Directions for this Course

Module 0
Orientation

Narration
OUTLINE

- RADIATION SAFETY PROGRAM ORGANIZATION
- REQUIRED RULES REGULATIONS AND REPORTS
- RADIATION USE AND STORAGE LOCATIONS AT CSU
- POSTINGS AND WARNINGS
- HEALTH EFFECTS
- ALARA
- PROTECTIVE DEVICES
- REPORTING RESPONSIBILITIES
- REQUIRED FORMS
• shall be kept informed of the storage, transfer, or use of sources of radiation
• shall be instructed in the health protection problems associated with exposure to radiation
• shall be instructed in precautions or procedures to minimize exposure
• shall be instructed on the functions of protective devices

• shall be instructed in, the applicable provisions of these regulations and licenses
• shall be instructed of their responsibility to report promptly any condition which may cause a violation of the Act, these regulations, and licenses or unnecessary exposure to radiation or radioactive material
• shall be instructed in the appropriate response to warnings
• shall be advised as to the radiation exposure reports
• If you are exposed to more radiation, then you are required to have more training

All of this is outlined in your Radiation Control Manual
Main Campus Sources
Dispersible Radioisotopes used for Research

Dispersible Radioisotopes used for Biological and Environmental Research are the Most Common Forms of Radioactive Materials at Colorado State University
Other Main Campus Sources

Cesium-137 source
Used for Campus Instrument Calibrations

Cabinet X-Ray Machine

Sealed Source (SS) Used for Instrument Quality Control in Laboratories
Veterinary Teaching Hospital

Sources

Animal X-Ray Machine

Nuclear Medicine
Use of Dispersible Radioisotopes

Multiple sites of bone metastasis.
Locations of Use
Health Effects of Radiation

Ionizing Radiation can directly and indirectly damage DNA

• Depending on the kind of radiation, the total dose, the rate of dose, etc., the health effects vary widely, but in general:
  • **Biochemical** effects are seen in SECONDS
  • **Cell division** effects are seen in HOURS
  • **Gastrointestinal** and Central Nervous System effects may be seen in a matter of DAYS
  • **CANCER** may be seen in YEARS
  • **Genetic** Effects may be seen in OFFSPRING
The Dose Response Model is a critical concept in understanding the relationship between exposure to radiation and the health effects it can cause. This model is used to predict the number of cancers that might occur as a result of radiation exposure at different dose levels.

There are four main theories regarding the dose response relationship:

1. **Linear No Threshold Dose Curve**
   - The NRC and the State of Colorado follow this theory, suggesting that there is no threshold dose below which radiation exposure is safe. Every unit of radiation exposure increases the risk of cancer.

2. **Decreased Health Effects Theory**
   - This theory posits that radiation effects decrease with decreasing dose levels.

3. **Threshold Dose Theory**
   - It proposes that there is a minimum dose below which no health effects occur.

4. **Increased Health Effects Theory**
   - This theory suggests that radiation effects increase with increasing dose levels.

The model includes known effects from various populations, such as Atomic Bomb Survivors, Uranium Miners, Radium Dial Painters, and Medical Patients. Each group is plotted on the graph, showing the dose (in rem) and the corresponding number of cancers observed.
Radiation Dose in Perspective

- Health effects are seen only when dose exceeds **10 rem** and at a high dose rate
- Occupational radiation doses are monitored and limited to **5 rem**
- For 95% of the Radiation Users at CSU, doses are **too low to measure**
Background Radiation Dose

Average Background Dose in U.S. is ~360 mrem.

- MEDICAL: 11%
- INTERNAL: 11%
- COSMIC: 8%
- TERRESTRIAL: 8%
- OTHER: <1%
- Nuc Medicine: 4%
- PRODUCTS: 3%
- RADON: 55%

Average Background Dose In Colorado it is ~ 450 mrem
 Radiation Effects for Embryo
Declaration of Pregnancy for Occupational Mothers

- Rapidly dividing and non-specialized cells are more sensitive to radiation
- Birth defects have been observed
- Dose limit to embryo / fetus is 500 mrem for the gestation period
- Avoid substantial variation during the gestation period
Protecting the Embryo/Fetus

- The only way to protect the embryo/fetus from excess radiation is to protect the mother
  - “Belly” badge for the baby is issued
  - Bioassay for radioactive material intake is initiated and repeated monthly
- Dose to baby is measured/estimated and reported

- Historically, pregnant women were not allowed to work with radiation
  - Loss of position and Loss of pay
- To protect her baby, a mother must voluntarily, in writing, declare herself pregnant
  - Present to Principal User/Supervisor and to the Radiation Control Office

- Additional information is available through the Radiation Control Office
- Confidential discussions with RSO about radiation risks to embryo/fetus
  - Even if just planning to get pregnant
  - Arrangements may be made to discuss with female radiation health professional
As Low As Reasonably Achievable

Philosophy

Radiation doses are kept as low as possible.

