Procedures for the manipulation of unsealed Sources

Generic Procedures

1 A project registration form and Risk Assessment must be completed by the Project Supervisor, and countersigned by the RPS, for each new procedure.

Completed Project Registration forms should be sent to the Radiation Safety Unit.

2 All users must be registered, or working towards registering, as Radiation Workers; non-registered workers should not work in an unsupervised capacity. In order to identify possible handling difficulties, a preliminary 'dummy' experiment with inactive materials should be carried out before any new procedure is attempted.

3 Eating, drinking, smoking, or the application of cosmetics etc. are not permitted in areas where radioactive materials are handled. No food, drink, crockery or cutlery should be brought into such areas.

4 No mouth operated equipment (e.g. pipettes) may be used. Self-adhesive, not gummed, labels should be used.

5 A laboratory coat must be worn for all work with unsealed radioactive materials. In certain circumstances the RPS may prescribe more stringent safety measures such as special safety clothing, disposable overshoes, eye protection and changing facilities.

6 Disposable surgical gloves, or equivalent, must be worn when there is a possibility of hands becoming contaminated. In certain circumstances, two pairs may be indicated by the Risk Assessment. Tissues should be used to prevent spread of contamination when handling switches, taps, monitoring instruments etc.

7 Any cut or break in the skin of the hands or other vulnerable area liable to contamination must be covered with a waterproof adhesive dressing before

entering the isotope laboratory. Any injury received during work with radioactive materials must be reported to the RPS who will arrange suitable first-aid. If a significant intake of radioactivity or excessive skin contamination is suspected, the RPS should be informed immediately and appropriate remedial action commenced.

8 A high standard of cleanliness must be maintained at all times, to avoid spread of contamination. Working areas should be kept free of articles not required for the work. Each worker must be responsible for tidying up after him/herself at the end of each working session.

9 Paper tissues must be used instead of handkerchiefs. They should be disposed of as low activity waste.

10 Personal dosimeters (body badges and/or TLDs) should be worn if issued.

11 Each consignment of radioactive material must be checked for leakage of radioactivity during transit, by monitoring the packaging materials.

12 Radioactive solutions should always be handled over a suitable tray lined with absorbent paper or a disposable liner. Benches should also be covered with absorbent paper with a non-porous backing.

13 Shielding and handling equipment (e.g. forceps etc.) should be used as appropriate. For accurately transferring small volumes of liquid, a disposable-tip, automatic pipette is recommended. Whenever reasonably practicable, dose rates should be kept below 1 $\mu Sv\ h^{-1}$. A Perspex 'pipette-guard' may be used to achieve this.

14 Radioactive solutions should always be manipulated behind a splash barrier appropriate to the radionuclide being handled. All procedures which are considered likely to produce vapour, spray, dust or radioactive gas should be carried out in an approved fume cupboard, glove box or safety cabinet.

15 If a hypodermic needle is to be used to dispense from a multidose vial, care should be taken to avoid the formation of aerosols/splashing due to pressure build up. Cooling the vial before puncturing the rubber septum should ensure that the pressure inside is less than atmospheric.

16 All radioactively contaminated waste must be segregated and disposed of in accordance with the conditions specified in the site Permit issued by the Environment Agency under EPR2011.

17 Designated Sinks must be clearly labelled and not used for handwashing. Due to the risk of contamination from splashing etc. the space below such sinks must be kept clear at all times and not used for storage.

18 All radioactive samples must be clearly labelled, in appropriate containers, and

securely stored in a locked room, cupboard, freezer or refrigerator when unattended. Each store should have an accurate up-to-date stock list.

19 Accurate records must be kept of all receipts, current stock and waste disposals. It is an offence under the EPR20111 not to have records up-to-date at all times.

20 Monitoring of all work areas should be carried out at the end of each work session. No item may be removed from the radioisotope area until it has been monitored and found to be free of contamination.

21 On completion of work disposable gloves must be washed and monitored before removal. Hands and clothing must also be monitored and washed where necessary. All protective clothing must be removed before leaving the laboratory.

22 A full area monitoring survey should be undertaken at regular intervals and records kept of all results, even if no contamination is found.

23 Potential radiation hazards should be assessed and, if necessary, contingency plans drawn up for use in an emergency. In the event of any such incident the area RPS and the RPA must be informed immediately.

Additional Procedure for the use of High Energy Beta Emitters

All work with high energy β-emitters must be undertaken in strict accordance with the procedures above. The greatest hazard is from external radiation to the skin and eyes, since the surface dose rate from 1 MBq in 1 ml of liquid may well be in excess of 200 $mSvhr^{-1}$. **The use of low energy alternatives should be considered and encouraged whenever practicable**.

