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Radiation Safety at UAH

Introduction

- This presentation is a continuation of the Radiation Fundamentals training. The goals of this presentation are to provide information that will assist Authorized Users and Workers in maintaining as low as reasonably achievable (ALARA) exposures to radioactive materials while conducting work at UAH.

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Relative Risk - A Comparison

Health Risk	Expected Life Expectancy Lost
Smoking 20 cigarettes a day	25 days
Overweight (15%)	2 years
Alcohol (US avg)	1 year
All Accidents	207 days
All Natural Hazards	7 days
Occupational dose (300 mrem/yr)	15 days
Occupational dose (1 rem/yr)	51 days
Examples of relative risk adapted from Cohen and Lee, "A Catalogue of Risks," Health Physics, vol. 61, Sep. 1991.	

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Reduction in Life Span

Activity	Avg. Reduction
Living in a city vs. country	5 years
Single vs. Married	5 years
Male vs. Female	3 years
Resulting from Lifetime Radiation Exposures	
Cosmic	25 days
Medical	30 days
Terrestrial	50 – 100 days
World Fallout	1 day

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Biological Effects

Two types stochastic and non-stochastic:

- Stochastic effects
  - Stochastic effects are associated with long-term, low-level (chronic) exposure to radiation. ("Stochastic" refers to the likelihood that something will happen.)
  - Increased levels of exposure make these health effects more likely to occur, but do not influence the type or severity of the effect.
  - The severity of the ultimate effect is not linked to the amount of the dose
  - There is NO threshold for the effects to be observed - Rad safety assumes no safe amount.

Somatic, “Prompt” Effects

Acute Dose (rem)	Syndrome
1 – 25	No detectable effects
25 – 100	Slight sickness RBC’s drop
100 – 1000	Hemopoietic
1000 – 5000	Gastrointestinal
5000 – 10000	Central Nervous System

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Gamma Radiation

Absorbed Dose	Survival Probability
100 rad	Virtually certain
100 – 200 rad	Probable
200 – 450 rad	Probable
500 – 600 rad	Almost impossible
900 – 1200 rad	Possible in some cases with bone marrow transplant

Determining Rem From Rad

- To determine your exposure from rad's – Multiply the rads by the quality factor
  - RADs X QF = REM
- Quality Factors
  - Alpha = 20
  - Beta = 1
  - Gamma = 1

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Non-stochastic Effects

- **Severity of the result is related to the dose (usually high dose).**
- Adverse effect happens soon after exposure and can be directly linked to exposure
- Generally related to a large dose over a short time
- There is a threshold level - observed effects follow typical distribution around a dose

Cancer Risks

Excess Cancer Deaths after Acute, one-time exposure to 10 rem per 100,000 People (BEIR V)

Adult Leukemia	95
Cancer of digestive system	230
Cancer of Respiratory System	170

Leukemia risk, without 10 rem, is 685 excess deaths per 100,000 people (1980 Vital Statistics of the U.S.)

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Teratogenic Effects

- Another class of biological effects of concern are called the teratogenic effects.
- Teratogenic effects are effects which occur in offspring as a result of exposure to a hazard while in-utero

Maternal Factors & Pregnancy

Maternal Factors & Pregnancy		
Maternal Factor	***Pregnancy Outcome***	***Occurrence***
Smoking	Babies weigh 5-9 oz less than avg	
< 1 pack/day	Infant death	1 in 5
> 1 pack/day	Infant death	1 in 3
Alcohol		
2 drinks/day	Babies weigh 2-6 oz less than avg	
2-4 drinks/day	Fetal alcohol syndrome	1 in 10
> 4 drinks/day	Fetal alcohol syndrome	1 in 3
Chronic alcoholism	Fetal alcohol syndrome	1 in 3 to 1 in 2
Radiation		
1 rem	Childhood leukemia deaths before 12 yrs	1 in 3333
1 rem	Other childhood cancer deaths	1 in 3571

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Occupational Dose

- Annual Limits For Workers
  - Whole body(active blood forming organs) 5 REM
  - Eyes – 15 REM; Extremities – 50 REM
  - Minors (10% of adults limits)
  - Embryo/Fetus – 0.5 REM over the entire pregnancy
- Annual Limits For General Public
  - Total Effective Dose Equivalent < 0.1 REM

Pregnancy Declaration

- Because of the increased risk to the fetus, pregnant workers are encouraged to voluntarily inform the Radiation Safety Officer, in writing, of her pregnancy and the estimated date of conception.
- The Authorized User must ensure that the dose to the embryo / fetus does not exceed 0.5 rem during the entire pregnancy.
- The revised occupational dose limits, for the embryo / fetus will not be enacted until the pregnancy is declared, in writing, to the RSO.

