UNIVERSITY
OF WOLLONGONG
AUSTRALIA

UOW WHS Unit

RADIOACTIVE WASTE DISPOSAL GUIDELINES

Contents

1 Introduction

This guideline outlines the University's process for the safety, minimization and management of radioactive waste according to NSW legislative requirements. It is essential that correct procedures are established and maintained to ensure that radioactive waste is appropriately stored and discarded through the appropriate waste stream or national classification criteria.

Disposal of contaminated items and waste, including unsealed sources, are covered by this guideline. Disposal of radiation apparatus, sealed source devices, or sealed sources is outlined in Radiation Safety Guidelines, as these require Regulator approval prior to disposal and do not pose a risk of contamination.

Material that has been classified as non-radioactive waste is managed in accordance with the University's Waste Disposal Guidelines.

2 Responsibility

2.1 Waste Generator

Waste disposal is the responsibility of the waste generator, e.g. the person carrying out the approved project. Key responsibilities include:

- Following appropriate procedures for disposal
- Use and decontamination of equipment and vessels
- Appropriate packaging, labelling, documentation and storage of radioactive waste
- Maintaining the management system implemented by the University

Waste generators shall consider storage and disposal requirements of radioactive waste during the project planning stage. This is to be documented and approved on the Radiation Project Approval Form.

The waste generator shall maintain ownership of all material until such time as it is disposed of, including while it is held within the Radioactive Waste Store.

2.2 External Radiation Safety Consultant (RSC)

Key responsibilities include (as requested by the University RSA):

- Assessment of radioactive waste for disposal
- Provision of monitoring services
- Provision of advice

2.3 Local Radiation Safety Supervisor (RSS)

Key responsibilities include:

- The monitoring and implementation of radiation safety requirements within the local Unit/School
- Organising access to the Radioactive Waste Store for waste generators
- Ensuring waste details on the Radiation Waste Disposal Identification Label and Radioactive Waste Register (see Appendix 5) are completed clearly and in full

2.4 University Radiation Safety Advisor (RSA)

Key responsibilities include:

- The monitoring and revision of University Radiation Safety procedures, in consultation with Local RSS and External RSC where appropriate
- Organising External RSC to assess radioactive waste for disposal
- Overseeing access to, and use of, the Radioactive Waste Store
- Informing the Manager Environmental Services of items which are safe to be removed from the Radioactive Waste Store, as determined by the External RSC

2.5 Manager Environmental Services

Key responsibilities include:

- Arranging the removal of waste from the Radioactive Waste Store once it has sufficiently decayed and has been classified as non-radioactive waste, as advised by the University RSA.

3 Definitions

Prescribed activity

- A substance has the prescribed activity if the expression below is equal to, or greater than 1:

$$\frac{A1}{40} + \frac{A2}{400} + \frac{A3}{4000} + \frac{A4}{40000}$$

*Where A**X** represents the total activity, in kBq of the Group **X** radionuclides contained in the substance.*

Prescribed amount

- The prescribed amount is 100Bq/g.

Specific activity

- Of a radionuclide:
  - The activity per unit mass of that nuclide
- Of a material:
  - The activity per unit mass of the material in which the radionuclides are essentially uniformly distributed

Specific activity ratio

- Specific activity ratio = SA1 + (SA2 x 10-1) + (SA3 x 10-2) + (SA4 x 10-3)

  Where SA1-SA4 are the specific activity of Group 1-4 radionuclides, as set out in Column 1 or Schedule 1 of the NSW Radiation Control Regulation 2013 (reproduced in Appendix 1).

Total activity

- The activity of the whole of the material in which the radionuclides are essentially uniformly distributed (determined using 1-kilogram representative samples of the whole material)

Total activity ratio

- Total activity ratio = (A1 x 10-3) + (A2 x 10-4) + (A3 x 10-5) + (A4 x 10-6)

  Where A1-A4 are the total activity of Group 1-4 radionuclides, as set out in Column 1 or Schedule 1 of the NSW Radiation Control Regulation 2013 (reproduced in Appendix 1).

