



Portland State
UNIVERSITY

Refresher
Radiation Safety Training
Scott Jaqua, RSO

Section 1



Introduction

RSO Contact Information

- www.pdx.edu/environmental-health-safety

Look for Research Safety

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SRTC 144

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RSO Services

- Training
 - Licensing
 - Dosimetry
 - Exposure monitoring
 - Meter Calibration
 - Outsourced
 - Monitoring and surveying.
 - Inspections
 - Leak Tests
 - Waste management
 - Radioactive Material Tracking, Processing & Security
 - Semiannual Inventory
-
- A resource for radiation safety information
 - 24 hour emergency response

Training Outline

- Review
- ALARA
- Detection & Measurement
- Operational Guidelines
- Emergencies

Review

- ALARA
- Terms
 - Radiation
 - Ionizing –vs – non-ionizing
- Types of radiation
 - Alpha, Beta, Gamma, Bremsstrahlung
- asdfs

ALARA

- As
 - Low
 - As
 - Reasonably
 - Achievable
- Principle of radiation protection that calls for every reasonable effort to maintain radiation exposures as far below specified limits as is practical.

Portland State University is committed to keeping radiation exposures to personnel ALARA

Radioactive Cookie Quiz

Goal: Minimize radiation exposure (ALARA)

☐ Alpha

☐ Beta

☐ Gamma

☐ Neutron



☐ Throw it away



☐ Eat it



☐ Hold in hand



☐ Put in pocket

Section 2



Detection & Measurement

Radioactive Material, Radiation & Contamination

□ Radioactive material

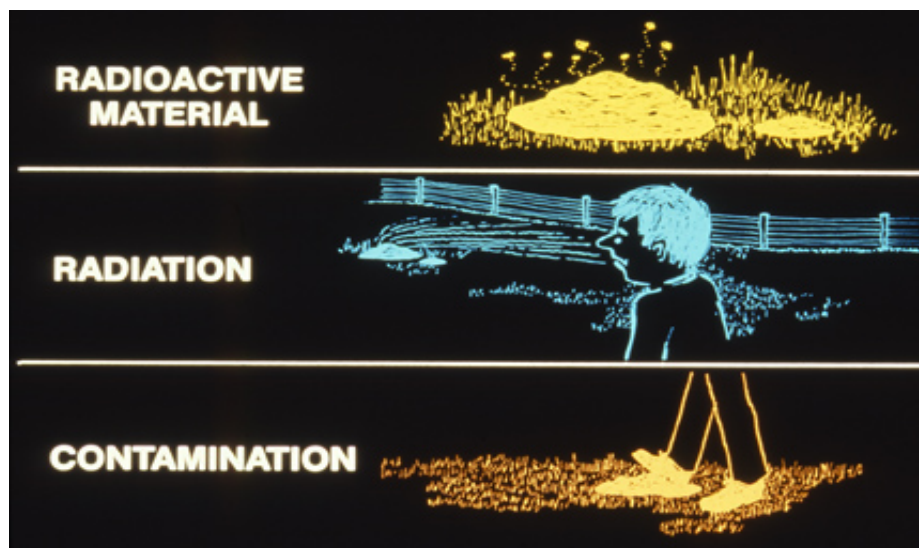
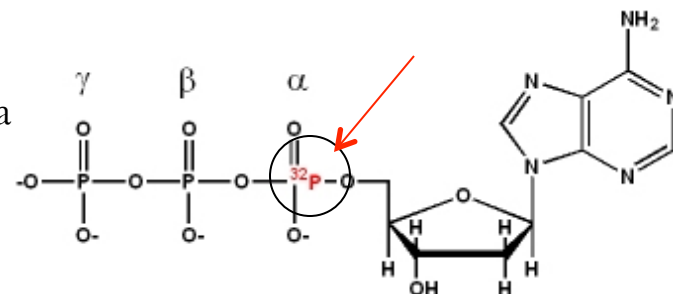
- A chemical, molecule, or mixture with a radionuclide as a component or additive.
- Example: adenosine triphosphate – ^{32}P

□ Radiation

- Review: [click](#)

□ Contamination

- The presence of radioactive material in an undesirable location. (i.e.: hands, bench, floor)



Shielding Beta Emitters

- ▣ ^3H , ^{14}C , ^{35}S use at PSU do not require shielding
- ▣ Higher energy beta emitters, such as ^{32}P , must be shielded with Plexiglass
 - Low Z (~ 17)
- ▣ Do NOT shield with high Z materials, such as lead
 - Can generate additional bremsstrahlung

