Sealed Sources

Training Notes for URI Radiation Workers

Sealed Sources

- Sealed sources are radioactive materials sealed inside metal or plastic encapsulation that prevents their radioactive contents from leaking or dispersing – barring tampering or a severe accident.
- In some forms, the radioactive material is an inherent part of the source and cannot be separated.

URI Examples

- Core Logger…Cs-137
- Moisture-Density Gauge…Am-241/Be & Cs-137
- Gas Chromatographs with Electron-Capture Detectors…Ni-63
- Mossbauer Equipment…Co-57
- Check sources in liquid scintillation counters
- Static eliminators…Po-210

Electron Capture Devices

- Some of the Gas Chromatographs (GCs) at the University of Rhode Island have Electron Capture Detectors (ECDs) which contain a small sealed source.
- These machines usually have a radioactive materials sticker or label, identifying the presence of the source.
- Dosimetry is not required for normal operation of these devices.
- ECDs must be leak tested periodically. If a source is found to be leaking at a level equal to or exceeding 0.005 uCi, it must be taken out of service for repair or disposal.

Liquid Scintillation Counters

- Many URI laboratories use liquid scintillation counters (LSCs) to analyze experimental samples and smear survey samples.
- LSCs which calculate efficiency may also contain a small Cs-137 or Ra-226 source. These internal sources are managed in the same way as other sealed sources and must be removed from the machine prior to disposal.
- Most LSCs have calibration check sources for routine use. These sources are usually H-3, C-14 or Cl-36 in sealed liquid form.

Sealed Sources

- Almost all "sealed sources" can be handled without concern that the radioactive material will rub-off or be dispersed onto hands or clothing. The exceptions are certain alpha and beta emitting sources.
- There is, however, reason to be concerned about exposure to the radiation emitted from the sealed source.

Forms

- Plated Sources
- Capsules
- Activated Metal

Plated Sources

- The activity is incorporated into a metallic substrate typically by electro-deposition.
- The activity is then diffusion bonded into the substrate yielding a very thin active layer on the surface of the substrate.
- These sources are typically used for alpha emitters in which thicker active layers would severely perturb the emission spectra.
- Plated sources are recommended for laboratory or primary calibration use, not for rugged field applications.

Capsules

- A capsule usually made of metal surrounds the radioactive material
- A mixture of radioactive compounds is placed into the capsule and it is welded or sealed closed.

Activated Metal

- A metal wire or foil has been exposed to a neutron flux to irradiate the metal and create a radioactive isotope from the original material
- It may have a plastic or epoxy coating to protect the activated metal or the activated metal may not be protected.

Hazard

- Sealed sources primarily present an external radiation hazard as opposed to a contamination hazard.
- Sealed sources can emit any type of ionizing radiation, including alpha particles, beta particles, gamma rays, x-rays, or neutrons.

Contamination

- Contamination is normally not an issue when working with sealed sources.
- If there is any reason to suspect that a source is leaking, a wipe test (smear) or a survey instrument (such as a Geiger counter) should be used to detect the presence or absence of radioactive contamination.