4 Segregation

Radioactive waste will need to be stored for a specific time until it has sufficiently decayed and may be safely disposed of. In these circumstances, adequate shielding should be in place and the waste segregated according to its:

- Classification
- Dangerous goods class
- Radionuclides
- Composition

4.1 Classification

Radioactive waste is classified as the following (according to the NSW EPA's Waste Classification Guidelines Part 3: Waste Containing Radioactive Material):

- Radioactive Hazardous Waste
  - Waste with a specific activity greater than the prescribed amount
  - Waste consisting of, or containing, more than the prescribed activity of a radioactive element in Schedule 1 of the NSW Radiation Control Regulation 2013 (reproduced in Appendix 1)
  - Waste with a specific activity ratio or total activity ratio greater than 1
- Non-Radioactive Waste
  - Waste with a specific activity ratio or total activity ratio equal to or less than 1

Radioactive waste may become non-radioactive waste once it has sufficiently decayed, after assessment by the University RSA. Details of previous radioactivity shall be provided with disposal documentation. It may also be diluted and dispersed throughout non-radioactive waste. Care shall be taken to ensure the specific activity is under the prescribed amount if this method is used.

Waste that has been assessed as non-radioactive cannot be disposed of prior to assessment against other relevant legislation, e.g. Nuclear Non-Proliferation (Safeguards) Act 1987 and Nuclear Non-Proliferation (Safeguards) Regulations 1987.

4.2 Dangerous Goods Class

If the radioactive waste is also classified as a dangerous good, then storage and packaging requirements in line with Dangerous Goods Storage and Handling Guidelines shall be taken into consideration.

4.3 Radionuclides

Radioactive waste from different processes may contain different radionuclides and have different concentrations. The different wastes should be segregated if segregation provides a significant benefit in optimising waste management of the different waste types. Segregation is most important if both short-lived and long-lived radionuclides are used. Waste containing (or possibly containing) alpha emitters should be segregated from waste with no alpha emitters, because disposal limits for alpha emitters are much more restrictive than limits for beta/gamma emitters.

Sharps waste containing mixed radionuclides may be collected so long as similar Groups of radionuclides (see Appendix 1) and similar half-lives (see Appendix 2) are kept together.

4.4 Composition

Radioactive waste shall be segregated and packaged into the following types:

- Liquid
- Non-liquid:
    - Solids (e.g. gloves, absorbent materials, animal bedding/cage waste)
    - Sharps (e.g. pipette tips, needles, scalpels, broken glassware, glass slides, scintillation vials)
    - Putrescible solid waste (e.g. animal carcases)

5 Packaging

Waste items shall be properly packaged to prevent the release of any potential contamination. The waste shall be in double containment, with the two layers of containment being composed of different materials, such as:

- A closed bottle of liquid inside a spill container
- A plastic bag inside of a hard plastic bin/bucket
- Double plastic bags, sealed individually

Packages should be as small as reasonably practicable for the amount of waste generated (or expected to be generated). This helps to eliminate the issue of waste being collected over a long period and knowledge of the contents being unfamiliar at the disposal time.

Any bag used shall be a minimum of 100 µm thickness. Bags should be sealed with a cable tie as this allows for the bag to be opened without damage if required.

The primary packaging bag should be transparent if possible to ensure the contents can be easily identified without opening the packaging.

Red radioactive waste bags (available from laboratory suppliers) shall not be used as primary packaging. However, they may be used as a secondary bag as they are easily removed for disposal. These bags have been known to degrade over time and should only be used for waste that is expected to be disposed of as non-radioactive waste within 12 months.

The maximum weight of any package/container should not exceed 15 kg.

5.1 Liquid Waste

Radioactive liquid waste cannot be discharged to the sewer and shall be collected and stored by the waste generator in a suitable glass or polyethylene container with an effective seal. Packaging shall comply with the prescribed transport of waste requirements under RPS C-2 Code for the Safe Transport of Radioactive Material and Australian Dangerous Goods Code.

