



For more information, refer to the Radiation Safety Manual, 2017 RSP-3

What are the four most basic rules for working safely with radioactive material?

There are four concepts that can help you understand how to stay safe when working with or around radioactive materials. They are **SHIELDING, TIME, DISTANCE AND CONTAMINATION CONTROL**.

How can I prevent an External Radiation Exposure?

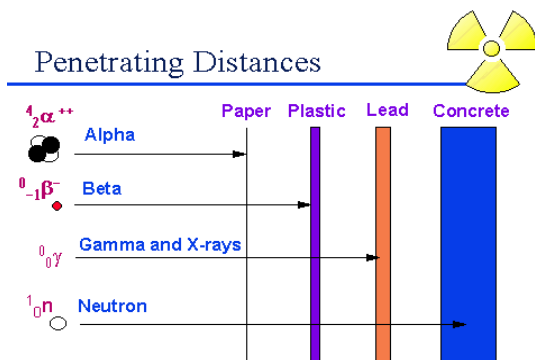
When working with radioactive material, you can protect yourself from receiving an external exposure from the ionizing particles and rays by using control methods - **SHIELDING, TIME AND DISTANCE**.

Shielding

Keep shielding between you and the radioactive material

Use different shielding for the various radioisotopes (depends on their emission and energy)

- The outer layers of your skin (like paper) will protect you from low energy beta and alpha emitters such as H-3 (no shielding is required).
- Lucite (plexiglass) or wood for mid energy betas such as P-32
- Lead or leaded glass for low energy gammas such as I-125 or Cr-51



At the University, the most commonly used radioisotopes can be shielded by plastic (Lucite) or lead

Radioisotope	Type of Emission	Energy (MeV)	Half-life	Exemption Quantity (EQ)	100 EQ	Shielding
H-3	Beta-	Lowest 0.018	12 years	1000	100 000	None required
C-14	Beta-	Low 0.156	5730 years	10	1000	None required
S-35	Beta-	Low 0.167	88 days	100	10 000	None required
P-32	Beta-	Mid 1.71	14 days	0.1	10	Plastic (lucite) or wood
I-125	X-ray/ Gamma	Low 0.035	60 days	1	100	Lead
Tc-99m	Gamma	Low 0.14 (85%)	6 hours	10	1000	Lead
Cr-51	X-ray/ Gamma	Low 0.32 (10%)	28 days	10	1000	Lead
F-18	Beta+/ Gamma	0.633/0.511	109.8 minutes	1	100	Lead
I-124	Beta+/ Gamma	1.532/0.511	4.18 days	0.01	1	Lead

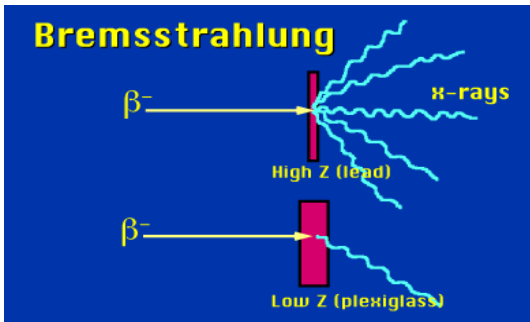
Tech Talk: BREMSSTRAHLUNG AND SHIELDING

Use care if using lead as a shield with P-32! If you use lead to shield a mid-energy beta particle, an X-ray may be created when the ionizing particle is deflected by the lead.

This deflection causes the particle to accelerate creating the X-ray.

Shield beta emitters with a layer of lucite or wood (not lead) closest to the radioactivity.

Remember X-rays cannot be shielded by lucite.



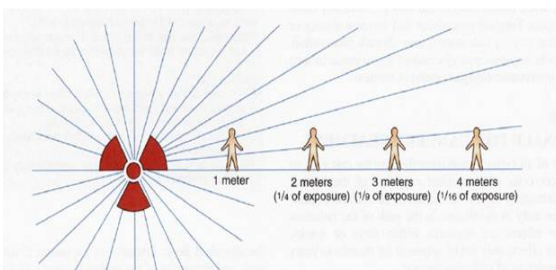
Time

Limit the time you handle the radioactive material by being prepared.

- Preplan
- Practice (dry run)
- Assemble supplies
- Keep source in shielding
- Work quickly

Distance

Doubling your distance from the radioactive material, you 'quarter' your exposure. This is known as the inverse square law and is a very powerful way to reduce radiation exposure. The distance effect can be affected by the energy level and particle size of the material. A decreasing energy level and increasing particle size will reduce the distance required to receive a quarter of the exposure.



For medium energy beta emitter like P-32, step back 1 meter from unshielded sources.

For gamma emitters, limit the time you are within 2 meters of an unshielded source.

How can I prevent an Internal Radiation Exposure?

Consider the Routes of Entry

Inhale (breathe it in)	Inject (cut or poke by contaminated sharps)	Ingest (eat or drink it)	Contact (get it on your skin)	Mucus membranes (rub your eyes)
				

How do I keep radioactive material outside my body?