Sealed Source Hazard Control

- Time
- Distance
- Shielding

Time

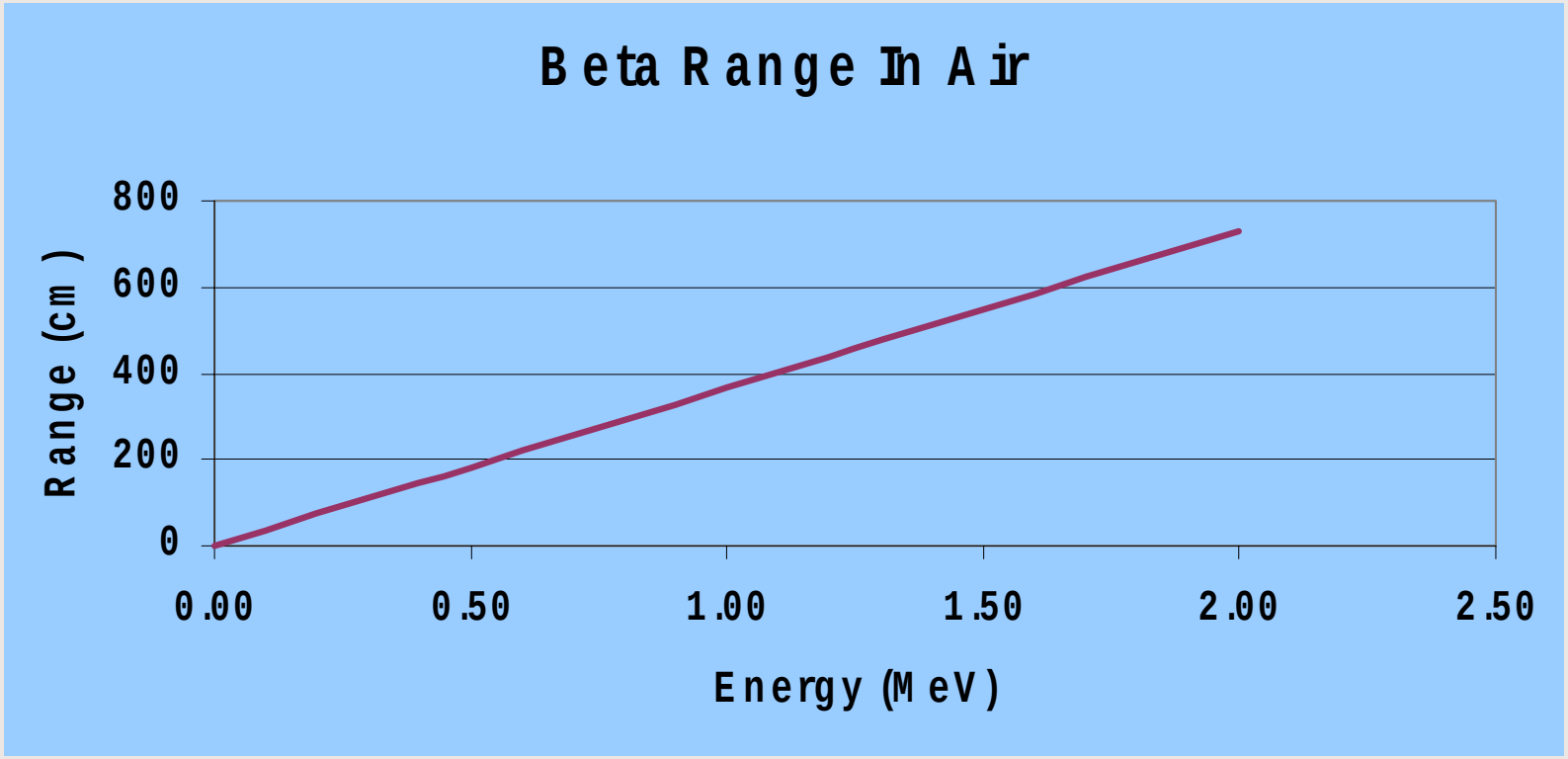
- Radiation exposure is directly proportional to the time spent in the field.
- If the time spent in a given radiation field is doubled, your exposure is doubled.
- What actions can you take to use this exposure reduction tool?

- Do not remove the source from its storage area until the last possible moment
- Thoroughly understand the experiment by completing several "dry-runs" prior to introducing the source to the experiment
- Understand where and when the radiation beam is present

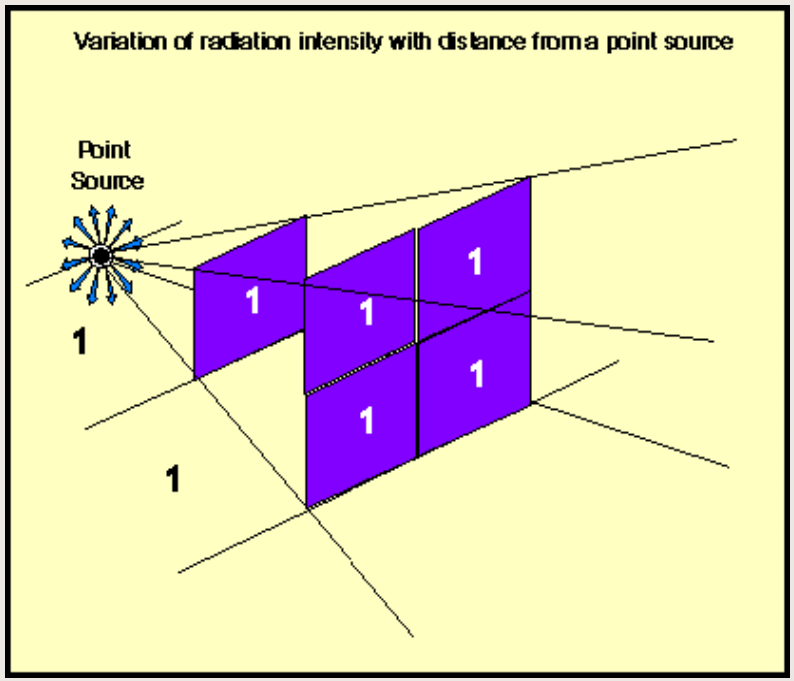
Understanding “Where” or “When” the Radiation Beam is Present

- Does the radiation stream from the source in 360 degrees or is the beam collimated in a particular direction?
- Does the experimental apparatus include adequate "beam stops"?
- Is the source removed from the experiment at the earliest opportunity?
- Has everyone who might come into contact with the experiment or work in the vicinity been informed of the presence of radiation?