The primary container should have a maximum volume of 15L and be filled no more than 75% of its capacity. The secondary container/bund shall be capable of holding 110% of the volume of the primary container(s) it is holding.

Radioactive organic liquid waste and aqueous waste should be kept separate, even if they are of the same radionuclide.

An inventory shall be maintained of all activity added to waste containers in order to ensure that the activity limit of 100Bq/g is not exceeded at the time of final disposal. Where total activity may exceed the limit:

- Short half-life radionuclides can be allowed to decay in storage (locally or in the Radioactive Waste Store) until appropriate levels are reached
- For long half-life radionuclides, it may be possible to mix differing levels of waste activities of the same radionuclides to ensure that the total activity remains below 100Bq/g at the time of disposal

All liquid wastes shall be assessed immediately prior to disposal to ensure they are classified as non-radioactive waste (e.g. by liquid scintillation counting).

5.2 Solid Waste

Lead pots and other shielding may be used while radioactive waste is decaying to a sufficient level; however, they do not constitute radioactive waste and must not be included within any package. Lead pots or shielding material shall be checked for contamination and cleared prior reuse, disposal or recycling as non-radioactive waste.

Standard solid waste (e.g. gloves, benchcote, wipes, paper towel) should be monitored for contamination prior to disposal. If the item is found not to be contaminated, then it should be disposed of as non-radiological waste. Contamination from some radionuclides, such as ^{14}C and ^{3}H, cannot be accurately detected without using a scintillation counter; therefore, users should assume that the standard solid waste is contaminated.

Radioactive waste that is known to be highly contaminated, e.g. following a spill, should be packaged separately to radioactive waste which is less (or only potentially) contaminated. This will allow for easier disposal of the less contaminated waste at the appropriate time.

Steps to ensure best practice packaging of radioactive solid waste include:

- Empty containers shall have clear plastic bags inserted as liners inside the container, ensuring approximately 10 cm of overlap on the outside of the bin (foot-operated) / bucket / box
- When the container is full, unfold and twist the 10 cm overlap of plastic and seal the plastic bag liner with a cable tie
- Place the lid back onto the bin / bucket or close the box (sealing further if necessary) to prevent any bagged waste from falling out during storage or transportation

Solid waste should be dry prior to packaging, if practicable, to eliminate the risk of a liquid spill. It may be dried in a fume cupboard if necessary.

Radiation hazard signs and labels shall be removed from waste prior to placing in primary packing. It should also be removed from primary packaging prior to sealing in secondary packaging, in line with section 6.

5.2.1 Animal Bedding

Animal bedding and other cage products shall be packaged separately to standard solid waste. The best practice packaging steps for standard solid waste should be followed, but a separate container used.

5.3 Sharps Waste

Sharps waste is to be packaged in line with the Working with Sharps Guidelines. This ‘Sharps Bin’ will be the primary container. A bag (minimum of 100 µm thickness), sealed with a cable tie, may be used as secondary containment. Alternatively, the bin (or bins) may be placed within a larger bin/bucket that is then sealed.

Pipette tips should be triple-rinsed (and the waste liquid collected as liquid waste) prior to placing in the sharps container. If there is a possibility of excessive liquids that may spill from the sharps container, an absorbent pad should be placed in the secondary container. Unsealed sharps containers can be placed in a fume hood for a period of time to ensure the contents are dry.

Sharps waste containing mixed radionuclides may be collected so long as similar Groups of radionuclides (see Appendix 1) and similar half-lives (see Appendix 2) are kept together.

5.3.1 Scintillation Vials

Scintillation vials (including their lids and contents, e.g. scintillation fluid) can be disposed of as sharps waste as they are frequently made of glass and have a high risk of breakage if the package is not handled correctly.

Used scintillation vials are not to be decanted of their contents before disposal. The procedure of decanting the scintillation fluid greatly increases the risk of the radiation worker being unduly exposed and possibly contaminated by the chemicals comprising the scintillant as well as the radioactive material being analysed by the procedure**.**

5.3.2 Broken Glassware

Broken glass shall be packaged following the guidelines for sharps waste (above). A ‘Broken Glass Bin’ may be used as a primary container if a sharps container is insufficient.