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ALARA

As

Low

As

Reasonably

Achievable

UAH is committed to keeping radiation exposures to personnel ALARA

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ALARA

- **Education** – Ensure proper training and use reduces unnecessary exposure
- **Dose** – The lower the dose the better, but all within reason
- **Reasonable** - is determined on a case by case basis with the PI and RSO
- **Protection** – Use proper shielding and reduce time of exposure

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Radiation Protection

- The three principles of radiation protection:
  - **Time**
  - **Distance**
  - **Shielding**

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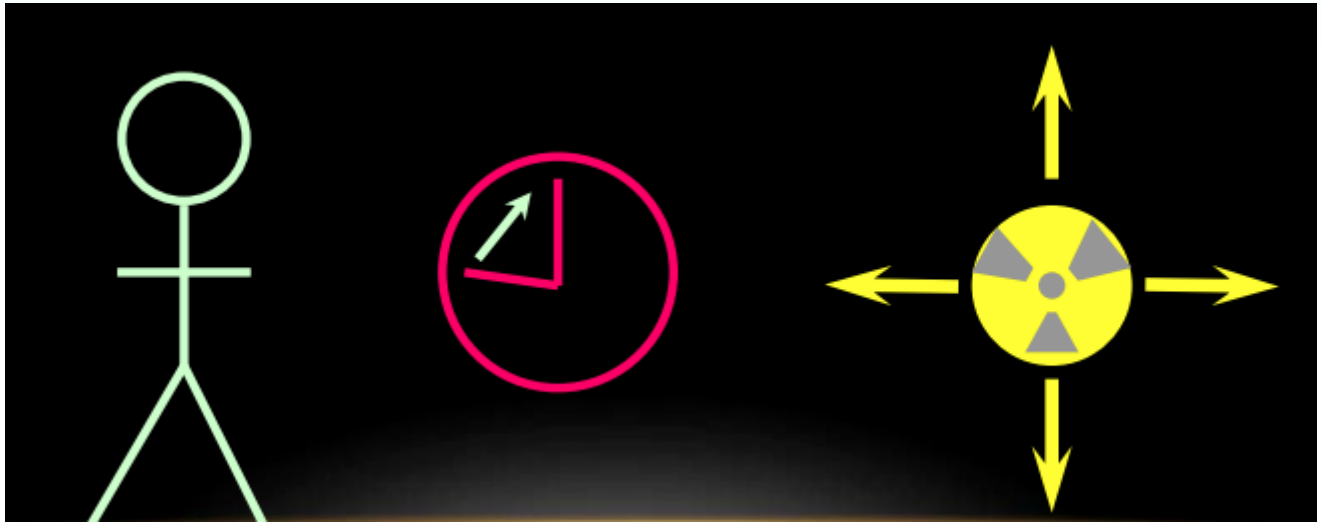
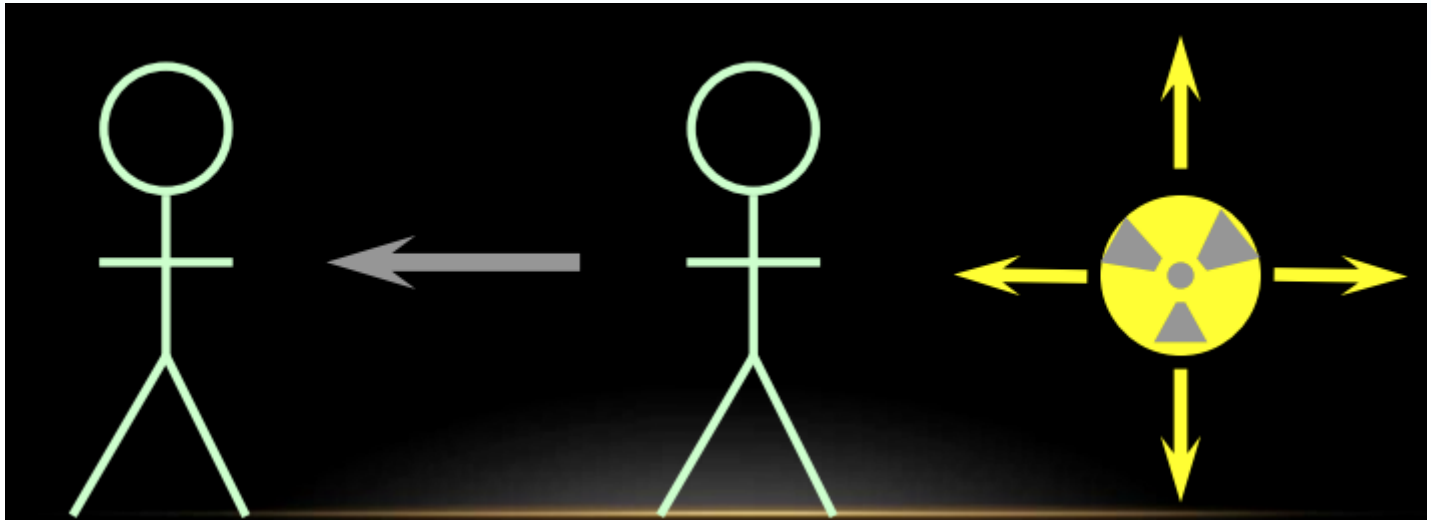
Time