Distance – Beta particles have limited ranges in air



Distance – Inverse Square Law

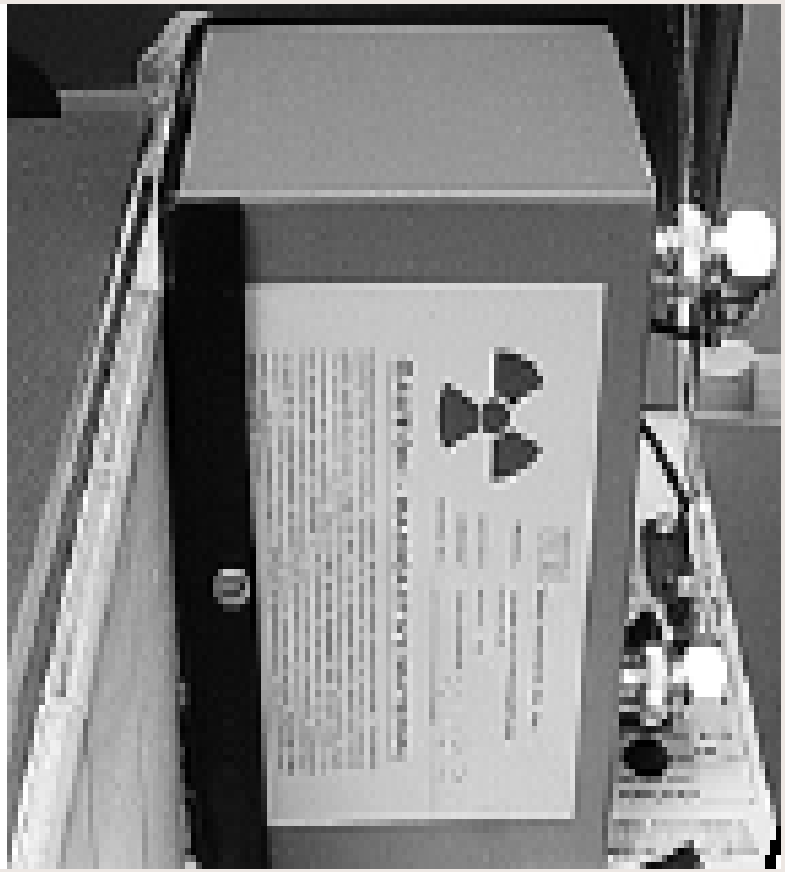


- Doubling distance from a point gamma or x-ray source, decreases dose rate by factor of four
- Tripling it decreases dose rate nine-fold

Neutron

Dose rate from 1 Curie ^{239}Pu-Be source is about 2.2 mRem/hr @ 100 cm based on typical emission rate of 2 x 10^6 neutrons/sec.

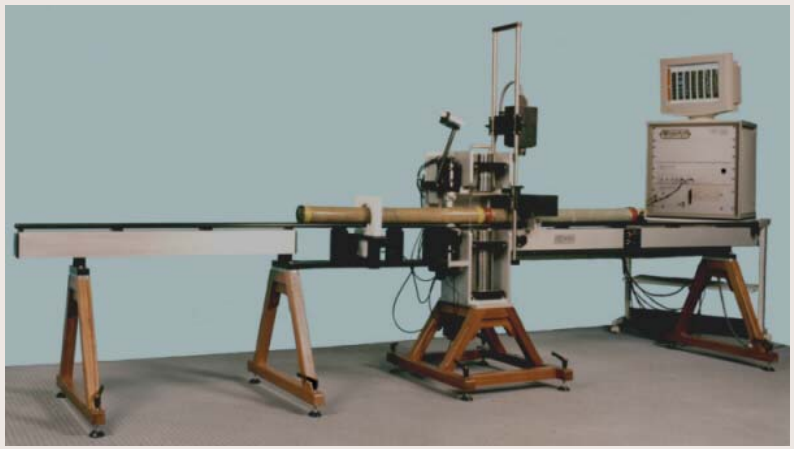
Shielding



Use low Z materials (plastic or glass) to shield a beta source

Note: Ni-63 ECD in this gas chromatograph is completely enclosed.

Shielding



- Enclose x-ray or gamma sources in dense materials (lead, depleted uranium, or concrete)
- Picture shows a sediment core logger

Leak Tests

- Leak tests are accomplished by wiping a piece of filter paper ("wipe smear") across a source or source housing.
- Radioactive contamination leaking from the source can then be measured by analyzing the filter paper in a liquid scintillation counter.

Leak Tests

- No action is taken if a leak-test on a source reveals contamination below 0.001 μCi per smear
- If source wipes reveal contamination above 0.001 μCi per smear, but below 0.005 μCi per smear, we recommend that the source be removed from use.
- If the leak-test reveals contamination above 0.005 μCi per smear, the source is required to be removed from use and either repaired or disposed of appropriately

Note: *Contamination above 0.005 μCi level requires notification of RI Dept. Of Health*

Posting

Signs on laboratory doors or devices must contain the universal tri-foil radiation symbol and the words "Caution -- Radioactive Materials" in the colors magenta and yellow.

Signs are available from the URI Radiation Safety Office.