5.4 Putrescible Solid Waste

Putrescible solid waste (e.g. carcases of experimental animals) is to be double bagged and stored in a freezer. Plastic, freezer waste bags shall be used.

Animal bedding and other cage products are to be packaged separately as solid waste, as outlined in 5.2.2.

6 Labelling

6.1 "In Use" Labels

While waste is being collected in the laboratory only requires basic information, including radionuclide, contact details of waste generator, and local waste reference number (if applicable). Further information may be available on the local Waste Inventory Log.

A primary container of solid waste should not display any labels or symbols so long as it is always kept within the secondary container (e.g. primary plastic bag within labelled secondary bin). This is to allow for easy disposal in future as the waste package must not display/contain any reference to radioactivity when being disposed of. The secondary container shall clearly display labels and symbols during collection/storage but these should be easily removable for disposal (e.g. remove label from bucket, take primary bag out of secondary bag).

Both the primary and secondary containers of liquid waste shall clearly display labels and symbols during collection/storage but these should be easily removable for disposal.

6.2 Waste Storage Labels

Each radioactive waste package is to be labelled using the Radiation Waste Disposal Identification Label (available from Print and Distribution Services). All information on the label shall be completed clearly and in full. Labelling shall also comply with any additional requirements for the waste such as any chemical biological or physical hazards (such as classification as a dangerous good or hazardous chemical). This could require attaching an additional waste label outlining the secondary hazard (see Waste Disposal internet page).

The Radioactive Waste Register (see section 7) includes examples of the information required on the Radiation Waste Disposal Identification Label.

6.3 Final Disposal

Any sign or label displaying the radiation trefoil symbol shall be removed or completely destroyed before disposal as non-radioactive waste. If the waste is still classified as hazardous (e.g. chemical, biological) then appropriate labelling must be applied prior to disposal. One way to ensure this information is correct is to use 3 levels of packaging, for example:

1. Primary - clear bag (sealed with cable tie)
2. Secondary - hazardous waste bag with relevant waste disposal label (sealed with cable tie)
3. Tertiary – red radioactive bag (sealed with cable tie)

On removal of the red radioactive bag, the waste will still be appropriately packaged and labelled for final disposal.

7 Documentation

Full details of each radioactive waste package shall be recorded on the Radioactive Waste Register (see Appendix 5) when the waste packages are accepted into the Radioactive Waste Store. Each radioactive waste package will be assigned a unique identification number on receipt into the Store. This number will be in the format of "YYYY-xx", with "xx" being 01 for the first package of the year (YYYY) and so on. Radioactive waste placed in the Radiation Waste Store prior to 2016 has a unique identification number with the School/Unit as the prefix instead of the year.

A Radioactive Waste Register shall also be maintained locally for radioactive waste undergoing decay prior to transfer to the Radioactive Waste Store.

Information required on the Radioactive Waste Register and Radiation Waste Disposal Identification Label includes:

- Waste Identification Number –will be allocated by the University RSA upon receipt of each package into the Store (if a local number was also used, this can be noted in the "Description" field)
- Waste Generator – details of person who produced the waste
- Unit/School – details of area where waste was produced
- Radionuclide – waste packages should only contain individual radionuclides if possible
- Date Waste Generated – date package sealed
- Estimated Current Activity – in becquerels (Curies or other units shall be converted), as at "Date Waste Generated"
- Type – liquid, solid, sharps, other
- Description – eg scintillation vials, gloves/paper/wipes, etc
- Precautions – eg non-radiation hazards and controls
- Weight/Volume – gross or net weight (g) or volume (mL) of package
- Local RSS/University RSA Signature – acceptance that packaging and labelling is in accordance with these guidelines and the waste will be accepted into the Radioactive Waste Store
- Waste Cleared – University RSA to complete once waste has been assessed and cleared for final disposal by the Consultant RPA

8 Radioactive Waste Store (41.G53 & 41.G53A)

The University has a Radioactive Waste Store where all radioactive waste is assessed for disposal. Radioactive waste may also be stored securely in this Radioactive Waste Store while it undergoes sufficient decay to allow disposal.