- Decreasing the time spent near a radiation source decreases radiation exposure



Distance

- Increasing the distance from a radiation source decreases radiation exposure



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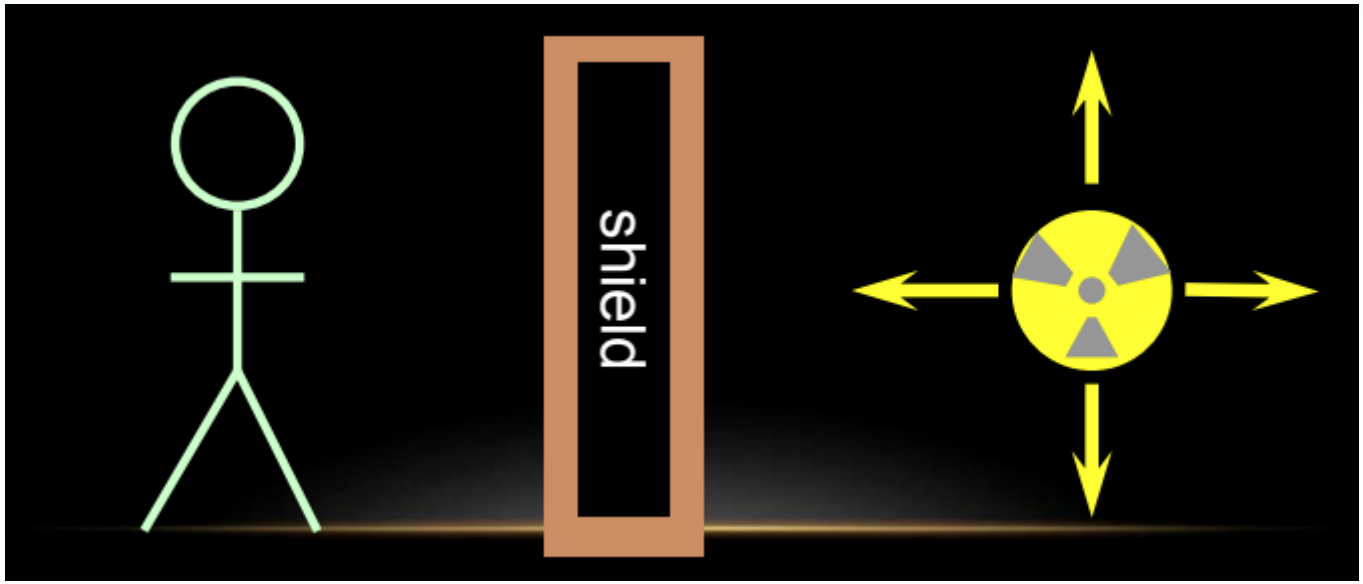
Shielding

- Increasing the shielding of a radiation source decreases radiation exposure



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Shielding Beta Emitters

- H-3, C-14, S-35 do not require shielding for the quantities typically in use.
- Higher energy beta-emitters, such as P-32, may need to be shielded
- Shield with low Z materials, such as Plexiglas or wood
- Do NOT shield with high Z materials, such as lead- you can actually generate additional radiation in the form of x-rays!