Geiger-Mueller

- Gas in detector is easily ionized,
 - Produces electrons, which are then read by the meter.
- Used to detect contamination.
 - How – what is it really seeing?
- Know its limitations
 - Efficiency:
 - ~25% for ^{32}P
 - ~3% for ^{14}C
 - Not able to differentiate between different types of radiation
 - Cannot detect ^3H

Geiger Mueller

- ❑ First - always check battery and calibration date!
- ❑ Always turn the sound on – why?
 - To alert others that radioactive material is in use.
 - To alert the user to the presence of radioactive material.
- ❑ What's wrong with the picture



Liquid Scintillation

- ❑ Three common-use LSC, SBI 509, SBI 29, SRTC 425E
- ❑ Used to detect all β emitters.
- ❑ Sample placed in scintillation cocktail
- ❑ β radiation causes liquid to scintillate, emitting photons
- ❑ Photocathode and photomultiplier tubes surround the sample vial in a very low background and detect photons
- ❑ Efficiency – 90% for ^{32}P , 80% for ^{14}C , 50% for ^3H

Activity Calculations

$$\text{Efficiency} = \text{cpm} / \text{dpm}$$

$$\text{dpm} = \text{cpm} / \text{efficiency}$$

$$\mu\text{Ci} = \text{total dpm} / 2.22 \times 10^6 \text{ dpm}/\mu\text{Ci}$$

□ Example:

After an experiment, you need to dispose of 500 ml of ^{32}P liquid waste. One ml was aliquoted to count and resulted in 75,000 cpm of ^{32}P . Calculate the activity assuming the LSC efficiency for ^{32}P is 95%.

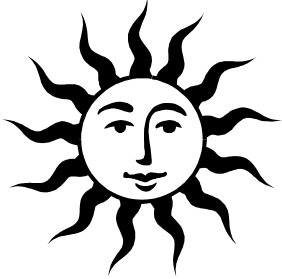
$$75,000 / 0.95 = 78,947 \text{ dpm/ml}$$

$$78,947 \text{ dpm/ml} \times 500 \text{ ml} = \underline{3.95 \times 10^7 \text{ dpm}}$$

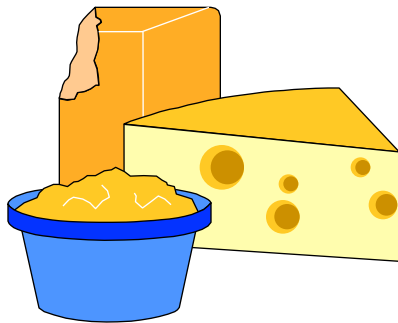
$$3.95 \times 10^7 \text{ dpm} / 2.22 \times 10^6 \text{ dpm}/\mu\text{Ci} = \underline{17.79 \mu\text{Ci}}$$

Background Radiation

Cosmic - 28 mrem



Diet - 40 mrem



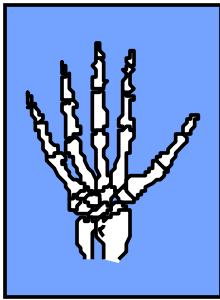
Radon - 200 mrem



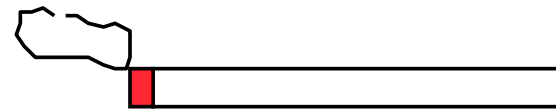
Terrestrial - 28 mrem

Man-made Radiation

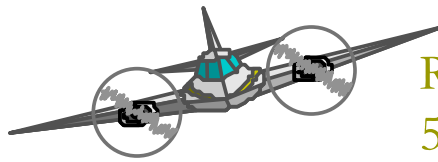
Man-made sources of radiation contribute to the annual radiation dose (mrem/yr).



Medical - 53



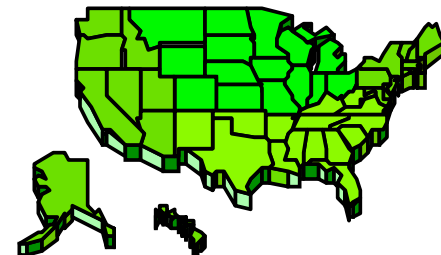
Cigarette smoking - 1300



Round trip US by air
5 mrem per trip



Building materials - 3.6
Gas range - 0.2
Smoke detectors - 0.0001



Fallout < 1

Section 3



Operational Guidelines

Dosimetry

- ❑ Ring badge is issued for working with ^{32}P
 - Must be worn at all times when using ^{32}P in the lab.
- ❑ Anyone who requests any type of badge will be issued one
- ❑ Dosimetry is picked up and exchanged quarterly. If lost, department is responsible.
 - Do not bring dosimetry off campus, unless approved by RSO.
 - Turn the detection area of the ring towards the source of radiation.
- ❑ Remember that exposures are to be kept ALARA.
 - What is ALARA?
- ❑ You may ask to see exposure report at any time.
 - See the RSO.
- ❑ On which finger would you wear your ring badge?

