STANDARD OPERATING PROCEDURE:

Handling sealed radioactive sources: alpha, beta and gamma

Note: To be undertaken only by trained personnel in conjunction with a site-specific risk assessment. Contact your state or territory radiation regulatory authority for the interpretation of regulatory matters. For contact details see:
http://www.arpansa.gov.au/Regulation/Regulators/index.cfm

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1. Introduction

It is desirable for students to develop a respect for the safe and proper use of radiation. The most common radioactive materials used in school science practical work are sealed radioactive sources. These sources are provided as small sealed, circular clear plastic discs approx. 2cm in diameter. Sources provided to schools produce ionising radiation and are generally supplied as an alpha-emitting americium-241 (Am-241) or polonium-210 (Po-210), a beta-emitting strontium (Sr-90) and a gamma-emitting cobalt (Co-60). The potential for harm from these sources is very low.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Australian Government's primary authority on radiation protection and nuclear safety. ARPANSA works with state and territory regulators to promote national uniformity of radiation protection. For details of your state/territory regulator see
http://www.arpansa.gov.au/Regulation/regulators/index.cfm

2. Context

- These instructions are for the use of experienced science teachers, technicians and students over the age of 16, who are under the direct supervision of a teacher.

3. Safety notes

- All persons handling radioactive sources must be trained in their use. Class work with radioactive sources for students in year 10 and under is restricted to teacher demonstrations. Students should be kept at least 2 metres away from these sources during demonstrations.
- For detailed information regarding practice-specific guidance on best practice see the ARPANSA *Safety Guide for the Use of Radiation in Schools* (2012) see http://www.arpansa.gov.au/pubs/rps/RPS18.pdf. It is recommended that persons handling sealed radioactive sources be familiar with this document and a **printed hard copy of this resource is recommended for reference.**
- Protection from radioactive sources can be achieved by:
  - reducing the time of exposure
  - increasing the distance from the source
  - increasing the shielding between persons and the source.

- Radioactive sources should therefore:
  - be handled for the shortest time possible (recommended less than 2 minutes)
  - **never** be picked up with fingers, but always with long tongs
  - be stored at least 2 metres (ignoring walls) from a place where anyone spends extended periods of time
  - be stored within lead lining in a metal box in a locked secure area in the science department away from highly flammable material
  - See the supplementary information on storage of radioactive sources (see p5).

4. Regulations, licences and permits

The ARPANSA *Safety Guide for the Use of Radiation in Schools (2012)* sets out the legal requirements for schools to use ionising radiation sources. For detailed information regarding regulations see the ARPANSA *Safety Guide for the Use of Radiation in Schools* (2012). To comply with these regulations your school will need:

- a responsible person who ensures that all legal and safety requirements are met, usually the school principal or the head of your state/territory education department
- a school radiation supervisor who will have responsibility for the safe storage, use and monitoring of radiation sources. See the supplementary information on Radiation supervisor appointment and responsibilities (see p10)
- a set of local rules for your **specific school site** that document where the radiation sources are stored, where they can be used, who can use them and where the use log is kept. See the supplementary information on the use of sealed radioactive sources (see p6)
- to contact your state Radiation Regulatory Authority to ascertain whether you need a radioactive licence. Consult the ARPANSA website (www.arpansa.gov.au) for the most up to date list of regulators.

5. Equipment

- Radioactive sources, eg americium-241/polonium-210 (alpha); strontium-90 (beta); cobalt-60 (gamma)

Disc source – caesium-137

Disk sources in storage box

- Geiger Müller (GM) Tube and Electronic Counter
- Long forceps or tongs
- Various radioactive absorption materials such as paper, plastic, aluminium and lead in different thicknesses.

