

Section 7. Laboratory procedures

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7.1 Open sources

To minimise the external radiation hazard the workers should:

- minimise exposure time, e.g. good experimental planning, equipment prepared;
- use adequate shielding, e.g. keep source behind appropriate shield, use pipette shield;
- maximise distance from radioactive source: Remember - inverse square rule, e.g. keep radioactivity at arm's length

No eating, drinking, smoking or application of cosmetics is allowed in laboratories in which radioisotopes are used. Cuts in the skin must be covered.

The absolute minimum of protective clothing is a buttoned laboratory coat with button up collar with elasticated cuffs on the sleeves (Howie coat) and disposable nitrile or neoprene gloves (or other

suitable gloves as specified in the risk assessment). The Scheme of Work¹ should identify whether additional measures such as plastic overshoes, additional screening and/or remote handling devices may be necessary.

All manipulations involving radioactive solutions should be done over trays lined with absorbent paper, to minimise the risk of accidental spills. When there is any possibility of radioactivity being dispersed in the laboratory air either in the form of an aerosol, fine powder or gas, an approved glove box or fume cupboard must be used. These enclosures must be clearly designated. Benches should be kept free from materials not required for current operations.

The mouth must not be allowed to come into contact with any apparatus. Pipettes should be used with a bulb filler.

Before any person working with an unsealed radioactive substance leaves the area for any reason (e.g. to go to the lavatory, eat or to go home) they should wash. Where appropriate they should check for contamination of clothing and skin.

Unsealed radioactive substances must be clearly marked with the compound, isotope, total activity and date. Their containers must be labelled with a trefoil (see *Signage* below) and the word Radioactive. The only exception is where the container is too small, in which case its holder should be labelled

For emitters of penetrating radiation, the sources should never be held in the hand nor directly manipulated by hand.

When a series of experiments has been completed, the working space must be tidied and monitored, all apparatus cleaned, the tray linings renewed and waste cleared away in the correctly tagged bags.

Glassware must be cleaned by soaking in a solution of an approved detergent. In the case of low-energy β -particles it is difficult or impossible to check the internal surfaces of, for example, glass apparatus, and special care must then be taken in rinsing and cleaning. This difficulty is one of the most important reasons why apparatus must not be taken from radiochemical laboratories into other rooms. If in any doubt about the extent of contamination, dispose of the contaminated glassware as this will help to avoid cross-contamination between experiments. All contaminated glassware should be monitored for radioactivity. For further advice on decontamination see *Radiation Emergency and Contingency Plan*.

¹ That is the Application for an Approved Scheme of Work for working with Ionising Radiations (Incorporating the "Prior Risk Assessment") (Form 4)

Reference should also be made to *Local Rules 9: Areas where ionising radiation or x-ray generators are used or stored* for rules relating to the management of authorised areas for radiation work.

Good laboratory practice for working with unsealed source

When working with radioisotopes and other forms of ionising radiation good laboratory practice is essential for all levels of work whether it is carried out in a dedicated radioisotope laboratory or in a designated area of the normal laboratory. The procedures described here are designed to minimise any internal radiation hazard resulting from ingestion and to minimise exposure from external sources of ionising radiation

Monitoring

All areas should be monitored using the correct monitor before and after work in the designated radiation area as failure to do so could lead to the contamination of you and your experiment.

Gloves

Preventing radioactive material from coming into contact with the skin is an important protection against contamination with radioactive material and suitable gloves should be worn for all operations involving radioisotopes. Suitable gloves would be disposable nitrile or neoprene gloves (Other suitable gloves may be suitable, as specified in the risk assessment). Latex gloves should be avoided, as they can be allergenic.

Shielding

Shielding should always be used when working with even small amounts of radioisotopes that emit penetrating radiation such as ^{32}P and ^{125}I . For ^{32}P it is possible to use a Perspex shield while gamma emitters such as ^{125}I will require lead shielding.

Tubes and containers

Usually the volumes of radioactive liquid handled are quite small and it is often convenient to keep them in 2ml micro-centrifuge (Eppendorf) tubes. However, to avoid contamination through the generation of aerosols the use of flip-top tubes for radioisotopes is banned. For all small volume radioactive samples use only **screw cap** micro-centrifuge tubes that are available from the stores.

Centrifugation

Centrifugation can generate significant aerosols and so it is important that all tubes are tightly capped before centrifugation and the tubes should be less than half full when centrifuged in fixed-angle rotors. Should any part the centrifuge become contaminated, immediately contact the UIRPO who will seek expert advice on the best decontamination procedure. (Life Sciences have guidance on the general use of centrifuges on their website).

Homogenisation

As in the case of centrifugation, homogenisation of radioactive solutions can generate significant aerosols and great care must be taken to avoid contamination of the environment. Always monitor the area around the homogeniser very carefully.

Signage

All containers in which radioactive materials are stored must be clearly and legibly marked. Signs must comply with the Safety Signs and Signals Regulations and so must consist of a Trefoil in a yellow triangle (see below) along with the wording “*Radioactive*”

Additionally, each container of radioactive substances should be labelled with the radionuclide, activity and preferably with a unique identifier to aid radiation accountancy.

NOTE: The above reflects Good Laboratory Practice for working with the range of isotopes used for research and teaching at Essex and are not “Special Procedures” as defined under IRR 2017: Regulation 16 and the Approved Code of Practice. Should Special Procedures be required for Controlled Areas, these will be determined in consultation with the University’s RPA.

