to monitor concentrations of airborne radioactivity. If you are working in an area and hear or see one of these instruments alarm (a whooper alarms and a red beacon begins flashing):

- Alert others
- Immediately leave the area
- Contact the assigned RSO via the Main Control Room



## 22.6 Emergencies Requiring Site-Wide Resources

### Emergencies Requiring Site-Wide Resources



When in doubt, assume that it is a serious emergency requiring site-wide resources. Click on the buttons on each side of this box to learn which situations are considered a site-wide emergency.

You must review each definition before you can advance in this training.



## Injuries in controlled area (Slide Layer)

**Emergencies Requiring Site-Wide Resources**

Injuries in areas controlled for radiological purposes. Remember, lifesaving actions take priority over radiological control considerations.

This slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with six circular icons: a person, a hand holding a head, a flame, an eye, a hand holding a tablet, and a person in a protective suit. A small icon in the top right corner indicates a slide layer.

## Leak or spill (Slide Layer)

**Emergencies Requiring Site-Wide Resources**


Leak or spill of radioactive material outside of a radiological area.

This slide features a central blue rounded rectangle containing the text. It is surrounded by a grey border with six circular icons: a person, a hand holding a head, a flame, an eye, a hand holding a tablet, and a person in a protective suit. A small icon in the top right corner indicates a slide layer.

## Fire or smoke (Slide Layer)

**Emergencies Requiring Site-Wide Resources**

Fire or smoke in a radiological area or involving radioactive materials.



The slide features a central blue rounded rectangle containing the text and an image. The image shows two firefighters in full protective gear, including helmets and jackets, walking on a paved surface. The slide is framed by a light gray border with a title at the top and a set of six circular icons on the sides: a person, a hand holding a mask, a flame, an eye, a hand holding a tablet, and a person in a protective suit.

## Exposure (Slide Layer)

**Emergencies Requiring Site-Wide Resources**

Exposure to the operating beam.



The slide features a central blue rounded rectangle containing the text and an image. The image shows a complex industrial facility with various pipes, machinery, and structural elements, likely a particle accelerator or reactor. The slide is framed by a light gray border with a title at the top and a set of six circular icons on the sides: a person, a hand holding a mask, a flame, an eye, a hand holding a tablet, and a person in a protective suit.

## rupture or breakage (Slide Layer)

**Emergencies Requiring Site-Wide Resources**

Rupture or breakage of a radioactive source.

This slide features a central blue rounded rectangle containing the text "Rupture or breakage of a radioactive source." The slide is framed by a light gray border. At the top left, the title "Emergencies Requiring Site-Wide Resources" is displayed. At the top right, there is a small square icon with a magnifying glass. On the left side, there is a vertical column of three circular icons: a person, a hand holding a mask, and a flame. On the right side, there is a vertical column of three circular icons: an eye, a hand holding a tablet, and a person with a radiation symbol.

## Personnel contamination (Slide Layer)

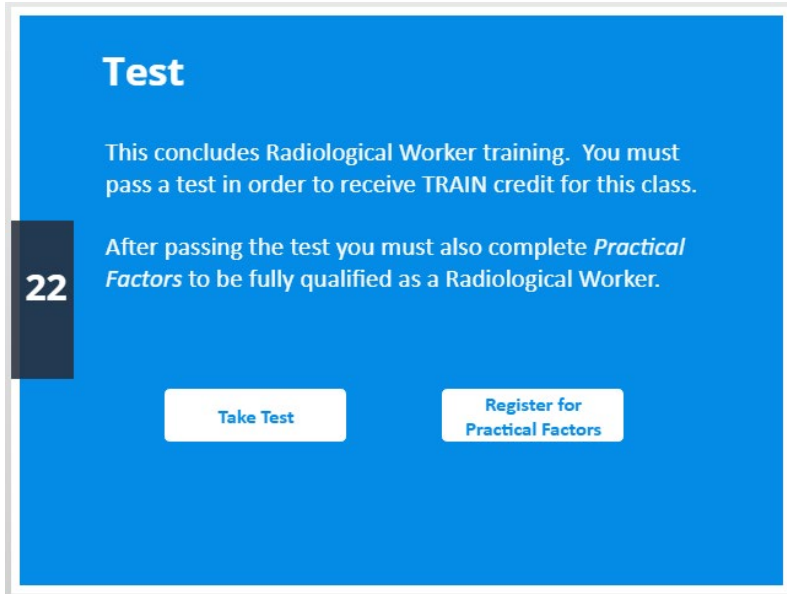
**Emergencies Requiring Site-Wide Resources**

Personnel contamination - external or internal

This slide features a central blue rounded rectangle containing the text "Personnel contamination - external or internal". The slide is framed by a light gray border. At the top left, the title "Emergencies Requiring Site-Wide Resources" is displayed. At the top right, there is a small square icon with a magnifying glass. On the left side, there is a vertical column of three circular icons: a person, a hand holding a mask, and a flame. On the right side, there is a vertical column of three circular icons: an eye, a hand holding a tablet, and a person with a radiation symbol.

## 23. Test

### 23.1 Test



**22**

## Test

This concludes Radiological Worker training. You must pass a test in order to receive TRAIN credit for this class.

After passing the test you must also complete *Practical Factors* to be fully qualified as a Radiological Worker.

[Take Test](#)      [Register for Practical Factors](#)