6. Operating procedure

1. Follow the local rules for **your specific school site.**
2. Sources must not be handled by persons with wounds on their hands
3. Refer to ARPANSA *Safety Guide for the Use of Radiation in Schools* (2012) page 22 for concerns regarding expectant mothers
4. Sources should not be left unattended
5. Carry each source in its storage container and keep it there until it is required. Do not handle the container for longer than necessary.
6. Use only one source at a time in any one investigation.
7. Handle the source with a long tongs, which keep the fingers at least 10 cm away.
8. Keep the source at least 20cm away from your eyes
9. Plug in GM-tube and electronic counter and operate reset switch to set counter to zero. See manufacturer's instructions.
10. Measure background radiation away from the sources for at least 2 minutes. This is normal everyday radiation which is always present.
11. Pick the source up with the long tongs.
12. Hold the GM-tube 5cm above the source and measure radiation.
13. Place absorption materials between the source and the GM-tube to observe the effects on the radiation count.

    Alpha particles – stopped by sheet of paper or surface layers of skin.

    Beta particles – stopped by a few millimetres of aluminium or 1-2 centimetres of plastic.

    Gamma rays – almost completely stopped by about 1 metre of concrete or about five centimetres of lead. Most will pass through the human body.
14. Complete the investigation in the shortest time possible, consistent with good results.
15. Return the source to its normal container immediately after completing the investigation.
16. The member of staff in charge is to check all sources for signs of damage on return.
17. Immediately report to the member of staff in charge any event in which a source cannot be accounted for, is dropped or may have been damaged.
18. Always wash hands thoroughly immediately after working with any radioactive source.

7. Trouble shooting/emergencies

- Make sure that the Geiger counter you are using is set up and working properly and will detect the radiation being tested. Some GM-tubes used in schools will not detect alpha radiation, as their end-window is too thick. Am-241, which is routinely used in schools, also emits a gamma particle as well as an alpha particle. The gamma particle will penetrate the thick-end window of the GM-tube. The result from the emission of the gamma particle can

be interpreted as the emission of an alpha particle if the GM tube only responds to beta and gamma radiation.

- If any source is dropped and damage to the source is suspected, follow the instructions in the supplementary information on conducting an inspection, wipe test and contamination check (see p8)

8. Waste disposal

- Radioactive sources can last for many years depending upon their half-life. In the unlikely event that a source is dropped and damaged or fails the wipe test, it will need to be disposed of.
- See the supplementary information on disposal of sealed radioactive sources (see p9)
- If you are unsure of how to dispose of your radioactive source, you should contact your radiation regulatory authority for advice about disposal

9. Related material

- Local rules for your specific school site
- Risk assessment.
- *Safety Guide for the Use of Radiation in Schools (2012)*. ARPANSA – Part 1, Ionising Radiation': in particular see:
  - Model Local Rules: Annex 5, pp 50–54.
  - Model Risk Assessment: Annex 4, pp 37–49.
- Manufacturer's Instructions for Electronic Counter and GM-Tube. (e.g. http://www.iecpl.com.au/z_pdfs/ap1884-001+002.pdf)

References:

ARPANSA. 2012. *Safety Guide for the Use of Radiation in Schools (2012)* http://www.arpansa.gov.au/pubs/rps/RPS18.pdf CC BY NC 3.0 AU http://creativecommons.org/licenses/by-nc/3.0/au/

NSW Department of Education and Training (2013). *Chemical Safety in Schools (CSIS)* Sydney: NSW – DET Intranet, http://www.dec.nsw.gov.au/ (Login required. Accessed March 2014)

SUPPLEMENTARY INFORMATION:

Storage of radioactive sources

Radioactive sources must be stored to minimise the risk of exposure to people in the surrounding area when not in use, as well as to provide a secure location to reduce the risk of theft or vandalism.

In consideration of **minimising the risk of exposure** to people in the surrounding area, the sources need to be shielded in lead to absorb the radiation. Very often they are delivered in a lead lined metal container, which is a suitable one for radioactive sources to be stored. Some of the gamma rays will still penetrate lead and for this reason the location of the store needs to be at least 2 metres in a straight line (ignoring walls) from a place where anyone spends extended periods of time.