Shielding Gamma Emitters

- Lead Shielding is not required for most quantities of gamma emitters in use, such as I-125 or Cr-51
- If lead shielding is used, be careful not to contaminate it with long-lived radioisotopes

Protective Clothing

- Gloves
- Lab Coat
- Eyewear
- Closed toe footwear

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Contamination Control

- Take care during experiments to prevent contamination from your “hot” hands
- Monitor yourself and your work area frequently for radioactivity
- Make sure to wash your hands after finishing an experiment

Avoid Ingesting Radioactive Material

- Don’t bring hands or objects to your mouth when performing an experiment
- Eating, drinking, smoking (including electronic cigarettes), and applying cosmetics are strictly forbidden in radioisotope use areas
- Never mouth pipette
- Food doesn’t belong in a refrigerator used for storage of radioactive materials

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Avoid Inhaling Radioactive Material

- Make sure that you have proper ventilation for your experiment
- When using volatile materials, use a fume hood which has been certified
- Place centrifuges in a biosafety cabinet or fume hood

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Radioactive Signs & Labels

Clearly mark Radioactive Usage Areas

- *Use warning signs/labels on*
  - Work areas
  - Rad waste containers
  - Sinks
  - Refrigerators
  - Equipment

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Using H-3 (Tritium)

- Betas from H-3 are stopped by the protective layer of your skin- shielding is not needed for quantities typically in use at UAH
- H-3 tends to “creep” - do not store tritiated water in refrigerators or freezers without keeping in a sealed container
- *Can not detect by Geiger counter - must use a wipe test.*

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Using C-14 & S-35

- Shielding is not needed for quantities typically in use at UAH
- “Spot checks” for contamination can be performed using direct monitoring, but contamination surveys must be performed using a “swipe” survey
- *These isotopes cannot be detected by Geiger counter.*

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Using P-32

- If shielding is needed, use a low Z material such as wood or Plexiglas
- Do **NOT** use lead shielding. X-rays can be generated through Braumstrahling
- *Geiger counter or wipe test will measure this isotope.*

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General Spill Procedures

- When cleaning up a spill, place absorbent material around the edges of the spill and clean from the outside edges of the spill towards the center to avoid spreading contamination
- Place materials used to clean the spill into the appropriate radioactive waste containers
- Monitor the area to ensure the spill has been cleaned completely and there is no residual radiation
- The Radiation Safety Officer can provide advice to lab personnel regarding decontamination procedures

Minor Radioactive Spills

- A minor spill is one that involves small quantities/activities/energies of radioactive material confined to a relatively localized area
- Most spills that occur in the lab are minor, and should be cleaned up by lab personnel ASAP
- You do not need to inform the Radiation Safety Officer in the event of a minor spill

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Intermediate Spills

- An intermediate spill may involve larger amounts of radioactive material spread over a greater area
- Intermediate spills can also involve small amounts of more hazardous radioactive materials, e.g., higher energy emitters

Intermediate Spills- What To Do

- Confine contamination with absorbent materials
- Check yourself for contamination before leaving area; remove contaminated clothing and shoes prior to leaving
- Restrict access to the spill area
- If the spill involves a volatile material, increase ventilation; if it is a dry spill, decrease ventilation

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Intermediate Spills- What To Do (Cont..)

- If contamination is widespread outside the lab, it may be necessary to contact campus police to assist with securing the area and controlling movement in the area
- Contact the OEHS (824-6053) to report the spill
- Do not attempt decontamination unless the situation threatens to become much worse

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High Level Spills

- Protecting personnel is the FIRST priority
- If high level exposures or airborne contamination are possible:
  - evacuate area immediately
  - rid yourself of contamination
  - keep others out of area

And Another Thing About Spills...

- You will not be penalized for reporting a spill. If spills or contamination are not reported and not cleaned it can harm other people and the Radiation Safety Committee will determine if there will be restrictions placed on the Authorized User(s).

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Radiation Survey Requirements

When should Surveys be conducted?

- Whenever radioactive materials are present in the lab, contamination surveys MUST be performed and documented at least once per week.
- The area in which you are working must be surveyed before finishing each day.
- If no experiments are being conducted, it is permissible to halt surveys until starting again.

