Ionising Radiation Regulations 2017

LOCAL RULES

These rules apply to the following areas:-
Biomedical Physics B6/7

Issue date 20/4/2018

Review date April 2020

Note If you are reading this document after the review date please check with your RPS that you have the latest version
Overview

- Only registered and suitably trained workers are permitted to work with isotopes in the University of Aberdeen.

- Registration is initiated using the IsoInventory software (http://isoinventory.abdn.ac.uk/).

- Completion of the online radiation user training course (accessed via https://www.abdn.ac.uk/safety/resources/radiation/ionising/) is mandatory before users can be registered. It is also mandatory for new users even if they have completed a similar course elsewhere.

- Supervisors and/or line-managers are responsible for ensuring that all technical or research staff and post-graduate students in their groups are registered to use isotopes before any such work commences.

- Supervisors and/or line-managers are responsible for ensuring that all workers are fully familiar with the IsoInventory software system that is used for isotope registration and the keeping of records of their usage and disposal.

**Isotope users who do not comply with these rules may be subject to disciplinary action including being barred from working with isotopes.**
1. **Radiation protection supervisor is:** Dr Tim Smith

2. **Designated areas**

<table>
<thead>
<tr>
<th>Controlled radiation areas</th>
<th>Supervised radiation areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Room B6/7 Biomedical Physics</td>
</tr>
</tbody>
</table>

3. **Unsealed Radionuclides used**

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Half Life</th>
<th>Emissions</th>
<th>Contamination monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>18F</td>
<td>110min</td>
<td>Positron, gamma</td>
<td>EP15</td>
</tr>
<tr>
<td>3H</td>
<td>5y</td>
<td>beta</td>
<td>Scintillation counter</td>
</tr>
<tr>
<td>111In</td>
<td>2.8d</td>
<td>gamma</td>
<td>EP15</td>
</tr>
<tr>
<td>99mTc</td>
<td>6h</td>
<td>gamma</td>
<td>EP15</td>
</tr>
</tbody>
</table>

4. **Radiation Equipment used in the area**

Scintillation counter

5. **General Lab arrangements**

These rules must be posted in each laboratory radioactive materials are handled. A prior risk assessment must be carried out before commencing new work activities and recorded using form on the iso-inventory system.

**Access to the lab**
- Access to radiation areas should be restricted to those who have been trained and are directly involved in the experiment unless authorised unless they are under the close supervision of the RPS.

**General**
- Work with radioactive materials should only be carried out in designated areas identified in section 2. If you wish to carry out work in an area not identified in section 2 then contact your RPS for advice.

- Experiments should be carefully planned and should only take place if no other equivalent experiment which does not involve radioactive substances exists. We are obliged by legislation to ensure that any experiments that require the use of an isotope utilizes the minimum quantity of radioactivity that will ensure a viable result.

- Consideration should be always be given to using the least hazardous radionuclide for example P-33 should be used in preference to P-32.
• Experiments involving radioactive materials should only be carried out by suitably trained staff/students. Any new member of staff or student wishing to undertake work with unsealed radioactive substances must first have completed the basic radiation safety course. Additionally the principle investigator/RPS should ensure that all staff or students working on the experiment are proficient in basic laboratory techniques before they start manipulation of radioactive substances unsupervised. It is important that all staff involved in this work are suitably trained in carrying out contamination monitoring.

lab procedures
• Observe all the basic laboratory safety procedures:
  o There must be No eating, drinking or applying cosmetics in the laboratory
  o Never use your mouth to pipette
  o If you see a colleague doing something dangerous, point it out to him/ her immediately and if necessary report it to the RPS
  o Work must not be carried out by a person with an undressed cut or abrasion below the wrist

• Lab coats or other suitable protective clothing should be worn at all times when entering a supervised area. Disposable gloves and protective eyeglasses should be worn whenever unsealed sources are being handled or manipulated.

• Work should be carried out over trays wherever possible.

