University of Aberdeen

Ionising Radiation Safety Arrangements

APPENDIX 2 Risk assessment for general lab

Version 3

May 2017

Authorised by Radiation Hazards Sub Committee

APPENDIX 2

Risk Assessment for the Use of Radioactive Materials in the University of Aberdeen and designation of areas with amendment for pregnant workers (May 2010)

This risk assessment covers most of the laboratories that use unsealed radioactive materials within the University of Aberdeen. Areas that are not covered in this risk assessment are those that use radionuclides not listed in table A2.3 or where activity levels exceed those listed in table A2.3. The assessment considers the risk in relation to the external hazard and the internal hazard.

A2.1 Internal Hazard

This problem is considered by the NRPB in document M443. In this document they indentified a wide variety of operational scenarios and exposure pathways to calculate the maximum quantities that could be used in different grades of laboratories. They did however use a dose constraint of 1mSv/y for the designation of a controlled area. The document took into account the grade of laboratory with "Grade C" laboratories being classed as a good chemical laboratory and a "Grade B" as a laboratory of a higher grade with changing facilities. It uses the concept of the Annual Limit of Intake (ALI) to identify the maximum amount of a radionuclide a person must work with in a year to identify whether a controlled or supervised area should be identified for the work. A larger number of ALIs are allowed in the higher grade of laboratory for area designation. Within the University there are very few areas that could considered to be classed as a "Grade B" laboratory and these will be dealt will in separate risk assessments.

From the document the levels allowed for a dose constraint of 1mSv/y are very large. For this assessment an annual dose constraint of **0.2mSv/y** has been adopted as the criteria for identification of a supervised area. Using this dose constraint for a Grade C laborartory the following levels of activity are permitted to be used by a worker in an area classed as a supervised area:-

Non-Volatile Work	**up to 120 ALIs**
Volatile Work in a fume cupboard	**up to 30 ALIs**

The quantity of radionuclides corresponding to these levels are listed in table A2.1. Lab areas where radioactive materials at an activity level less than those in Table A2.1 can be designated as a "Supervised Areas" with regard to the internal hazard. Any applications requiring activity levels exceeding those in the table or involving radionuclides that do not appear in the table should contact the RPA for advice who will advise on preparing a separate risk assessment.

Radionuclide	Activity level representing 30 ALIs	Activity level representing 120 ALIs
H-3 (Water)	33 GBq	132 GBq
H-3 (OBT)	14 GBq	56 GBq
C-14	1 GBq	4 GBq
S-35	450 MBq	1.8 GBq
P-32	186 MBq	744 MBq
P-33	420 MBq	1.7 GBq
I-125	39 MBq	156 MBq
Ca-45	222 MBq	888 MBq

Table A2.1 activity levels corresponding to 30 ALI and 120ALI

The above risk assessment assumes that standard protective clothing and good operational techniques are used and that 1 major spillage occurs each year which accounts for the bulk of the dose to the worker.

Good experimental technique and laboratory practices should normally be sufficient protection to restricted doses to well below 0.2mSv. The following protective clothing should always be worn when working with unsealed sources:-

- Gloves
- Lab coat
- Protective eye wear

Work involving unsealed radioactive materials should always take place over a surface designed to contain any spills and that is suitable for decontamination such as a drip tray

A2.1.1 Pregnant Workers

The HSE in report 397/2001 have identified that the foetus may be subject to an increased dose compared to the mother should ingestion take place during a pregnancy. The increased dose factors shown in table A2.2 were identified for the pathway of ingestion identified.

The dose limit allowed for the foetus during a declared pregnancy is 1mSv. Based on the activity levels allowed for a dose constraint to the mother of 0.2mSv an enhancement factor of 5 can therefore be accommodated. The only radionuclides of concern are therefore those of phosphorus and calcium where the enhancement factor can be as high as 25. It is therefore recommended that a constraint of 0.04mSv be adopted for the maternal constraint dose for pregnant workers. This is translated into a maximum activity to be worked with of 149MBq for P-32, 340MBq for P-33 and 178MBq for Ca-45 for non-volatile work. This will in fact allow pregnant workers to work with all but the largest stocks of P-32.

Radionuclide	Pathway	Increased Dose Factor
H-3 (water vapour)	Inhalation or Ingestion	x 2 at 10 weeks x 1.7 during rest
H-3 (OBT)	Inhalation or Ingestion	x 1.8 at 10 weeks x 1.5 during rest
C-14 (monoxide)	Inhalation	x 3.1 up to 10 weeks x 2.9 during rest
Other C-14 compounds	Ingestion	x up to 1.4 during rest
P-32	Highest Inhalation	x 17 at 35 weeks x 13 during rest
P-32	Ingestion	x14 at 35 weeks x 10 during rest
P-33	Highest Inhalation	x 23 at 25 week x 19 during rest
P-33	Ingestion	x 25 at 25 weeks x 20 during rest
S-35	Ingestion of Organic Sulphur	x 2.2 at 10 weeks x 2.1 during rest
Ca-45	Ingestion	x 16 at 25 weeks x 11 during rest
I-125	Not significantly Different except	x 1.3 at 35 weeks
I-131	Ingestion	x 2.7 at 35 weeks x 1.05 during rest

Table A2.2 Increased dose factors for pregnant workers

A2.2 External Hazard

The only radionuclides listed in table A2.1 which may provide an external hazard problem are gamma and hard beta emitters these are I-125 and P-32.