The routes of entry for all hazards are inhalation, ingestion, injection and adsorption.

You can protect yourself to prevent radioactive material from entering your body by using industrial hygiene barriers –

ENGINEERING CONTROLS, SAFE WORK PRACTICES AND PERSONAL PROTECTIVE EQUIPMENT.

Engineering Controls

- Use radioactive materials in a separate work area
- Use a fume hood for volatiles (e.g. unbound iodines) and aerosol producing procedures (e.g. vortexing)
- Use secondary containment for moving and storing the material
- Use splash shields
- Keep containers closed when not in use

Safe Work Practices

- Read the (M)SDS and RSDS or CNSC Radionuclide Booklet for the physical data on select radioisotopes sheets for the radiolabelled chemical
- Cover work surface with a plastic backed absorbent pad (absorbent side up) and change often
- Label equipment & area with the striped tape and with the radiation warning symbol when actively manipulating radioactive material
- Tie back long hair
- Keep lanyards and the cuffs of your lab coat sleeves from being contaminated or touching possibly contaminated surfaces
- Wash hands regularly, when you remove gloves and always before you leave the radioactive work area or touch keys, keyboards, phones, door knobs or light switches
- Never eat or drink in the lab and keep your lunch, gum, and cigarettes outside of the lab.
- Keep your personal items out of the lab (coats, backpacks) and cell phone out of reach to prevent if from being contaminated
- Be aware of your personal mannerisms (pushing up glasses, chewing ends of pens, touching face) and do not do these things until you have removed your gloves and washed your hands to prevent contaminating yourself
- Plan for emergency situations (fire alarm, spill)
- Follow your working alone plan (review and update if required)
- Frequently monitor for contamination (area, lab coat, dosimeter, keys)

Personal Protective Equipment (PPE) (gloves, lab coats, masks, eyewear)

- Make sure it fits you
- Use it properly (dedicated for radioactive work only, don't cross contaminate)
- Wear it properly (lab coat buttoned)
- Select gloves & masks based on their protective value
- Dispose of it properly (radioactive waste)
- Decontaminate non-disposable PPE (such as eyewear) after use
- DO NOT spread contamination, monitor often!

All personal contamination must be reported to the Radiation Safety Officer as soon as possible.

How do I set up a Radiation Work Area?

Know the properties of the radioactive material that you will use

- Radioisotope: what type of emission and how energetic will help to determine shielding and monitoring method
- What is the chemical that is labelled with the radioisotope (what are the related chemical hazards)
- Volatility of the radioactive chemical and the solution it is dissolved in
 - If packaged in ethanol consider evaporation
 - Is it unbound iodine or S-35 labelled proteins – these have volatility concerns

Choose a work area

- Could aerosols be created by the work procedure (vortex, pipette, sonicate, homogenize)
- A fume hood should be used for volatiles and aerosol producing procedures
- A bench area should be away from high traffic flow in the lab (not by an entrance, away from any desks or computer workstations)
- Consider a location with a wall or window on the other side of the bench and not open to another bench (protect your fellow workers from exposure, splashes)
- Electrical panels should not be in the work area, consider access by Physical Plant, they have keys to your room too!

If shielding is required for the work area

- Mid to high energy betas require lucite (plexiglass) or wood
- Gammas require lead or leaded glass
- Radiolabelled samples and waste (solid, liquid, etc.) require shielding as well
- Work procedure may require splash shields (plexiglass)

Supplies that will be required for the work area

- Absorbent plastic backed pads (absorbent side up)
- PPE (disposable gloves & lab coat must be worn when handling any open source radioactive material)
- Labels for the area and equipment (don't forget the sink!)
- Waste containers and waste tags
- Paper towels/kimwipes
- Dedicated equipment (pipettes, vortex, microfuge)
- Any items needed for the procedure (tip boxes, racks, tubes)
- Access to a contamination meter to:
 - Monitor for the presence of radioactivity (except for the radioisotopes H-3 & C-14)
 - C-14 can be detected with a Ludlum 44-9, but only at large quantities. *For P32, the meter must have its calibration verified at least every three years to use for weekly contamination monitoring
- Access to a liquid scintillation counter for contamination monitoring for all other radioisotopes (weekly wipe testing)

- Label the radioisotope work area with 'Striped Tape' to indicate where you have to wear disposable gloves and a lab coat to prevent the spread of radioactive contamination. Only use the radiation warning symbol when you know radioactive material or radioactive contamination is present.



Striped Tape or



Trefoil (radiation warning symbol)

Are you Prepared for an Emergency?

- What if you spill 5L of radioactive buffer?
- Do you have what you need?
- Do you know what you need?
- Where is the eyewash and do you know how to use it?
- Spill kit
 - Do you know where it is and how to open it?
 - Does it have what you need and are the supplies usable?
 - Refer to Radiation Safety Manual RSP-3, section 10.8
- What is your plan? Do you know who to call and how to call them?

Review the emergency response procedures RSP-1 (for fire) and RSP-3, Section 11.



One hour of planning and preparing could save many hours of clean-up and reporting!