Pregnant Worker Policy

- ❑ Dosimetry is not required for pregnant worker, but will be provided upon request.
- ❑ Declaring pregnancy is optional.
- ❑ Declaration must be in writing to supervisor and/or RSO.
 - RSO must receive copy of the written declaration.
- ❑ For more information, see pregnant worker information:
 - [PSU Environmental Health & Safety website](#)

Material Control and Accountability

- ❑ Principle Investigators / Licensees are ultimately responsible for control and accountability of the radioactive material in research labs.
- ❑ Each radioactive material supervised user must be responsible for their work, and for the record keeping in the work that they do.
- ❑ Each user is responsible for keeping the lab and all radioactive material secure from theft.
- ❑ Do not leave the lab open and unattended at any time.
- ❑ Always lock radioactive material storage areas.

Radioactive Material Use, Storage

□ Use

- Only on specifically designated, prepared, and approved areas of labs & in approved rooms.
- Never on desks.
- Benches must be covered with a removable, disposable barrier

□ Storage

- In specifically designated freezers, refrigerators.
- Locked

□ Moving Material Between Rooms/Floors

- Example: Moving RAM from 3rd floor to 5th floor, SBI, to use the LSC.
 - Have all radioactive material in leak proof containers.
 - No need for gloves in hallways

Ordering Radionuclides

- ❑ Laboratory member(s) place order with desired vendor.
- ❑ Email a copy of the order confirmation to the RSO
 - ❑ Include:
 - PO number
 - PI name & contact information
 - Radionuclide, activity, & chemical form
 - Expected arrival date & vendor information
- ❑ The RSO will deliver the material when it arrives on campus
- ❑ Each lab has an approved possession limit for each radionuclide, labs may not go over this limit.
- ❑ PSU P-cards are not an allowed payment method for radioactive material orders

Radioactive Material Receipt

- ❑ Must be completed within three hours of arrival at PSU.
- ❑ RSO surveys labeled boxes prior to delivery to laboratory.
- ❑ Laboratory personnel are responsible to monitor the pig and vial to prevent contaminating storage area(s).
 - LSC/wipe survey for H-3 & C-14
 - Meter/wipe survey for P-32, P-33, & S-35
- ❑ If any counts are higher than 2000 DPM, call the RSO.

If there is no log sheet accompanying a radioactive package, contact the RSO immediately!!

Receipt and Use Log

- ❑ Used to track what was used and where it went.
- ❑ Only three possibilities:
 - Use & store as waste (dry, liquid, LSC)
 - Use & dispose (drain, RSO waste pick up)
 - Transfer to another lab
- ❑ There will be semi-annual (every 6 months) inventories at which time your lab will be required to account for all isotope ordered, used, and disposed.

Drain Disposals

- ❑ Drain disposal log is required to be posted near the hot sink in the lab. Records must be kept indicating the activity disposed.
- ❑ The amount of drain disposal will be reported to the RSO at inventory time.
- ❑ Activity determination:
 - Aliquot & count on LSC
 - 3-protocol average
 - No dry waste generation
- ❑ Always record drain disposals on Receipt and Use Log Sheet
AND
on Drain Disposal Log Sheet