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Radiation Surveys

- Contamination Surveys are conducted by the laboratory supervisor. These quantify removable and fixed contamination in and around the lab. The purpose is to prevent and or identify personnel contamination and monitor the efficacy of existing radiation safety measures.
- Area Radiation Surveys are conducted by OEHS once per year. The survey quantifies ambient radiation fields in and around the lab. The purpose is to insure radiation levels are within compliance.

Contamination Surveys

- Direct monitoring with a Geiger counter can be performed when using P-32 and other high energy beta emitters
- “Swipe” surveys must be performed for low energy beta emitters (e.g., H-3, C-14, S-35) and must be counted in a liquid scintillation counter or equivalent instrument

Swipe Surveys

- Swipe tests are a method of determining the presence of removable contamination and must be performed in addition to any area radiation surveys required.
- Principal Investigators should require surveys of the work area after each procedure involving unsealed sources of radioactivity.

Swipe Surveys (cont.)

- Wipe tests should be performed with the frequency given by the following schedule. Records must be retained.
  A. Monthly in areas where fewer than 50 mCi per protocol of dispersible radioactive materials are used.
  B. If the laboratory is merely storing radioactive material, a survey shall be performed in or around the radioactive material storage area only to assure the primary vial is not damaged or breached causing contamination.

General Survey Information

- Randomly survey selected areas outside of normal radioisotope use areas at least once a month
- Using a map of your lab can make documenting surveyed areas easier
- Look for levels twice as large as the background
- Check for contamination wherever human hands normally go...

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10 Most Often Contaminated Sites

10. Soap/towel dispenser
9. Microwave oven
8. Radio dial
7. Phones
6. Pens/pencils
5. Chairs
4. Drawer handles
3. Refrigerator handles
2. Lab books

1. Geiger counters

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Documenting Surveys

- Contamination surveys must be documented
- Record the following:
  - date performed
  - area(s) surveyed (a map helps!)
  - Results
  - identity of surveyor
  - instrument used
  - action taken if contamination is found

RADIATION CONTAMINATION SURVEY
WWW.UAH.EDU/OEHS/RADIATION

RADIOACTIVE CONTAMINATION SURVEY

Date : ____________

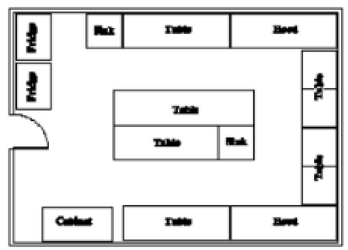
Location : ____________ **Location :** ____________

Survey Performed By : ______________________

Isotopes in Use : ____________

Survey Instrument : ____________ **Background :** ____________

Survey Map : ____________



Total Area Surveyed :

___ft x ___ft

= ______ft2

Net Results :

Location #	Direct Read (CPM)	Swipe Read (CPM)	Re-count (CPM)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

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Step-by-step Guide To Swipe Surveys - General Tips

- Change gloves frequently
- Avoid cross-contaminating samples
- Use filter paper or cotton swabs

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Step-by-step Guide To Direct Monitoring

1. Wear protective equipment (e.g. gloves)
2. Check your Geiger counter:
   - battery test
   - note background radiation level
   - turn on speaker
   - check probe with check source

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Step-by-step Guide To Direct Monitoring, How-to

3. Switch Geiger counter to lowest multiplier, usually X1
4. Hold probe window 1 cm from the surface you are surveying
5. Move probe over surface at a rate of about 1 cm/sec
6. If surveying for alpha or beta contamination, do not cover probe with parafilm or plastic wrap
7. Document results

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Step-by-step Guide To Swipe Surveys, How-to

1. Wear protective equipment (e.g., gloves)
2. Lightly moisten swipe with alcohol or water
3. Using uniform pressure, “swipe” an area about 100-200 cm^2 (survey a discrete area so that if contamination is found the area will be easier to identify)
   - **Decontamination Action Level**: While any excess activity should be removed when discovered, areas with wipe test results of 500 dpm/100 cm^2 or greater must be decontaminated until further wipe tests show results below this threshold.

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Radioactive Material Delivery

- Deliveries are generally performed every weekday afternoon except for University holidays
- All packages are delivered the same day that they are received; we will not hold a package unless absolutely necessary
- If you did not receive a package you were expecting, contact Purchasing Services, the vendor, and the carrier before calling the Radiation Safety Technician.