In addition to the general rules the following procedures should be observed:-

1 Work should be carried out behind a Perspex screen (10 mm thick), which will completely absorb the β-radiation. The use of angled screens will reduce the dose to the eyes. To minimise the dose from bremsstrahlung (X-ray) radiation caused by absorption of high energy ß particles, shielding should be made of low atomic number material (e.g. Perspex).

2 An extremity monitor (TLD) must be worn for work with any radionuclide where the activity exceeds 40 MBq, and in such other cases as advised by the RPS.

3 A suitable contamination monitor must be available at all times to monitor gloves, wipes and equipment.

4 Disposable gloves must be worn at all times. Two pairs may be desirable in the

case of certain radionuclides (e.g. in the case of lipid-soluble compounds). Gloves should be monitored frequently and the outer pair replaced if they become contaminated. Contaminated gloves will irradiate the skin at high dose rates through the glove material.

5 All work must be carried out in a tray, using a disposable liner. High activities (>1MBq) should be manipulated in a fume cupboard designated as a Controlled Area; for non-classified workers, a System of Work will apply for such operations.

6 Due to the possibility of a direct radiation dose from the stock material as supplied by the manufacturer, it will be necessary to check packaging materials for potential leakage during transit, in a low background area. The sample container itself should be wiped with a tissue which can then be checked with a monitor.

7 To minimise the dose rate to the hands all high-energy beta and gamma emitters must be adequately shielded, and suitable handling equipment (e.g. forceps, shielded syringes etc.) used. Direct handling of samples must be avoided, and sample tubes should be placed in vial-shields such as bored-out Perspex blocks. Any handling tools used should not increase the risk of spillage.

8 If the solution is to be extracted with a syringe the barrel should be covered by a Pipette guard. If this is not possible the capacity of the syringe should be large enough to ensure that the fingers are at a maximum distance from the solution, so that the radiation dose received is reduced as far as reasonably practicable. Wherever possible it is preferable to transfer small volumes of radioactive liquid with an automatic pipette using disposable tips.

9 The disposal of all radioactive waste, including needles and pipette tips, must be strictly in accordance with the procedures detailed elsewhere.

Additional Procedures for the use of electron-capture radionuclides (e.g. Iodine-125)

Electron-capture radionuclides typucally emit low energy X-ray and gamma radiation with a maximum energy of 35 keV. **Due to the volatile nature of iodine, the most significant hazard from ^{125}I is from inhalation**, the critical organ for uptake being the thyroid. The Annual Limits on Intake (ALI) for ^{125}I are the lowest found for nuclides commonly used in laboratories, the values given for inhalation and ingestion being 2 MBq and 1 MBq respectively. All work with ^{125}I must therefore comply with the following procedure:-

1 Solutions containing iodide ions should neither be made acidic nor stored frozen; both lead to formation of volatile elemental iodine.

2 Care should be taken when opening vials to avoid the production of minute airborne droplets.

3 Iodine-labelled compounds can penetrate surgical rubber gloves. Two pairs should be worn, or polythene over rubber.

4 Low activity RIA kits (< 370 kBq) may normally be handled on the open bench, but all other work with iodine should be carried out in a fume cupboard, given the likelihood of aerosol production.

5 For work with higher activities special transparent shielding made from lead impregnated acrylic is commercially available which has a lead equivalence value of 0.5mm. Stock solutions of ^{125}I as supplied by the manufacturer, should be shielded with 1mm of lead.

6 Direct handling should be avoided, and forceps etc. should be used.

7 Spillages of iodine may require special treatment because of the volatility problem. An alkaline solution of 5% sodium thiosulphate (25g sodium thiosulphate + 2g sodium iodide in 1 litre of 1N sodium hydroxide) should be used to render the spill chemically stable prior to decontamination by the normal methods.

8 A portable monitor with a scintillation detector should be used to monitor for surface contamination. Geiger-Muller tubes are generally unsuitable as they are not sufficiently sensitive.

9 All workers handling radioiodine should regularly monitor their thyroid glands following the instructions given below.

10 In the case of an accident involving possible ingestion/inhalation of radioiodine the RPS must be contacted as, with medical supervision, it may be possible to block uptake to the thyroid by the administration of potassium iodide tablets (200mg given orally two hours after ingestion will reduce uptake by 80%).

Guidance on Monitoring the Thyroid for Iodine-125 uptake

Routine monitoring is best carried out about 24 hours after exposure to risk of ingestion, but if a significant ingestion is suspected measurements should take place on the day of exposure.