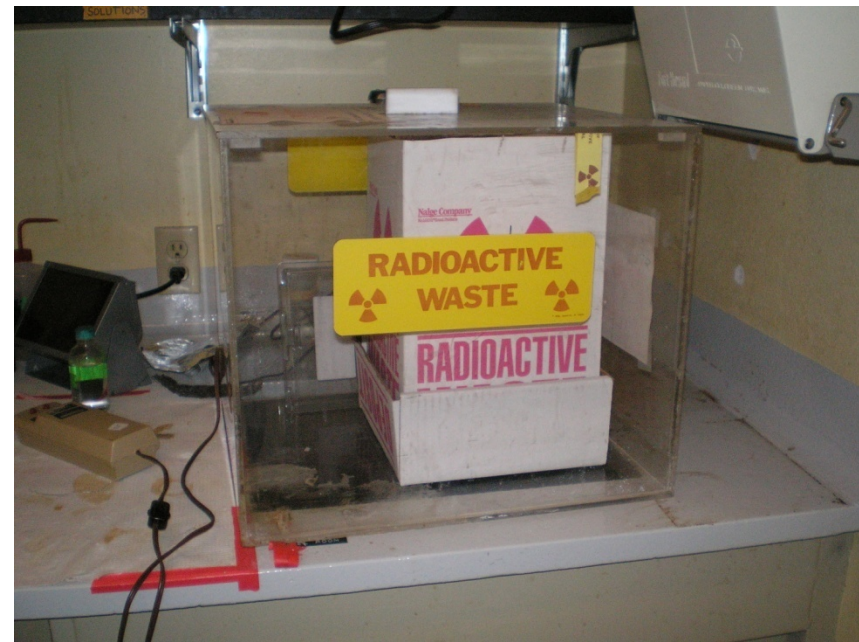
Drain Disposal Limits

Radionuclide	Activity Limit (per month)
^3H	1 mCi
^{14}C	1 mCi
All others combined	1 mCi

- ❑ Only water soluble and dispersible liquids may be disposed of down the drain

Radioactive Waste

- ❑ Solid
 - Use beta boxes
 - No lead, LSC or liquids
- ❑ LSC
 - Biosafe: may be drain disposed
 - Hazardous: RSO must pick up
- ❑ Liquid Waste
 - Must have 2° container
 - May have RSO pick up or drain dispose
 - No activity limit



**All Radioactive waste containers must be labeled
and have an inventory of contents**

Radioactive Waste (cont' d)



- ❑ > 90 day half-life
 - May mix H-3, C-14
- ❑ Very expensive
 - Verify items are really contaminated prior to placing in waste
- ❑ LSC vials
 - Triple rinse in sink
 - Place in special LSC vial drum (high volume counting)

- ❑ < 90 day half-life
 - May mix P-32, P-33, S-35
- ❑ RSO decays the waste for 10 half lives.
 - How long is that?
- ❑ Must be free of radioactivity markings prior to pick up



**All Radioactive waste must have accurate activity totals
(i.e. decayed to the date of pick up)**

The photograph shows a laboratory waste disposal setup. A clear plastic bag is lined with a red plastic bag. A white paper 'Waste Log' is taped to the bag. The log has columns for 'Waste Type', 'Volume', 'Date', and 'Initials'. A yellow biohazard sticker is on the bag. A black lid with a white label 'Petri Plates ONLY' and 'NO TRASH' is visible in the background.

Lab Surveys

- ❑ To detect any contamination that may have occurred in your lab, meter surveys and/or wipe tests are required.
 - Monthly when radioactive material is used.
 - Must document non-use
 - All survey records must be retained for inspection.
- ❑ To determine whether contamination exists, calculations must be performed on your LSC data:
 - Minimum Detectable Activity (MDA) calculation

$$\text{MDA}_{\text{dpm}} = (2.71 + (4.65 * (\text{BKGD})^{1/2}) / \text{Efficiency}$$

- LSC: 2 X MDAdpm – contaminated
- Meter: 3 X BKGD – contaminated

RADIATION/CONTAMINATION SURVEY DATA SHEET

Licensee							SURVEY DATA	
Building	Desk		Desk	Desk		Desk	Location	Dpm/100cm ²
Room#	Hot Sink 1		2				1	
MDA _{dpm}							2	
³ H _____							3	
³⁵ S/ ¹⁴ C _____							4	
³² P _____							5	
¹²⁵ I _____							6	
Instrumentation	4						7	
Dose Rate Meter	Bench						8	
Serial #							9	
Cal. Date								
Count Rate Meter								
Serial #								
Cal Date								