• Contamination monitoring should take place before starting work and after the work is completed. Procedures for carrying out and recording contamination monitoring are explained in section 10.

• If using isotopes other than Tritium always check your gloves, hands and laboratory coat for radioactive contamination before leaving the laboratory.

• Wash your hands using the hand wash sink before leaving the laboratory.

• All apparatus being used with radioactive materials must be labelled using "radioactive" warning tape. The tape must be removed when the apparatus has been washed and found to be clear of contamination.

• Radioactive substances must only be removed from controlled or supervised areas in closed uncontaminated containers.

• Radionuclides emitting penetrating radiations must be adequately shielded. Lead shielding must be used for gamma emitters and perspex shielding for beta emitters.

• Containers for radioactive materials other than Carbon - 14 and tritium should not be directly held in the unprotected hand. (Note: the outside of containers of Carbon-14 and H-3 can become contaminated so it is good practice to wear gloves when handling them). Tweezers should be used for handling sealed radioactive sources.

• Contamination must be contained without delay and you must be familiar with the contingency procedures given in section 14

• Keep time manipulating radioactive substances to a minimum.

• Place any waste items in the appropriate bin as described in section 13
• Keep all radioactive materials in labelled containers and stored in designated fridge. In general, fridges that are used to store radioactive materials should not be used to store non active items. If it is necessary to use a fridge for active and non active items there should be clear demarcation and additional containment for the active items.

• In case of emergency remain calm and follow the contingency procedures section 14.

6. Local arrangements and procedures

Sources are manipulated on the tray within the lead enclosure within lab B6.

Protein/precursor labelling: the activity is transferred to reaction tube containing precursor molecules and incubated on the tray or in the adjacent water bath. When centrifuging down samples use centrifuge adjacent to the lead enclosure keep outside 1M of centrifuge (check dose rate at this distance with the mini 900 ratemeter). Non-incorporated activity from washes (centrifugation washes) are disposed of down the sink in B7 and washed down by running tap at moderate rate for 5min.

Cell incubations: Flasks of cells (up to 20) are incubated with tracer (up to 10MBq total activity) is dissolved in 7ml of medium solution on the tray within the lead enclosure and 0.3ml added to each flask. Flasks incubated in incubator in lab B7 for requisite time - check dose rate at 1M keep outside area until processing cells). Processing cells involves pouring media down sink and washes 3X with PBS each time pouring wash down sink. By this stage as only about 5% of incubation activity incorporates, 95% (so 9.5MBq) will be in liquid waste.

Preparation of liposomes containing 99mTc or 18F: 2MBq of either 99mTc or 18F are added to a phospholipid mixture in total volume of 1ml. The solution is loaded into a syringe which is attached to a second syringe via a sealed union. The solution is then pumped through the grid to the second syringe. This procedure is repeated 10-20x - total time<5min). The solution is then unloaded into a centrifugal filter and centrifuged at 12000g for 15mins and the filtrate placed into a microfuge tube. PBS is added to the liposomes held on the filter and the centrifugation repeated up to 20X and the filtrate collected and stored behind lead blocks until experiment end. The liposomes are collected from the filter. The filter is store until all activity has decayed. The syringes are washed under the tap in the designated sink and checked for remaining activity – further washing as required. The liposomes will be administered to cells as described above for tracers. After counting activity in all the washes the contents will be disposed of down the designated sink. About 10% of the activity will be in the liposomes which will also be disposed of via liquid waste (designated sink).

Use of Well counter: (1) Prior to counting samples and to ensure that the counter is not contaminated carry out a background measurement (2) On completion of using the counter ensure all samples must be removed.

7. Pregnant and breast feeding

Any worker who becomes pregnant should inform the Radiation Protection Supervisor as soon as possible and discuss the situation. It is also the University's policy that anyone who works with any form of ionising radiation and becomes pregnant should be given the option of alternative work. This recommendation would also apply to breast feeding mothers. However if the pregnant or breast feeding female continues working a risk assessment should be carried out to assess the hazard and additional protection measures that may be required. The RPA can advise.