A Mini-Instruments scintillation monitor, such as normally used for the detection of ^{125}I surface contamination, is suitable for detecting ^{125}I accumulation in the thyroid gland, using the following method:-

1 Apply the probe end to the surface of the neck with its rim tangential to one clavicle and the midline of the neck (see Figure below).

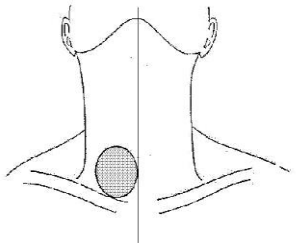
2 Point the probe radially into the neck and move it slowly up and down. Note the maximum reading on the monitor.

3 Repeat on the other side of the midline and again note the maximum reading.

4 Add the two maximum values together, after subtracting the background from each, and compare the sum with the **action level** given in the Table.

5 If the sum exceeds the value given in the table notify the RPS and make arrangements with Medical Physics, Manchester Royal Infirmary, for a more accurate test.

Measurements should be made well away from any other sources of activity after carrying out a battery check on the instrument for at least 10 seconds. The background count-rate should be noted and a written record kept of all observations.



Probe position for ^{125}I Monitoring

Action Levels for Iodine-125 in the thyroid

Probe	**Action Level (cps above background)**	**Calibration (cps/kBq)**
Mini Type 42 A or B	**20**	27
Mini Type 44 A or B	**70**	95

The action levels correspond to an activity of approximately 0.75 kBq of ^{125}I in the thyroid. As the Annual Limit on Intake for ^{125}I is 1 MBq, these levels in no way imply a biologically significant intake of radioactivity, but values of this order obtained regularly would indicate poor laboratory practice and suggest the need for an investigation into both the methods used and the ways of improving them.

Additional Procedure for the use of High Energy Gamma Emitters

All work with γ-emitters, such as Caesium-137, must observe the generic procedures previously described. The greatest hazard is that of external irradiation which, in the case of high energy sources, can penetrate into or through the body. In addition to the general rules the following procedures should be observed:-

1 High energy γ-emitters may only be stored and used in areas approved by the RPS. The total time spent in the area must be the minimum necessary to safely carry out the required procedures.

2 Stock solutions and working samples must be shielded at all times with sufficient lead to ensure that the dose rate in the working area is less than 7.5 μSv per hour. It may be necessary to shield individual sample containers to satisfy this condition. The boundary of the area where the γ-dose rate exceeds this level must be clearly marked with warning tape and the area inside designated as a Controlled Area. Unless specifically calibrated for the isotope in question monitors used to measure dose rate should have a response which does not vary with photon energy.

3 Radiation doses to the body and hands must be monitored by means of personal dose monitors. The dose rate in the working area should be monitored regularly to confirm that the shielding provision remains adequate and the working conditions satisfactory. Contaminated gloves will irradiate the skin at high dose rates through the glove material; they should therefore be monitored frequently and replaced if they become contaminated.

4 To minimise the radiation dose to the hands, direct handling of tubes containing radioactive material should be avoided wherever practicable. Time and distance should both be taken into consideration. Specially designed remote handling devices should be used if the use of ordinary forceps etc. would increase the risk of spillage; a Risk Assessment and associated “dummy run” should give an indication of the likelihood of this situation occurring.

5 All equipment which may potentially have become contaminated should be checked for contamination in a low background area.

6 Whenever possible, contaminated equipment should be put to soak in Decon solution immediately after use, for subsequent disposal as liquid waste via a Designated Sink. Other than the very low levels permitted in the normal waste bins, the University has no authorisation for the disposal of solid waste contaminated by isotopes with a long half-life e.g. ^{137}Cs.

7 Monitoring for surface contamination must be carried out at the end of each procedure and whenever dispersal of radioactive material (splashes etc) is suspected. The results of all monitoring, including negative findings, must be recorded. If, due to the presence of contained sources of activity, the background count rate is too high to permit detection of contamination levels, wipe tests must be used, and the wipes counted in a gamma counter.

Additional Procedure for the use of Tritium

Tritium is an emitter of very low-energy β-particles (maximum energy 18.6keV). The maximum range of such particles in air is ONLY 6mm. It is therefore **impossible** to measure levels of tritium contamination with any of the monitors typically used for other radionuclides.

Routine monitoring **must** be conducted using the **wipe test** method described in the "Radiation Monitoring" section.

Storage of both tritiated water and aqueous solutions of tritiated compounds in freezers may give rise to contamination of the frost within the freezer. Routine monitoring of such freezers should be undertaken by scintillation counting of ice samples.

[Tritiated water should be stored at room temperature in a suitable store where practicable].