Stems from Linear-No-Threshold dose model.

ALARA program required by Federal and State regulations.
ALARA Requirements

- Each laboratory or approved radiation use must have an individual ALARA program
- ALARA rules must be posted and taught to each radiation user
- What is “Reasonably Achievable?” Consider the following factors:
  - Dose Limits, Regulations, Social Impacts, Economic Impacts

AND READ IT !!
ALARA Example 1

- Nurse near x-ray room
- Reduce dose from 40 mrem to 20 mrem by adding shielding
- Cost of shielding is $10,000
- Employee satisfaction with increased safety?
ALARA Example 2

- Lab worker routinely uses “hot” samples of P-32
- Accidental spill on hands could result in a skin dose above limit
- Should the worker wear one pair of gloves? Two pairs?
ALARA - Summary

- ALARA programs are required for each laboratory or use of radiation
- **Learn the ALARA rules for your lab**
- Review your work practices with the concept of ALARA in mind
- Review the ALARA rules at least annually
Personal Protective Equipment
Required for using Radioisotopes

- PPE is worn on the body
- Primary purpose is to provide a barrier to radioactive materials or radiation

Eye Protection

Latex Gloves

Lab Coat

Complete Coverage

Feet and Legs

- No Shorts
- No Half Shorts
- No Open-Toed Shoes
- No Mini-Skirts

Full Length Dresses or Pants ONLY
Minimum PPE for X-ray

Depending on your work, PPE may include:

- Lead Apron
- Lead Gloves
- Thyroid Collar

Protective Devices are for Scatter Radiation

No one is permitted to be exposed to the primary beam

**ONLY**
Other Protective Devices

**FUME HOODS**
Prevent the inhalation of dispersible radioactive materials -- dusts, mists, vapors, gasses, etc.

**INTERLOCKS**
Physical, mechanical, or electrical safety features built into machines to prevent the operator from exposing themselves and others to radiation from the machine itself.

Examples:
- X-ray machines
- Irradiators
Protective Devices - con’t

• Shielding
  • Place material between the radiation and the user

• Examples
  • Lead
  • Plastic
  • Steel
  • Concrete
Protective Devices - Summary

- Principal User must provide
- Find out what PPE and other devices are available in your lab
- Learn how to properly use all protective devices from your PU or another qualified user
Colorado Department of Public Health and Environment

Applicable Regulations

- Key Parts of the "Rules and Regulations Pertaining to Radiation Control"
- Part 4: Radiation Protection Standards
- Part 10: Workers’ Info
- and Part 6 for X-ray users
Standards for Protection Against Radiation

Part 4 of the State Rules and Regulations

- RH 4.5 Radiation Protection Program
  - Met for the University via the Radiation Control Manual
- RH 4.6-4.13 Radiation Dose Limits
  - Also listed in the Radiation Control Manual
  - Dose Limits for the PUBLIC
    - The University and all radiation users are responsible for protecting the public to meet ALARA principle
Radiation Surveys
(Part 4 of the State Rules and Regulations)

- RH 4.16-4.18 requires radiation surveys and monitoring
- RH 4.19-4.21 lists requirements to control access to Radiation Areas
- RH 4.22-4.24 discusses internal exposures
Radioactive Materials Security
(Part 4 of the State Rules and Regulations)

• RH 4.25-.26 lists SECURITY requirements
  • Recent incidents in other states have prompted the NRC to increase security requirements
  • The State of Colorado has asked CSU to address security issues

• All sources of radiation must be secured against theft or use by unauthorized individuals - CHECK SECURITY IN YOUR LAB !!
Radiation Postings / Labels
(Part 4 of the State Rules and Regulations)

RH 4.27 - RH 4.31 lists requirements for:

- posting or labeling
  - Rooms
  - Containers
  - Machines
- exemptions to above

RH 4.32 requires specific methods to receive and open radioactive shipments

Radiation signs contain important information. If you don’t know about the radiation or radioactive materials

ASK !!! BE FOREWARNED
It’s on the streets ...

Transportation Placards And Labels

[Image of a truck with transportation placards and labels]
Radioactive Waste
(Part 4 of the State Rules and Regulations)

- RH 4.33-4.39 deal with proper methods to dispose of waste
  - Solid waste
  - Sewer discharge
- CSU has detailed and specific instructions for users generating radioactive waste
  - Module 3 training is required for all generators
So Many Regulations... Why?