In consideration of the **possibility of a fire**, the sources need to be housed in a strong steel container (such as a tool box) that should be recognisable after a fire or other such major incident and stored away from flammable materials, so that firefighters do not have to contend with both radioactive sources and flammables. This means that they should not be stored in the chemical storeroom, which will also reduce the likelihood of corrosion. Often they will be stored in the preparation room giving consideration to relevant distances.

In consideration of the **risk of theft or vandalism**, the sources need to be in a secure store, such as the steel container being kept in a fixed, locked cupboard or drawer, making sure there is no access via an adjacent cupboard or drawer, or in a lockable, steel cupboard that is securely fixed. Some schools use wall safes for this purpose. The key to this locked store should be unique and also kept secure.

In order to **warn others in the area of the presence of radioactive sources**, the outside of the containers should be clearly labelled with the contents and the international radiation symbol (also called a trefoil sign) with the wording ‘radioactive materials’. The outside of the cupboard, drawer, wall safe (and the separate metal container, if used) should also be labelled with the trefoil warning sign. The text is optional, but is useful for those unfamiliar with the symbol. Further signage of room doors is not required as it may draw unwanted attention to their presence, however this can be a school-based decision.

Summary for storage of radioactive sources:


Radioactive Materials

Radioactive sources must be stored

- in a lead lined container
- so that the outside of the container is clearly labelled with
  - the contents
  - a trefoil warning sign and
  - the wording ‘radioactive materials‘
- at least 2 metres in a straight line (ignoring walls) from a place where anyone spends extended periods of time
- in a strong steel container
- away from flammable materials and the chemical store room
- in a secure location, with a unique key for access

Use of sealed radioactive sources

Rules must be established for the use of radioactive sources to minimise the risk of exposure to people using the sources.

Records must be kept to ensure that the type and whereabouts of the sources is known at all times, and that inspections, wipe tests, contamination checks and disposal of sources is documented.

Rules

Local rules should be written for **your specific school site**. They are written to ensure that radiation doses and risks of contamination are minimised.

Annex 4 of the *Safety Guide for the Use of Radiation in Schools (2012)* contains example details of the model local rules that can be adapted to meet the needs of **your specific school site:**

Local rules for the **use** of radioactive sources must contain:

- Name of school
- Name of responsible person
- Name and contact details of radiation supervisor
- Location of secure store for radioactive materials
- Laboratories/rooms where radioactive sources are used
- Location of the following documentation
    - Radioactive source history
    - Use log for radioactive sources
    - Monitoring record for radioactive sources and store
    - Contact details of your Radiation Regulatory Authority

Local rules for **science department staff** which detail the safety procedures and administrative requirements should be developed for your **specific school site**: see example set in *Safety Guide for the Use of Radiation in Schools (2012)* pp 50-51

Local rules for **staff and supervised students in years 11 and 12** see example set in *Safety Guide for the Use of Radiation in Schools (2012)* p 52

Record keeping: radioactive source history

An inventory of all radiation sources should be kept and the following **individual** records need to be kept for **each** radioactive source:

- their purchase.
    - a copy of the purchase order/invoice/receipt
    - the radioactive source history including, where possible, the:
        - unique name or reference number
        - radionuclide or chemical name
        - original activity
        - delivery date, supplier and manufacturer.
- their use, inspections, wipe tests and contamination checks.
- their disposal.

Record keeping: use log for radioactive sources

Each time a radioactive source is accessed it needs to be recorded in a 'use log'. The following events constitute a use:

- **a security check for the presence of the sources** (required at 'appropriate intervals'). In most schools where they are used over a period of a few days, and then not for another year, a year would be an appropriate interval.
- **when used in classroom investigations**
- **inspections, wipe tests and contamination checks** (see supplementary information Conducting an inspection, wipe test and contamination check, p8)

Note: Managers and staff in schools and colleges should take all possible steps to ensure that loss of a radiation source cannot happen. However, in the event that a source is missing, the radiation supervisor should check that it has not been:

- returned to the wrong store
- left inside the piece of equipment within which it was last used
- temporarily removed to another area, or
- placed with waste for disposal.