8. Personal Monitoring
If you are issued with a personal dose monitor you must wear it and it is your responsibility to look after it. These badges should be worn at hip or waist level. For work with certain isotopes, additional dosimeters may have to be worn on the fingers or at neck level. If you lose your dosimeter or it is damaged (or goes through a washing machine) tell your RPS without delay and arrangements will be made to issue a replacement. You should stop working with radioactive materials until a replacement monitor has arrived.

Dosimeters are issued to Lutz Schweiger (PET Centre) for Tim Smith and to Tim Smith (Biomedical Physics building for his students). Other lab users obtain their dosimeters through their designated route.

9. Dose investigation levels

The following dose investigation levels apply.

<table>
<thead>
<tr>
<th>Investigation level (over the wear period of the dosimeter¹)</th>
<th>Effective whole body dose (mSv)</th>
<th>Equivalent dose to the skin (averaged over &lt;100cm²) (mSv)</th>
<th>Equivalent dose to lens of the eye. (mSv)</th>
<th>Equivalent dose Hands, forearms, feet and ankles (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 7.5 0.3 7.5 7.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹wear period will be either 1 or 2 months as directed by RPA

If one of these levels is exceeded an immediate investigation should take place to establish why the level has been exceeded and any preventative actions that are required.

10. Contamination monitoring

Introduction

Contamination monitoring should be carried out before commencing any work with unsealed radioactive material and after completion of the work (see A5.1). In labs where isotopes with half lives greater than 24 hours are used, a check of the area should be made every 2 weeks (see A5.2). Users should also monitor themselves when work is completed or during work if contamination is suspected. If a significant spill occurs then follow the lab contingency plans given in the local rules.

Contamination monitoring must be recorded in each lab or work area on the contamination monitoring record provided at the end of this appendix. In labs where both tritium and other radionuclides are used it may be helpful to use a separate form for tritium. Both daily before and after work checks and, area checks should be recorded on this sheet. Each column should be dated and records for that day entered in that column. If multiple experiments take place or if contamination is found then more than one column can be used for each day.

For before and after work monitoring the PI/lab supervisor should decide in consultation with the RPS the areas and equipment that should be checked and they should be entered into the first column for the record sheet under readings before experiment and readings after experiment.

For area checks the PI/lab supervisor should decide in consultation with the RPS which areas should be monitored and a plan should be drawn up on the reverse of the monitoring record sheet indicating the areas to be monitored and allocating them a number. If you require more than 5 areas add them to the first column on the monitoring sheet under weekly check.
Contamination Monitoring Before and After Work with Radionuclides

Instructions for monitoring all radionuclides except tritium (H-3)

1. Select an appropriate contamination monitor (see table A5.1) and check the battery status and the last calibration is within 12 months.

2. Note the background radiation level on the monitor away from the work area and enter this number into the background 1 box on the monitoring record. Typical background readings are:
   - GM detector e.g. EP15 or type E < 5 cps
   - Scintillation detector e.g. 44A 5 – 15 cps

3. Before starting work, monitor the work area, floor in front of experiment and any items noted on the monitoring form. Monitoring should be carried out slowly and methodically with the probe held about 1cm from the surface being checked. Enter readings in the each box (no ditto marks!).

4. If the area is contaminated note this on the monitoring record. Wearing gloves, decontaminate any areas where the reading is more than 2 times the background. Wipe the area using a paper towel and 5% decon solution or other suitable cleaning agent. Dispose of the paper as radioactive waste. Monitor the area again and repeat this process until the reading is below the action level and record the result on the record sheet. If you are unable to decontaminate successfully contact your RPS for advice and ensure no further work is carried out in the area until the issue has been resolved, make a note of this action on the monitoring record.

5. After completing the work monitor the work surface, floor around work area, the disposal sink and any other areas noted on the monitoring sheet under readings after experiment.