Since 1945, the American PUBLIC has demanded...

Government Control of Radiation

Government bureaucracies control by accountability, which means…

Paperwork, forms, etc., which means

RECORD KEEPING
Required Records include:

- Laboratory Radiation Safety Programs
- Contamination Surveys of each Lab and Source
- Dose Monitoring to Users and the Public
- Radioactive Materials Inventory
- Waste Disposals
- Security and Safety Tests
• Reports to State
  • Incidents
  • Lost, stolen, broken radioactive materials
• Radiation Levels
• Reports to individuals
  • Dose Monitoring
  • Discussed later
Notices, Instructions, and Reports to Workers

Part 10 of the State Rules and Regulations

- Covers important laws for employers and rights of the Radiation Workers
  - Posting of Notice to Workers
  - Required Training
  - Calling for Inspections
  - Required Reports to Workers
Notice to Workers
(Part 10 of the State Rules and Regulations)

• Must be posted at the entrance to each lab where radioactive materials are used
• Employer & Employee Responsibilities
• Responsibility to Report Violations
• Laws Protecting “Whistle Blowers”
• Instructions on Contacting State & Federal Agencies
Inspections, Training, Dosimetry

(Part 10 of the State Rules and Regulations)

- Inspections
  You have the right to ask for a radiation safety inspection from the University or the State.
  The State has the right to interview every radiation worker during safety inspections.

- Training
  Your training must be commensurate with the Radiation Hazards at the University.

- Dosimetry Reports
X-ray Users should consult Part 6: X-rays in the Healing Arts

- General requirements for x-ray use
  - Machine requirements
  - Minimum required training
  - Distance and shielding requirements
- Specific types of x-ray devices
  - Includes veterinary uses
- Restrictions and Limitations
- Take Module 8 for more information
Rules & Regulations

Complete copies of the Federal, State, and CSU rules and regulations concerning radiation safety, as well as complete copies of our licenses and registrations are available in the Radiation Control Office.
What Do You Report?

• ANY EVENT incident or condition, real or perceived, that may cause an excessive radiation dose to:
  • YOURSELF
  • OTHER WORKERS
  • THE PUBLIC or the Environment
Report to Whom?

During Business Hours Contact the Radiation Control Office or the VTH Radiation Technician
After Hours Contact CSU PD

For **FIRE**, **Life Threatening Emergencies**, or Eminent Danger:

**IMMEDIATELY CALL 911**
For Radiation Emergencies...

- Immediately call
  - RADIATION SAFETY OFFICER...  x3736
  - VTH RADIATION TECHNICIAN..  x4439
  - Alternate RSO.........................x3928
  - Radiation Control Technician.........x4835
- If no answer, call
  - Environmental Health Services.......x6745
- After hours, call
  - CSU Police Department........... x6425 (911)

• See the back cover of your Radiation Control Manual.
• The Manual also lists Radiation Emergency Procedures
Environmental Health Services

- Maintains an around the clock Emergency Response Team
- Will be able to contact University Radiation Safety Personnel for immediate response
- Will respond to other hazardous conditions
For Radiation Concerns...

- Take all radiation safety concerns, no matter how inconsequential, to your Principal User
  - The matter should be discussed
  - Often radiation concerns may be understood with additional instruction, training, or education
- If your PU does not satisfy your concerns, contact the Radiation Safety Officer
Rights / Responsibilities

- Not only do you have the **RIGHT** to report unsafe conditions,
  - protected under the Notice to Workers
- You have the **RESPONSIBILITY** to report these same conditions

- You have the **right** and the **responsibility** to have all radiation safety concerns addressed to your satisfaction even if you have to take them to the State or Federal authorities
Laboratory Postings Required

“Notice to Workers” and Emergency Contact Information should be posted at the entrance to your lab or radiation work space.

- Caution Sign and Hazards
- Radioactive Materials Posting
- Lab Emergency Phone Numbers
- Colorado Notice to Workers
- RCO Emergency Phone Numbers
Radiation and Local Warnings

- Equipment or devices may have a visible or audible alarm to indicate a failure that may cause a radiation incident
  - Freezers
  - Baths / Hot Plates
  - Centrifuges

Response to Warnings

- If devices or equipment in your lab have warning indicators:
- Have your Principal User explain their meaning and...
- Learn and Understand the proper response to local warnings
- Post contact phone numbers on equipment if necessary
Emergency Warnings

• Temporary postings may be placed to warn of emergency procedures in progress
  • **DO NOT CROSS** MARKED BARRIERS or ENTER POSTED AREAS