The store is classified as Low-Level, based on the criteria in Schedule 2, Table 2 of the Appendix F of the NSW Radiation Control Regulation 2013. Radioactive waste which is above the activity limit per package (see Appendix 3) is to be stored by the waste generator using the appropriate means until the activity has decayed to an acceptable level and is able to be transferred to the Radioactive Waste Store.

Even if putrescible solid waste (e.g. carcases of experimental animals) has decayed to an appropriate level they should continue to be stored by the waste generator until disposal. The freezer shall be regularly inspected to ensure that any malfunction is identified and rectified immediately (connection to an uninterruptable power supply is recommended however the freezer can still malfunction). Frost-free freezers should be used as radioactive materials can off-gas which may then become trapped in the frost build-up. Where frost free appliances are not available, regular testing of ice build-up should be conducted and defrosting undertaken.

No waste will be accepted into the Radioactive Waste Store unless it is packaged and labelled correctly. When radioactive waste is being transported from the local area to the Radioactive Waste Store, trolleys should be used to minimise the risk of hazardous manual tasks. Prior to transport, packages should be inspected to ensure seals are intact. Local procedures shall also be followed.

The University RSA may occasionally approve non-waste items to be kept in the Radioactive Waste Store for a defined period, eg regulated material requiring temporary storage during laboratory refurbishment. In rare circumstances, the University RSA may approve a long-term high activity/energy radionuclide to be transferred to the Radioactive Waste Store with appropriate shielding.

Contained within the Radioactive Waste Store shall be the following items:

- Disposable gloves of various sizes
- Paper towel, detergent and running water
- Radioactive waste bin
- Non-radioactive waste bin
- Broom, mop, dustpan/brush
- Benchcote
- Cloth tape and packing tape
- Scales
- Land line phone
- Radioactive Waste Disposal Identification Labels
- Reclassified Waste Disposal Labels
- ToxFree Declarations
- Spill kit including vermiculite
- Large waste bags, free of hazard symbols
- Zip lock bags of various sizes
- Cable ties
- Drench hose
- Basic stationery
- Contact details for each Local RSS, University RSA, WHS Unit, Security, Emergency Services
- Printed copy of Radiation Safety Guidelines and Radioactive Waste Disposal Guidelines
- Completed Radioactive Waste Register (Appendix 5)

8.1 Access

Local RSS is to contact the University RSA to arrange access as required. Keys will be allocated only to those requiring regular access.

Service, maintenance, and cleaning personnel entering the Radioactive Waste Store shall only do so under direct supervision of the University RSA or approved delegate.

8.2 Area Monitoring

To ensure that radioactive waste levels are within the regulations, the storage room will be monitored periodically to ensure that exposure to ionizing radiation is limited to below established dose limits and as low as reasonably achievable. The store will also be monitored by the to confirm low radiation levels of radiation prior to service, maintenance, and cleaning personnel accessing the store. This service will be provided by the University RSA or External RSC.

The maximum dose rate, as measured at any location outside the facility, will not exceed 0.5µSv/hr.

8.3 Personal Monitoring

Personnel entering the Radioactive Waste Store are required to monitor their personal exposures.

Personnel who have been issued with a personal radiation monitor shall wear their badge to enter the store (monitors are available from the WHS Unit by completing the Radiation Monitoring Registration Form).

8.4 Ante-Room (41.G53)

The ante-room for the Radioactive Waste Store is where the labelling and recording of radioactive waste can occur. No waste packages are to be prepared in the ante-room; however packages may be opened for monitoring purposes. Benchcote shall be laid prior to the opening of any packages.

The door to the ante-room should be kept closed when personnel are opening packages.

8.5 Storage Room (41.G53A)

Waste is stored according to its disposal date, determined by its rate of decay, to simplify the process for discarding waste at the appropriate time. No high energy isotopes should be allocated space in the storage structure along the western wall of the storage room (corridor interface). These items should be kept in the centre storage shelves to maintain dose rates in the corridor around background levels.