All incidents or accidents involving radiation sources, such as a situation where a radiation source cannot be found, must be reported to the relevant radiation regulatory authority. In the first instance, this will usually be the Principal. If you suspect that someone has removed the source unlawfully from the premises, the Principal, in consultation with the radiation regulatory authority, will need to inform the police.

Record keeping: monitoring record for radioactive sources and store

Regular inspections and wipe tests should be conducted and the results entered into the use log. Instructions for conducting an inspection, wipe test and contamination check are on p8.

Regular inspections, wipe tests and contamination checks ensure that the mechanisms for preventing dispersal of radioactive materials are functioning as intended. You should carry out an inspection and wipe test once a year on each source kept in the radioactive materials store, including stock bottles of radio chemicals if applicable. A simple record such as pass or fail in the use log will be necessary for each source.

Contamination checks should be conducted anywhere that there is a possibility that radioactive materials may have been deposited on surfaces, e.g. containers, radioactive store or when a source has been dropped.

Summary of the use of sealed radioactive sources:

- Local rules should be written for **your specific school site**
- An inventory of all radiation sources should be kept
- Each time a radioactive source is accessed it needs to be recorded in the use log
- Regular inspections, wipe tests and contamination checks should be conducted and the results entered into the use log

Conducting an inspection, wipe test and contamination check

Good light is needed to conduct a regular, visual inspection of a radioactive source which should be held at least 20cm away from your eyes. All scratches and any signs of deterioration particularly to the seals need to be recorded. A routine check and wipe test should be carried out annually. The wipe test is used to check for the unlikely event of leaks of radioactive material from a sealed radioactive source. If there is any damage the source should be withdrawn from use and disposed of appropriately.

A contamination check should also be conducted anywhere that there is a possibility that radioactive materials may have been deposited on surfaces, e.g. containers, radioactive store or when a source has been dropped.

Conducting an inspection, wipe test and contamination check:

An annual set of monitoring checks needs to be conducted using the following procedure:

- Wear PPE: a disposable apron, safety glasses and disposable gloves.
- Carry out the work on at least two sheets of newspaper.
- With all sources at least 2 metres away and using the GM-tube, the background radiation should be measured for 2 minutes. This background count is recorded.
- **Inspect and test one source at a time**, keeping other sources in their normal containers at least 2 metres away.
- Using long tongs pick up the sealed source and carry out a visual inspection keeping the source at least 20cm away from your eyes. A mirror could be placed on the work surface so that the window side can be viewed facing away from the eyes. Record any small blemishes or scratches for future reference.
- **Wipe test:** Using a clean, dry, paper tissue, gently wipe across the window side of the source.
- Move the source at least 2 metres away and measure the radioactivity 2mm from the wipe area on the tissue paper with a GM-Tube for 2 minutes. The count is recorded.
- Repeat this procedure with other sources using new tissue paper and record the results
- Providing the tissue count was less than 1.5 times the background count, the source has passed the wipe test. A record of the annual results needs to be kept for comparison and any noticeable changes need investigating for leaks or expiry.
- **Contamination check:** The GM-tube also needs to be passed over the interior of the lead lined storage box or metal box to check for any contamination. If the count is 1.5 times higher than local background radiation then the storage areas need to be carefully and thoroughly wiped out with tissues soaked in strong detergent. Shelves and cupboards need to be checked also. The origin of the contamination needs to be defined.
- If the source appears to be damaged or fails its wipe test, note the action taken. Keep any such source inside its normal container and place it in a strong plastic bag. Seal and suitably label this bag and keep it in the usual store. Consult the radiation regulatory authority as professional disposal may be required.
- When work is complete, place disposable materials that were used in a strong plastic bag, which is tied for disposal with normal garbage.
- Always wash hands thoroughly immediately after working with any radioactive source.