Follow Emergency Responder Instructions
Dose Reporting (RH 10.4)

- Radiation exposure data and the results of any measurements, analyses or calculations regarding radiation doses shall be reported to the individual
  - Annually in a written report, mailed to your address in March for the preceding year
  - Monthly dosimetry information may be provided to your Principal User to assist in ALARA reviews; refer to Modules 1 and 5 for more information
  - Furnished upon written request within 30 days

NRC Form 5
The Radiation Control Office Is Required to Provide this Form To ALL Badged Personnel

Occupational Exposure Report for a Monitoring Period

<table>
<thead>
<tr>
<th>Account Number</th>
<th>Series Code</th>
<th>Participant Number</th>
<th>Radiation Control Office</th>
<th>Environmental Health Services</th>
<th>Fort Collins, CO 80521-0021</th>
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<td>082672</td>
<td>XIC</td>
<td>GD012</td>
<td>Colorado State University</td>
<td>Colorado State University</td>
<td>MARCH 2019</td>
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- Deep Dose Equivalent (DDE) = 11. M
- Eye Dose Equivalent to the lens of the eye (LDE) = 12. M
- Skin Dose Equivalent, Whole Body (SDE-WB) = 13. M
- Skin Dose Equivalent, Extremity (SDE-EX) = 14. M
- Committed Effective Dose Equivalent (CEDE) = 15. M
- Committed Organs Dose Equivalent (CODE) = 16. M
- TOTAL EFFECTIVE DOSE EQUIVALENT (TDEE) = 17. M
- TOTAL ORGAN DOSE EQUIVALENT (TOOE) = 18. M
- MAX ORGAN Dose Equivalent (MAXOE) = 19. M

Notice to Workers

This report is distributed to you under the provisions of Colorado Rules and Regulations Pertaining to Radiation Control. Part 10. Your School provides this report for health information.
The RCO Needs Information

Specific forms (RF-1A and RF-1B) must be completed and submitted to:
- The RCO
- Request a dosimeter
- Provide personal information
- Provide historical information
- Change information

These forms are located in the back of your Radiation Control Manual

Complete all the blanks and sign the form. Ask for help.
Your Records are Kept on File

- Includes
  - Dosimetry Data
  - Training Data
  - Relative radiation information
- CONFIDENTIAL
  - Only you and RCO personnel have access
- May request to view your file anytime
Radiation Safety Training

- Your Principal User is responsible for ensuring that you are adequately trained to work with radiation.
- Your Principal User must provide you with information on your expected dose.
- PU provides “hands on” training.
- The Radiation Control Office also offers additional training.
- See the Radiation Control Manual for descriptions of radiation user categories.
  - Ancillary User, Normal User, Qualified User, and Principal User.

Additional Training Modules are listed in your Radiation Control Manual.
# RCO Training Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
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<tbody>
<tr>
<td>0</td>
<td>Orientation (This Module)</td>
</tr>
<tr>
<td>1</td>
<td>Safety and Radiation</td>
</tr>
<tr>
<td>2</td>
<td>Basic Radiation Principals</td>
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<tr>
<td>3</td>
<td>Radioisotope Acquisition and Disposition</td>
</tr>
<tr>
<td>4</td>
<td>In-Lab Verification of Training</td>
</tr>
<tr>
<td>5</td>
<td>Dosimetry</td>
</tr>
<tr>
<td>6</td>
<td>Laboratory Radiation Safety Program Development</td>
</tr>
<tr>
<td>7</td>
<td>Irradiators – Sealed Sources</td>
</tr>
<tr>
<td>8</td>
<td>X-Ray Machines</td>
</tr>
<tr>
<td>9</td>
<td>Veterinary Teaching Hospital Students</td>
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See the Radiation Control Manual and Radiological Instruction RI-44 for descriptions and additional information on the Modules.

Contact Environmental Health Services at 491-6745 for the latest training schedule and to register for the Modules.
Certification

• Make sure you have signed the Training Roster
• Read and Understand the Radiation Control Manual
• Sign the Certificate in the back of your manual
• Return the Certificate and both the RF-1A and RF-1B Forms to the RCO through Campus Mail
Questions ???

If you have any questions while reading the Radiation Control Manual

Please Feel Free to Contact: The Radiation Control Office

133 General Services Bld.
CSU Main Campus
Fort Collins, CO. 80523-6021

Environmental Health Services: 491-6745
Radiation Safety Officer: 491-3736
Alt. Radiation Safety Officer: 491-3928
Radiation Control Technician: 491-4835
VTH Radiation Technician: 491-4439