Safety Information for Sealed Source Users

University of Arkansas
Environmental Health & Safety
Sealed source

Radioactive materials sealed inside metal/plastic.

Most sealed sources can be handled without concern that the radioactive material will be dispersed onto hands or clothing.
Sealed source

Types of sealed source

**Plated**
May be covered by Mylar, aluminum, steel or plastic

**Activated metal**
- Foils
- wires

Neutron Flux
Sealed sources are used

- in many laboratory devices, such as Radiation counters, gas chromatographs (with ECD), and portable gauges.

- as check sources, calibration sources for the detectors
Types of radiation

Alpha ($\alpha$) : Highly Energetic Helium Nucleus ($^4_2\text{He}$)

Beta ($\beta$): Electrons

Gamma ($\gamma$), X-ray (X) : Electromagnetic Wave

Neutron(n) : Neutrons
Alpha particles

- 2 protons & 2 neutrons
- +2e charge
- Massive & Slow
- Typically emitted from heavy nuclides (Pu, U … etc.)
- Travel only short distances (a few inches in air)

Example

\[ ^{238}_{94} \text{Pu} \rightarrow ^{234}_{92} \text{U} + ^{4}_{2} \alpha \]
Beta particles

- Electron (positron)
- -e charge (+e charge)
- Small particle
- High speed
- Energy distribution

Example

\[ ^{32}_{15}P \rightarrow ^{32}_{16}S + ^{0}_{-1}\beta \]
Gamma-ray, X-ray

- Electromagnetic wave
- No charge
- No mass
- Travels at the speed of light
- Very penetrating

Example

\[
\begin{array}{c}
{60 \atop 27} \text{Co} \rightarrow {60 \atop 27} \text{Co} + \gamma
\end{array}
\]
Neutrons

- No charge
- Classified by energy
  Fast neutrons
  Thermal neutrons
- Produced through nuclear reactions (fission, excitation)

Example

$$\frac{9}{4} \text{Be} + \frac{2}{1} \text{D} \rightarrow (\frac{11}{5} \text{B})^* \rightarrow \frac{10}{5} \text{Co} + \frac{1}{0} \text{n}$$
Sealed sources on campus

Am-241
Alpha source
Used in gauges, smoke detectors …etc.

Cs-137, Co-60
Gamma-source
Used for meter calibration, to check source.

Cf-252, Am-241:Be
Neutron Source
Used for meter calibration, activation, and in gauges.

Ni-63
Beta source
Used in GC-ECD.

Sr-90
Beta Source
Used as irradiation sources.
Units

**Ci (Curie)** Original Unit of radioactivity
1 Ci = Activity of 1g Ra
   = 3.7 x 10^{10} dps (disintegration or decay per second)
1 mCi = 10^{-3} Ci, 1 \mu Ci = 10^{-6} Ci

**Bq (Becquerel)** International Unit
1 Bq= 1 transformed per second
1 Ci = 3.7 x 10^{10} Bq

**Decay calculation**
\[ A_t = A_0 e^{-\lambda t} \]
- \( A_t \): Activity at time \( t = t \)
- \( A_0 \): Initial activity, Activity at time \( t=0 \)
- \( \lambda \): decay constant (= ln2/Half life)
Units

**R (Roentgen)**
- The unit of radiation exposure in air.

**Rad (Radiation absorbed dose)**
- Radiation energy absorbed within the unit mass of material.

**Rem (Roentgen equivalent man)**
- Weighting factor Rad.
- Expressing actual effect to humans of different types of radiation.
Authorized users

**Authorized user**
Need to apply for authorized user status. Radiation Safety Training (for new user) and on-line annual refresher training is required.

**Radiation worker**
Work with sealed source under Authorized User’s supervision. Initial training and on-line annual refresher training is required.

**Non-radiation worker**
Not using sealed sources, but have access to the sealed source. Need HAZCOM training including radiation awareness training (Contact EH&S for the schedule).
Applying for the Authorized user status

1. Prepare application form (Contact RSO for the form)
2. Submit application form to the RSO
3. The application will be reviewed by Radiation Safety Committee & the Arkansas Department of Health.
4. You may purchase the sealed source (or devices containing sealed source) upon receiving a copy of the approval letter from the Department of Health.

* When purchasing a new sealed source, you need to go through 1-4 again!
User responsibilities

**Authorized user**
- Supervising activity using sealed source
- Assisting Leak test, Notify the RSO any leak/damage
- Preparing Quarterly Report
- Ensuring Security
- Ensuring that all workers received appropriate training
- Notifying the RSO of any staff changes

**Radiation Workers**
- Follow the instructions of authorized users
- Take required training
Be sure to monitor the work area while handling sealed sources.

Select appropriate meters for monitoring.

Alpha, low-energy Beta sources
→ Scintillation survey meters (ZnS, CsI) Gas-flow counters,
   Silicon diodes
High-energy Beta sources
→ GM counters
Gamma sources
→ Scintillation survey meters (NaI)
Neutron sources
→ Neutron detectors (BF$_3$), Proportional counters
Purchasing Sealed Source

1. Be sure to obtain approval from the Radiation Safety Committee & the Arkansas Department of Health to possess the particular sealed sources.