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Receipt Of Radioactive Materials

- Wear personal protective equipment
- Open containers with volatile, gaseous or readily dispersible materials in a fume hood
- When you receive your shipment, check the inner container for leakage- a simple swipe test is sufficient
- If there is a problem with the shipment, notify the Radiation Safety Officer immediately
- Remember to document the receipt of radioactive material in your lab's records (OEHS Radiological Safety)

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Personnel Monitoring

- Personnel monitoring devices are assigned at the discretion of the Radiation Safety Officer in accordance with all applicable rules and regulations

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The Care And Feeding Of Your Dosimeter

Always:

- Return for exchange on the appropriate date
- Report contamination of dosimetry
- Store away from radioactive sources

Never:

- share dosimeter
- remove film from holder
- expose to heat
- take off campus
- intentionally expose to radiation

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Wearing Dosimeters

Whole Body:

- Wear between neckline and waist unless otherwise instructed
- Wear with name on badge facing outwards

Extremity:

- The label side of the ring should usually face the palm
- Wear gloves over ring, if possible

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Missing Dosimeters

- If you lose, damage or fail to exchange you will be required to provide a detailed description of all radioactive sources in use during the wear period and pay for the lost dosimeter.

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Storage Of Radioactive Waste

- Each radioactive waste container must have:
  1. “Caution Radioactive Materials” sign/label
  2. Labeled with the date the first quantity went into the container
  3. The activity(ies) and the isotope(s)

  Radioactive waste containers must be stored in a controlled area

Radioactive Waste Types

- Solid
- Liquid
- Sharps
- Carcass

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Solid Radioactive Waste

- Segregate waste into three categories:
  - Glass and plastic that cannot be decontaminated easily
  - Paper, gloves, etc.
  - Short-lived waste ($T_{1/2}$ < 90 days) to be held for decay
- Line containers with clear plastic bags at least 4 mils thick
- Do not put liquids into the solid waste

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Liquid Waste

Organic:

- Store in 1 - 5 gal plastic carboys with in a bin/tray for spill containment
- Filter out solids (use 60 mesh screen)
- pH must be adjusted to between 6.8 and 8.0

Aqueous:

- Low activity waste can be disposed into the sanitary sewer system in specific amounts and/or concentrations ONLY with prior approval from the Radiation Safety Officer

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Radioactive “Sharps”

- Radioactive sharps are items such as Pasteur pipettes, syringes and hypodermic needles
- Most glass items (test tubes, vials, etc.) can be decontaminated and should not be disposed of as radioactive sharps
- Follow university procedures for the disposal of laboratory glass

Radioactive Carcasses

- Prior arrangements must be made with the Radiation Safety Officer for disposal of radioactive carcasses

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User Definitions

Authorized User - Tenure Track UAH Faculty. Approved by Radiation Safety Committee

Workers - Those staff or graduate research students, who are using radioactive materials under the supervision of an Authorized User

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User Responsibility

Authorized User:

- Ensure that all procedures are authorized and followed
- Ensure surveys are conducted and reported
- Monitor use and disposal of isotopes
- Ensure their workers are trained

Workers:

  - Must be trained and pass short course test
  - Must practice ALARA and monitor use
  - Conduct surveys and report spills or contamination

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Access to Radioactive Materials Laboratories

- Authorized User - Has full access to facility in which radioactive materials are used.

- Workers - May only have access after passing test.

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UAH Radiation Safety Manual

The UAH Radiation Safety Manual contains information that all users of radiation sources should know.

- Permission to use
- Worker and PI responsibilities
- Health Definitions
- Forms in the handbook and on the web
- Contact the RSO for information

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UAH Radiation Authorization

Rad Safe Test – take on your own

- You must take the UAH Rad Safe test and pass
- with a score of 75%
- A link to the test is in the Radiation
- Fundamentals training
- Sign and agree to info on the test form
- Return forms and test to OEHS

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UAH Radiation Authorization

Orientation to Lab Radiation Work

- Conducted and documented by AU
- Tour / review of work area and storage
- Answer questions on use, procedures, and SOPs
- Swipe test / Survey review
- Key control / access privilege
- Review Radiation Safety Manual & Lab SOPs

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Acknowledge Training

Click here to acknowledge receipt of training

If you have any questions contact:

Office of Environmental Health and Safety
Physical Plant Building
301 Sparkman Drive
Huntsville, AL 35899

oehs@uah.edu

256-824-6053

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