6. Decontaminate any areas if necessary as in 4 above.

7. Finally check your gloved hands and lab coat for contamination and any other locations that may have become contaminated. If you find your gloves are contaminated remove them and dispose as radioactive waste and recheck your hands. If your un-gloved hands are contaminated then wash them without delay using a liquid detergent. Contaminated lab coats or other clothing should be bagged and allowed to decay or disposed of as radioactive waste. If in doubt ask a colleague to help and follow the contingency plan in the local rules.

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Contamination Monitor</th>
<th>Action Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tritium (H-3)</td>
<td>Wipe tests</td>
<td>2 times the background reading</td>
</tr>
<tr>
<td>Carbon-14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus-32</td>
<td>GM detector e.g. EP15; Cap off</td>
<td></td>
</tr>
<tr>
<td>Phosphorus-33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphur-35</td>
<td>44A scintillation detector</td>
<td></td>
</tr>
<tr>
<td>Copper-67</td>
<td>GM or Scintillation detector</td>
<td></td>
</tr>
<tr>
<td>Iodine-125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron 59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon-11</td>
<td>GM detector e.g. EP15; Cap off</td>
<td></td>
</tr>
<tr>
<td>Nitrogen-13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorine-18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table A5.1 Contamination monitor for common radionuclides - If the radionuclide does not appear on the list then check your risk assessment or contact your RPS.

A5.1.2 Instructions for monitoring of tritium
Contamination monitors are not sensitive enough to detect the low energy beta radiation emitted by tritium. Monitoring must therefore be done using wipe tests. It is normally assumed that 10% of any contamination will have been transferred to the wipe. The monitoring procedure is the similar as described in A5.1.1 above with wipe tests substituted for monitoring with a contamination meter.

1. Take 2 sterile wipes or swabs and place each straight into a separate scintillation vial with appropriate quantity of liquid scintillant to obtain 2 background readings. The background readings should be entered on the monitoring sheet as background 1 & 2.
2. Before starting work use a sterile wipe or swab to wipe an area of about 100 cm² for small objects or surfaces and 1000 cm² for larger surfaces such as benches or floors. Use a separate wipe or swab for each item listed on the monitoring sheet.
3. Place the wipe in a scintillation vial with appropriate quantity of liquid scintillant.
4. Count the samples in a liquid scintillation counter. The action level is set at 2 times the average background reading.
5. Decontaminate any areas with readings above the action level as described in 5.1.1.
6. Take further wipe tests after completing the work, including the work surface, floor area, disposal sink and any other item noted on the monitoring sheet.
7. Decontaminate if necessary and record actions on monitoring sheet.
8. If the decontamination was unsuccessful then contact your RPS for advice and ensure no further work is carried out in the area until the issue has been resolved.

A5.2 Area checks
In addition to the monitoring described above, in labs where long lived radioisotopes are used, checks of a larger area should be undertaken every 2 weeks or after every experiment if work is infrequent. This is to ensure that there is no build up of radioactivity over time. Checks should extend into ‘clean’ areas and include 2 or 3 random areas of the lab to confirm that there is no contamination outside the normal work areas such as door handles, telephones and fridges. Monitoring should be carried out as shown below:

<table>
<thead>
<tr>
<th>Radioisotope</th>
<th>Routine monitoring method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tritium (H-3)</td>
<td>Wipe tests, liquid scintillation counter</td>
</tr>
<tr>
<td>Carbon-14</td>
<td></td>
</tr>
<tr>
<td>Phosphorus-32</td>
<td></td>
</tr>
<tr>
<td>Phosphorus-33</td>
<td></td>
</tr>
<tr>
<td>Sulphur-35</td>
<td></td>
</tr>
<tr>
<td>Iodine-125</td>
<td>Wipe tests with gamma counter if available, or scintillation detector</td>
</tr>
<tr>
<td>Iron-59</td>
<td></td>
</tr>
</tbody>
</table>

A plan of the lab should be drawn on the back of the monitoring record sheet with the areas that are monitored marked on it see A5.0. An entry should be made on the record sheet every time monitoring is carried out, whether contamination is found or not. If a lab is not used for a period of time, there is no need to carry out routine contamination checks, but this should be indicated on the record sheet.
<table>
<thead>
<tr>
<th>Lab/Lab area</th>
<th>Radionuclides</th>
</tr>
</thead>
</table>

**Monitoring method**

Enter counts recorded in each column. Where counts are over 2 times above background average please decontaminate, recount and enter new count in next column.