Experience of finger monitoring in the University has shown that finger doses from these radionuclides are kept to less than 3mSv per year with most people recording doses less than 1.2 mSv per year. Body monitoring also reveals low body doses with most workers recording doses less than 0.6mSv per year.

It should be noted however that the dose from unshielded P-32 is far from negligible. The dose rate 10cm from 1MBq of P-32 is 1Sv/h assuming no shielding at all.

The self absorption of a solution in a container of 1mm of glass or plastic will reduce this to approximately 0.2mSv/h/MBq. When handling stock solutions of say 100MBq it is approximately 20mSv/h. Simple suitable shielding reduces this dose rate by at least an order of magnitude and should always be used. For P32 Perspex shielding

at least 6.7mm will absorb Beta particles. For this risk assessment the constraint dose adopted for the fingers is 30mSv/y. This constraint means that manipulations using stock solutions of 100MBq should only take place for a total of 90 minutes in one year.

Anyone handling stock solutions greater than this amount (100MBq) must carry out the operation in a controlled area after consultation with the RPA.

The dose rate from I-125 is much lower at approximately 12.5µSv/h 10cm from a 1MBq source. For 156MBq (the maximum on the grounds of internal hazard) stock solutions this equates to 15 hours of manipulations in one year. For I -125 shielding using a 1mm of lead will reduce the dose rate by at least an order of magnitude.

A2.4 Accident scenarios and Contingency arrangements

The most significant incident that could occur is a spill of a stock solution contaminating a laboratory and a worker. Such an incident can be dealt with without significant additional exposure the following steps should be taken:-

- In the unlikely event anyone requires urgent medical care, either by immediate first aid or transfer to A&E **DO THIS FIRST.** Inform A&E that the casualty is contaminated. Take any obvious steps to reduce or eliminate the hazard to the casualty, to yourselves or anyone attending the casualty. Contact Radiation Protection Service

- Any one dealing with a spill should first don protective clothing including disposable cloves, lab coat, protective eye wear and overshoes.

- Attend to contaminated persons first; always try to localise the contaminated area and just wash that bit. Washing with soap and water. A whole body shower is seldom the best approach. Remove contaminated clothing. Washing out any open wound, eyes, mouth, nose etc. If contamination persists contact radiation protection

- Prevent the spillage becoming worse. Use an appropriate contamination monitor to assess the extent of the spill. Use temporary barriers or close the door. Prevent people walking through the contaminated or potentially contaminated. Use an appropriate contamination monitor to assess the extend of the spill. Check personnel for contamination before they leave the vicinity.

- Clear up and decontaminate the area so it can be put into use. The purpose of the decontamination is to transfer the radioactive material from the floor or person to the waste store. Use absorbent material i.e. paper towels to soak up the material. Dispose in appropriate bin. Estimate activity. For stubborn areas of contamination use a normal detergent or decon. When clearing up a spill always work from the outside in.

Contingency plans particular to each area must be summarised in local rules and practised on a regular basis.

A2.3 Summary

At the levels of activity used in the University Tritium, Carbon-14, Sulphur-35 and Iodine-125 can be used in any supervised area with the proviso that all Iodine manipulation work must be carried out in a fume cupboard. Work with these radionuclides can also be carried out by all registered staff. Phosphorus-32 and 33, and calcium-45 work have limits for pregnant workers. The amount of phosphorus-32 that can be manipulated in a supervised area is also limited and amounts above 100MBq must be handled in a controlled area. Table A2.3 summarises these findings.

Radionuclide	Limit for use of non-volatile substances	Limit for use of volatile substances in fume cupboard	Addition limits for pregnant workers	Personal monitoring	Bench shield	Syringe/pipette shield
H-3 (Water)	132 GBq	33 GBq	/	/	/	/
H-3 (OBT)	56 GBq	14 GBq	/	/	/	/
C-14	4 GBq	1 GBq	/	/	/	/
S-35	1.8 GBq	450 MBq	/	/	/	/
P-32	100 MBq*	100 MBq*	100 MBq*	Finger dosimeters	>7mm Perspex	>7mm Perspex
P-33	1.7 GBq	420 MBq	340 MBq	/	/	/
I-125	156 MBq	39 MBq	/	Body dosimeters	1mm lead	1mm lead
Ca-45	888 MBq	222 MBq	178MBq	/	/	/

*Limited by external hazard to the fingers

Table A2.3 Summary of finding from risk assessment