Disposal of sealed radioactive sources

A sealed radioactive source with an activity below the exemption level as specified in Table 3 in the *Safety Guide for the Use of Radiation in Schools (2012)* may be disposed of without regard to its radioactive properties. However it is important to check the current requirements in your jurisdiction with your radiation regulatory authority.

Radionuclide	Max activity of sealed radioactive sources in NDRP for use in schools (kBq)	Exempt activity in NDRP (kBq)
Cobalt-60	200	100
Strontium-90	80	10
Caesium-137	200	10
Polonium-210	–	10
Radium-226	20	10
Americium-241	40	10

Table 3: Sealed radioactive sources for use in schools and colleges

Exempt radioactive sources do not need to be treated as radioactive for disposal and can therefore go out with general garbage when they are no longer needed. There may however, be requirements for its chemical properties. If you are disposing of a source that has decayed to an activity below the exemption level for regulatory control, you should permanently remove or obscure all markings relating to its previous radioactive status.

If you wish to dispose of a radioactive source with an activity above the exempt level, or if you wish to dispose of any other type of radiation source, such as an X-ray unit or a Crookes tube or if you are unsure of how to dispose of your radioactive source, you should contact your radiation regulatory authority for advice about disposal.

Summary of disposal of sealed radioactive sources:

- A radioactive source with an activity below the exemption level:
  - Should have all markings relating to its previous radioactive status permanently removed or obscured and then
  - Can be disposed of with the general garbage
- A radioactive source with an activity above the exemption level:
  - Contact your radiation regulatory authority for advice about disposal

Radiation supervisor appointment and responsibilities

Each science department should have a named radiation supervisor nominated by the Principal. The radiation supervisor would probably be a member of the teaching staff such as the Head of the science department or the Head of Physics. The Principal/education department should ensure that the Radiation Supervisor is competent and is fully aware of his or her duties. The radiation supervisor should understand the basic principles of radiation protection and the relevant requirements of the local radiation protection legislation. They should be fully aware of the hazards and control measures associated with each radiation source in his or her care.

A school radiation supervisor has responsibility for the safe storage, use and monitoring of radiation sources. The radiation supervisor should liaise with the Principal/education department regarding the development and agreement of written 'local rules' for your specific school site and ensure that all staff and permitted students who handle radioactive materials should be familiar with, and have easy access to, the 'local rules'. The Radiation Supervisor should be satisfied that all persons involved are informed and trained to a level which enables them to carry out procedures safely.

Summary of Radiation supervisor appointment and responsibilities:

The radiation supervisor should ensure that:

- *they are fully aware of the hazards and control measures associated with each radiation source in his or her care*
- *all such work is carried out in accordance with the local rules*
- *regular monitoring is carried out on radioactive sources and their containers*
- *all records required are accurate and kept up to date*
- *they know what to do in an emergency*
- *there are written standard operating procedures for work with radioactive materials*
- *all radiation sources have been replaced in the store after use*
- *relevant checks have been conducted*
- *correct disposal procedures are followed*

The radiation supervisor should provide appropriate instruction and training in:

- *security and storage arrangements*
- *record keeping (inventory of sources and the use log)*
- *safe handling of each type of radiation source*
- *correct use of associated equipment, particularly that used for monitoring purposes*
- *action to take if a radioactive source is dropped or a spill occurs*
- *when to seek help and advice from the radiation supervisor*

Other aspects

This document summarises the main requirements for the safe storage, use and disposal of sealed radioactive sources. There are many other aspects that are addressed in the *Safety Guide for the Use of Radiation in Schools (2012)* such as radiation and its properties, choices of radiation sources; cleaning up a spill and example Risk Assessments.

References

ARPANSA. 2012. *Safety Guide for the Use of Radiation in Schools (2012)* http://www.arpansa.gov.au/pubs/rps/RPS18.pdf CC BY NC 3.0 AU http://creativecommons.org/licenses/by-nc/3.0/au/