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Initials</th>
<th>Date</th>
</tr>
</thead>
</table>

**Readings before experiment**

<table>
<thead>
<tr>
<th>Background 1</th>
<th>Background 2</th>
<th>Work area</th>
<th>pipettes</th>
<th>container</th>
<th>Other equip – specify</th>
<th>Other equip – specify</th>
<th>Floor in front of exp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contaminated (Y/N)

**Readings after experiment**

<table>
<thead>
<tr>
<th>Background 1</th>
<th>Background 2</th>
<th>Work area</th>
<th>pipettes</th>
<th>container</th>
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<tr>
<td></td>
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</tr>
</tbody>
</table>

Contaminated (Y/N)

**Twice weekly lab check or with every experiment if experiments are less frequent**

<table>
<thead>
<tr>
<th>Background 1</th>
<th>Background 2</th>
<th>Area 1 on lab plan</th>
<th>Area 2 on lab plan</th>
<th>Area 3 on lab plan</th>
<th>Area 4 on lab plan</th>
<th>Area 5 on lab plan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contaminated (Y/N)
Radionuclides used:_____________________ Date:_______

Plan of lab showing areas to monitored for radiation contamination once every 2 weeks:
11. Ordering radioactive materials

**Sealed sources must not be ordered**

Unsealed sources to be ordered must be registered on the iso-inventory system prior to ordering. A source number will be generated provided that the requested activity does not result in the site limit being exceeded. The source can then be ordered through ‘One-Source’ – indicating that the requested item is radioactive. On arrival the source should be labelled with the source number generated by the iso-inventory system and stored in the designated storage area (Fridge or freezer in lab B7) and its arrival entered onto the iso-inventory system.

12. Storing radioactive materials

Radioactive materials are either store in the designated fridge or freezer in B6 within the containers labelled ‘Radioactive’.

13. Disposing of radioactive waste

**Aqueous Liquid Waste**

This may be disposed of only via the approved sinks in the radioactive laboratories and with the following precautions:

- The radioactive waste should be poured carefully and directly into the waste outlet.
- The total activity of waste discharged per month must not exceed the maximum permitted under the terms of the Authorisation Certificate for the school given in section 3. Liquid waste disposals should be logged onto the iso-inventory system before disposal is made to ensure limits are not breached.
- Cell incubations with up to 10MBq of 18F, maximum that will incorporate will be 5% so rest is disposed down sink. Remaining 0.5MBq (more usually less than 0.4MBq) will be collected into 20 vials, counted and then dissolved overnight in NaOH in Room B6 after which all activity will have decayed.
- Experiments involving 111In – 10MBq collected from the ARI Radiopharmacy 2MBq will be utilised for labelling proteins, nanoparticles, tracer precursors. Wash volumes kept to less than 10ml total volume after centrifugation and placed in original source vial and returned to Radiopharmacy. Labelled tracer incubated with cells (as for 18F above) and about 90% washed away and disposed of down sink as liquid waste. Solid waste (the remainder) kept within lead enclosure for 2 weeks to decay.
- Experiments with 3H: procedures as above but from cell experiments the 5-10% of 1MBq will be added to scintillation fluid and counted. These will then be washed out in the sink in B7 utilised for radioactive disposal, activity checked by swabbing washed tubes and adding swab to a scintillation tube and counting. If not above background tubes disposed in biological waste bags. Disposals in the designated sink will be recorded in the iso-inventory. Items allowed to decay to be recorded and source status et to ‘Dead’ and disposal date recorded.
Solid waste

Solid waste should be disposed of according to the following diagram.