3

Bench

5

Refrigerator

6

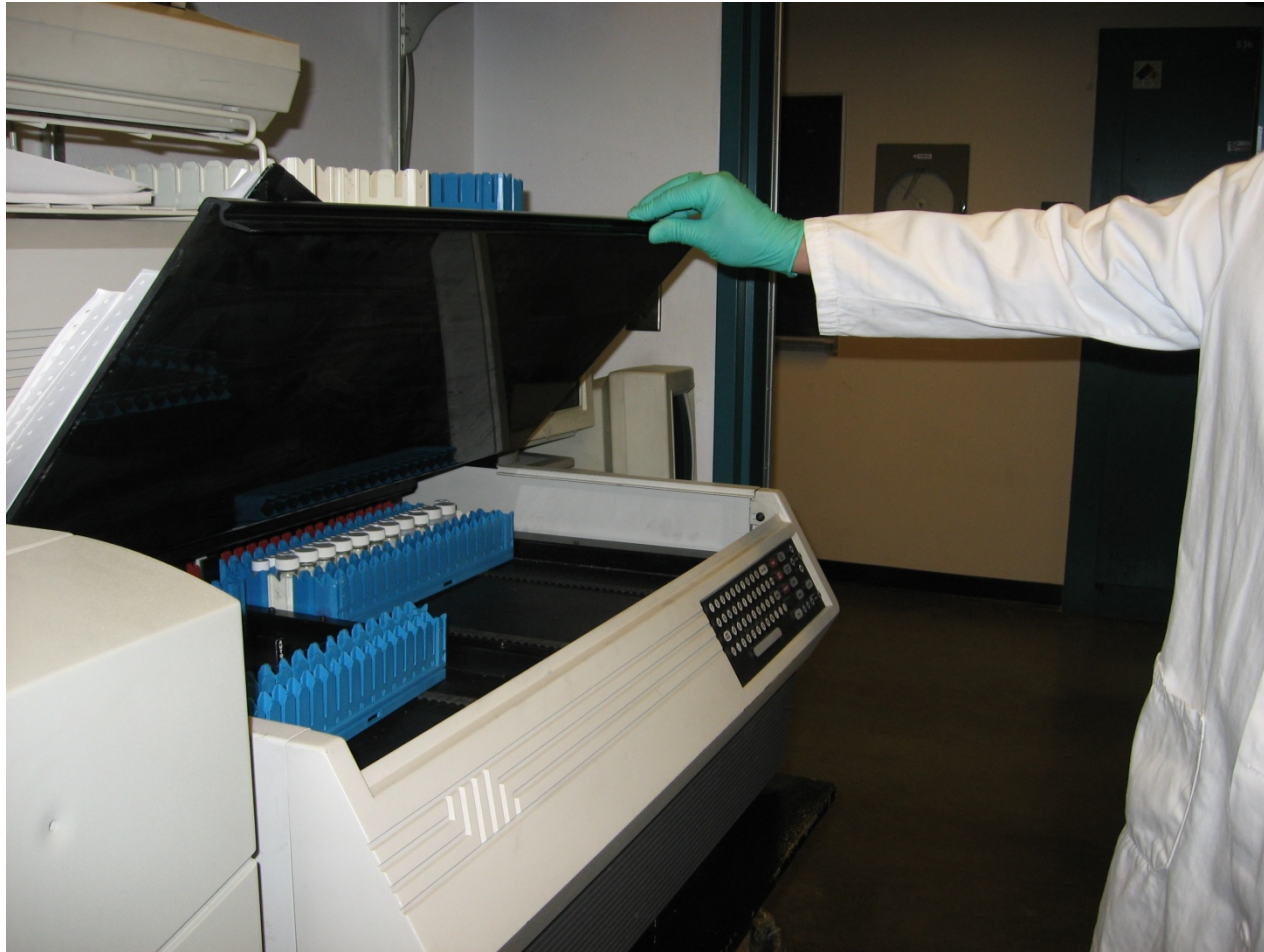
Waste

7

8

-80 Freezer

LSC Use



Section 3



Emergencies

Emergencies

▣ Spills and Other Mishaps

- Immediate actions must be taken after a radioactive material “spill” to prevent spreading contamination and minimize exposure
- Always treat injuries first without regard for radioactive contamination

Immediate Actions for all spills

S.W.I.M.S.

Stop the spill if possible without risk of personnel contamination.

Warn others in the area and notify Radiation Safety Office.

Isolate the affected areas by closing doors, establishing barriers, etc.

Minimize your exposure/contamination.

Stop local fans if radioactive material can be spread.

Security of Radioactive Material

- ❑ In the lab
 - Stock vials must be secured from unauthorized access.
 - Laboratory must be locked when unoccupied.

- ❑ Methods of security
 - Lockboxes
 - Locked refrigerators/freezers
 - Others?

Thank you

- ❑ Thank you for assisting in keeping PSU compliant with ALARA principles.
- ❑ Contact the Radiation Safety Committee or Radiation Safety Officer with any questions or comments.
- ❑ Please email completed tests to sjaqua@pdx.edu