7.2 Disposals

All radioactive waste must be disposed of according to the approved procedures for that particular Scheme of Work.

An accurate record of the disposal of radioactive waste must be kept in each department. See *Local Rules Section 6.1: Record Keeping*. On no account should radioactive waste be allowed to accumulate in the laboratory for more than one day.

(i) SOLID: All solid waste should be treated as contaminated. All combustible solid waste should be put into plastic bags and sealed ready for incineration. A unique numbered tag must be attached to the bag (Section 6.1.2). All non-combustible solid waste must be decontaminated and disposed of in normal waste bins. If in doubt consult the DIRPS or UIRPO.

(ii) AQUEOUS LIQUID: All aqueous waste must be disposed of via the designated sink in room 3.02 ensuring that the liquid is poured directly into the plughole and flushed copiously with water. Entrained²

² Entrained means: Insoluble solid, gas or organic liquid which is suspended or trapped in the waste aqueous solution.

solids, gases or non-aqueous liquids must not be disposed of with aqueous waste, if in doubt consult the DIRPS or UIRPO (for example, it might be necessary to filter the aqueous waste).

(iii) **ORGANIC LIQUID:** Vials containing liquid organic waste must be put into plastic bags and stored for incineration. A unique numbered tag must be attached to the bag (Section 6.1.2).

(iv) **GASEOUS:** All procedures that may result in the production of gaseous waste must be carried out in the designated fume cupboard in room 3.02. All gaseous disposals will be made through duct 9.

Achieving best available technique (BAT): optimising use of radioactive sources to avoid contamination and waste.

The procedures and engineering controls used must minimise the spread of contamination into the environment. These will need to be recorded as part of the Scheme of Work³ and should be followed by the Radiation Worker. Examples of good practice are:

- Returning stock to their storage location rather than leaving them out
- the use of containment boxes for moving radioactive substances
- the use of containment trays, monitoring and personal protective equipment
- Arranging to share stock or work facilities may also be a useful means of minimising stock volumes, although unused or out of date stock should be disposed of promptly.
- All radioactive substances must be stored in a suitable lockable container or be in continuous surveillance.

Spot checks on procedures in any laboratory where ionising radiation is used may be made by the RPA or UIRPO at any time without prior notice.

³ That is the Application for an Approved Scheme of Work for working with Ionising Radiations (Incorporating the "Prior Risk Assessment") (Form 4)

7.3 Monitoring contamination

7.3.1 Equipment

Equipment suitable for monitoring the sources of radiation must be provided in each laboratory area. Ensure that the appropriate monitor and techniques are used (See Local Rules *Section 8: Monitoring of Radiation*). If in doubt consult the DIRPS or UIRPO

Monitors are routinely calibrated annually conforming with the 'Good Practice guide No 14 (Issue 2) – The Examination and Calibration of Portable Radiation Protection Instruments'. Copies of the calibration certificates are held by the UIRPO.

7.3.2 Monitoring Procedures

The department must devise a routine monitoring procedure which must be followed precisely. All areas where open radiation sources are used must be checked for contamination using appropriate monitoring methods at least every fortnight. In addition, radiation workers are expected to monitor, before and after each work session.

A permanent record must be kept of all results obtained from such monitoring. If a significant level of contamination is found in any area the DIRPS, in conjunction with the RPA and UIRPO, shall determine the source of the contamination as well as checking the experimental procedures that led to the contamination. An action level should be set which, if breached, requires the removal of the radioactive contamination. Readings should be in real numbers, rather than a tick, with the background subtracted.

Usually such contamination indicates poor laboratory technique and persons found to have caused contamination may have their registration as radiation workers withdrawn.

Information on monitoring techniques is given in Local Rules *Section 8: Monitoring of Radiation*

7.4 Closed (sealed) sources

Closed sources may only be used in accordance with an approved scheme of work and in an appropriate area. Closed sources must be stored in a secure enclosure and their physical location checked at least once a month and a record of each check must be made. The loss of a closed source is regarded by the Environment Agency as a very serious event and usually prosecution will follow any such loss.

Closed sources should only be removed from their containers using either tweezers or some other remote handling device. Closed sources should *never* be handled directly. Whenever possible, closed sources should be adequately shielded while they are in use.

When sources are installed in fixed apparatus it should be monitored to ensure that shielding is adequate, and the outside of the instrument must be clearly marked with details of the source that it contains.

The areas in which closed sources are used must be designated according to the radiation hazard (see *Local Rules 9: Areas where ionising radiation or x-ray generators are used or stored*) and clearly marked with notices giving details of the type of isotope, amount of isotope and the type of radiation emitted by the source.

No other types of work involving persons may take place in the area while ionising radiations are being used and persons not involved in the work must be excluded from the area.

Closed sources **must** not be exposed to conditions in use or in storage which might be likely to disrupt the integrity of the sealed source. Similarly any events which might damage the sources must be reported to the UIRPO and DIRPS who will arrange for the sources to be leak tested.

7.5 X-Ray generators

X-ray generators may only be purchased and installed in appropriate areas with the advanced approval of the UIRPO, following consultation with the University's RPA.

There are a number of legal requirements that must be met with regard to the design of the equipment and its management. For this reason anyone considering purchasing an X Ray Generator must first contact the UIPRO, who will provide more detailed advice on requirements and what conditions will need to be met in order for approval to be given.