- **Solid or Scint waste**
  - Put waste in numbered waste to appropriate bag in lab
  - **LLW Solid waste**
    - Includes empty vials, pipette tips, contaminated gloves and other experimental materials
    - Seal bag when full
    - Attached green label
    - Transfer to waste store
  - **LLW Scint waste**
    - Mainly liquid scintillation vials plus any other items containing contaminated scintillation fluid.
    - Solid plastic bin with sealable lid to be used.
    - Seal bag when full
    - Attach yellow label
    - Transfer to waste store
  - **VLLW**
    - Solid waste below the thresholds given in table 7.1 or that will below the thresholds within 12 months. Must NOT include sharps bins or any other waste that would not normally be put in normal refuse.
    - Seal bag when full
    - Attach orange label
    - Transfer to waste store

Scintillation waste and vials must be disposed of using a solid plastic bin/tube with a sealable lid to prevent leakage in the waste store.

Never dispose of non-radioactive waste with radioactive waste. If you are unsure check the waste with a suitable contamination monitor. Cans and packaging in which radioactive material has been supplied are not normally contaminated. These should be checked with a suitable monitor and, if no contamination is detected, treated as non-radioactive waste. Be sure to remove references to radioactivity; for example, the outer labels of cans should be removed or obliterated or otherwise defaced.
14. Contingency arrangements

RADIATION SPILLAGE

1. Immediately alert personnel working near the area of the radiation spill and if possible alert RPS. If in doubt contact radiation protection service for help and advice. Any personnel not required to deal with the spillage should remove them selves from the area after checking them selves for contamination.

2. Put on apron, over shoes and gloves

3. Do not allow anyone to walk through the spillage and spread the contamination. If possible isolate and cordon off the area.

4. Use a contamination monitor to locate areas of contamination on the work bench, floor and workers.

5. **If a worker has become contaminated deal with them first** (although it would be prudent to cover the spillage with absorbent material such as paper towels to prevent it from spreading.)
   - If a member of worker believes they are contaminated they should always attempt to locate the contaminated area and decontaminate just that area. Only if large areas of the body are contaminated should staff resort to a full body shower.
   - **Contamination of the skin, hands, arms.** If significant contamination is found on the hands staff should remove and discard gloves and re-monitor their bare hands. If still contaminated then the hands should be washed using a suitable detergent and then re-monitored and if necessary a soft brush should be used. Care should be taken not to break the skin. Other areas of exposed skin should be washed in a similar manner and re-monitored. The RPS should make a suitable report of any incident, including an estimation of dose, and submit it to the RPA.
   - **Contamination in the eyes.** If a member of staff suspects that radioactivity has splashed into their eyes, they should use an eye bath. Another member of staff should then take a reading using the contamination monitor. If contamination persists then contact the RPA. The RPS should make an appropriate report of any incident, including an estimation of the dose, and submit it to the RPA.
   - **Contamination on clothing.** If contamination is found on a lab coat or other clothing it should be removed, bagged and either disposed of or be allowed to decay.

6. Cover the spillage with absorbent material such as paper towels to prevent it from spreading.

7. Remove as much contamination as possible by absorbing the spill on paper towels. Contaminated towels should be disposed of as radioactive waste.

8. Ensure that any glass that has broken is placed in a sharps bin and label as radioactive.

9. Any residual contamination should be cleaned using a detergent, when mopping up always work from the outside in.
10. Monitor the area to ensure that all the activity has been removed.

11. If the area has been cleared of radioactivity, remove the tapes and signs.

12. Remove apron, shoes, gloves and place in the plastic bag monitor and dispose as radioactive waste if necessary

13. Monitor hands, clothes and feet to ensure that they are not active.

14. If clothes or shoes become contaminated, remove them and bag them. If mildly contaminated they should be washed as normal before they are worn again.