2. Place an order and notify the vendor to deliver the source to:
   Attn: Radiation Safety Officer
   University of Arkansas
   Environmental Health & Safety
   521 S. Razorback Rd., Fayetteville AR 72701

3. Forward a copy of source certificates, manifest of shipping, and other documents to the RSO.
Transferring Sealed Source

- New owner must be authorized to possess the source before the transfer takes place.

- When transferring the source to an off-campus user, the RSO must check the receiver’s license and packaging and ship them out.
**Terminating use**

Contact the RSO to discuss how we are going to treat the sealed source.
- Transfer to someone else
- Ask Manufacturer to take it
- Put in storage for later use, etc.

**You’re not off automatically !!**

You/RSO need to request the removal of your name from active user list. Even though you do not have any radioactive materials, you’re responsible to keep records, submit report, take training, etc. while your name is on the list.
Training

New user training
- For all new users
- Before handling sealed source
- 3-4 hours

Refresher training
- All active sealed source users

HAZCOM & Radiation awareness training
- For all laboratory workers
- 30min. – 1 hour

Call 5-5448 for the schedule.
Posting/Labeling

Door

sources

Cs-137
30 μCi
T_{1/2} = 30.1y

Storage/case

Am-241 1 mCi
Cs-137 8 mCi
## Door posting

<table>
<thead>
<tr>
<th>Radiation Area</th>
<th>Area where RAM amount exceeds 10 times the specified limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radioactive Material</td>
<td>&gt; 0.005 rem/hr at 30cm from the source</td>
</tr>
<tr>
<td>High Radiation Area</td>
<td>&gt; 0.1 rem/hr at 30cm from the source</td>
</tr>
<tr>
<td>Very High Radiation Area</td>
<td>&gt; 500 rads/hr at 1m from the source</td>
</tr>
</tbody>
</table>
Documentation

Authorized users
- Source information
  - Nuclides
  - Initial activity & reference date
  - Manufacturer, model#, serial#
  - Shipping manifest
- Copy of Quarterly Reports
- Training records

RSO
- Copy of source information
- Leak test results
- Training records
ALARA = As low as reasonably achievable

- Radiation protection philosophy
- Should be applied to maintain any dose at levels as low as are practicable
Protection

**Time**: Shorter usage → Less exposure

**Distance**: Keep distance (Inverse square law)

**Shielding**: Shielding material selection
- Bremsstrahlung

**Monitoring**: Survey meter selection

**PPE (Personal Protective Equipment)**:
- gloves, glasses, lab coat, etc.
Time

- Planning of experiment
- Cold run
- Written procedure
Distance

Distance is a large factor in reducing exposure

Inverse Square law
“When you double the distance the exposure rate is decreased by four”
“Triple the distance? Half the distance?”

Proper equipment (e.g. tongs)
Shielding

Select proper shielding material

Gamma, X-ray – Thick/dense material
(e.g. lead, concrete, steel)

Neutron – Neutron absorber (e.g. Paraffin)

Beta – Low Z material (e.g. Plastic, wood, glass)

Alpha – No shielding required

Why not lead??
* See next slide
Shielding - Bremsstrahlung

High Z materials (dense materials like lead, steel) promote bremsstrahlung production

 Atom of shielding material

\[ e^- \quad X-ray \quad (Bremsstrahlung) \quad e^- \]

Atom of shielding material
Leak test

Sealed source tests are performed routinely by the RSO.

All alpha sources ➔ Quarterly
GCs ➔ Every 3 years
Others ➔ Every 6 months

Authorized users are responsible for assisting the RSO’s work.

Results are all kept at the office of EH&S. Feel free to contact the RSO for a copy!
Security

- Be sure to limit access to the sealed sources/devices containing sealed source.

- Always be aware the location of your sources.

- Contact the RSO or UAPD immediately, if your sealed sources are lost, stolen, or misplaced.
Personal monitoring

TLD (Thermo Luminescence Dosimeters) will be provided by the RSO.

Do!
- Wear assigned badges when handling sealed source
- Return used badges promptly after wearing period
- Report the RSO any loss, damages, other problems
- Return badges when leaving the University

Don't !!
- Take badges home
- Use other people’s badges
- Work without monitoring
- Wear during medical procedures
Emergency Response

Emergency at the storage area
Fire, Explosion, Flooding, etc.

- Help any injured persons
- Warn others in the area
- Evacuate the area
- Call UAPD & RSO
Emergency Response

Source problems

- Rupture, leak
  - Call RSO
  - Secure the ventilation
  - Evacuate the area

- Theft
  - Call RSO
  - Secure other sources
  - Limit the access to the area
Contact information

• Office of Environmental Health & Safety
  5-5448
  (M-F, 7:30am – 5:00pm)

• University of Arkansas Police Department (UAPD)
  5-2222
  (After hours & Holidays)

• Radiation Safety Officer
  5-3379