8.5.1 Ventilation

The storage room shall contain an air extraction system with an exhaust airflow rate adequate to dilute the contaminants and be arranged to discharge them outside the building in such a manner that no danger or nuisance results to people outside the building. Due to the potential presence of low density solvents, the extraction point shall be at ceiling height. The hazard of airborne emissions from radium, thorium or uranium compounds requiring extraction at floor level is less than that of the solvents.

The exhaust fan shall be activated a minimum of 5 minutes prior to entry into the storage room. To maximise ventilation, the door to the storage room shall not be closed at any time while the room is occupied.

8.6 Radioactive Waste Register

The Radioactive Waste Register is kept in the ante-room. Full details must be completed prior to waste being placed into the storage room (see Appendix 5 for required information).

9 Final Disposal

Waste contained in the Radioactive Waste Store will be cleared for removal once the material has decayed to an acceptable level for the waste to be treated as non-radioactive waste. The maximum time that waste will be required to decay is 10 half-lives of the radionuclide (see Appendix 4), however, waste may have undergone appropriate decay in less time depending on its original activity.

The University RSA coordinates with the External RSC to determine waste that has decayed sufficiently to be disposed as chemical, industrial or clinical waste or as a Dangerous Good other than Class 7.

Any sign or label displaying the radiation trefoil symbol shall be removed or completely destroyed before disposal as non-radioactive waste. The Reclassified Waste Disposal Label will be applied by the University RSA. The full page Avery L7173 template for these labels is located at URM 1939157 in the University Records Management System (this is accessible only by WHS Unit ONLY).

Radioactive Waste Approved for Removal by Waste Contractor

Register Number: _____

Isotope: _____ Weight: _____

Specific Activity: _____ Bq/g

University RSA: _____

Date Cleared:

Waste removal will then be arranged through an approved contractor by the Manager Environmental Services.

10 Program Evaluation

In order to ensure that these guidelines continue to be effective and applicable to the University this program will be reviewed regularly by the WHS Unit in consultation with the WHS Committee. The review is to focus on the effectiveness of the methods used to identify, assess and control risk in the workplace.

Conditions which might warrant a review of the guidelines on a more frequent basis would include:

- Reported hazards or injuries
- Non-conforming systems
- WHS Committee concern

Following the completion of any review, the program will be revised and updated in order to correct any deficiencies. These changes will be communicated to the University community via the WHS Committee and via the Document Review system.

11 Related Documents

- NSW Radiation Control Act 1990
- NSW Radiation Control Regulation 2013
- NSW Protection of the Environment Operations Act 1997
- NSW Protection of the Environment Operations (Waste) Regulation 2014
- Waste Classification Guidelines (NSW EPA)
  - Part 1: Classifying Waste
  - Part 3: Waste Containing Radioactive Material
- Australian Standards
  - AS 4031:1992 Non-reusable containers for the collection of sharp medical items used in health care areas
  - AS/NZS 2243.4:1998 Safety in Laboratories - Ionising radiations
  - AS/NZS 2982:2010 Laboratory design and construction
- RHS 13 Code of Practice for the Disposal of Radioactive Wastes by the User (ARPANSA)
- RPS C-2 Code for the Safe Transport of Radioactive Material (ARPANSA)
- RPS 16 Predisposal Management of Radioactive Waste (ARPANSA)

12 Version Control Table

Version Control	Date Released	Approved By	Amendment
1	April 2003	Manager WHS	New document.
2	October 2005	Manager WHS	Scheduled review – minor amendments.
3	February 2010	Manager WHS	Scheduled review – amendment to acceptable limits as per legislative requirements.
4	August 2010	Manager WHS	Document updated to incorporate the Personnel name change to Human Resources Division.
5	April 2011	Manager WHS	Inclusion of lead pots requirement.
6	March 2012	Manager WHS	Re-brand
7	October 2013	Manager WHS	Update for legislative changes and WHS name change
8	February 2014	Manager WHS	Information surrounding radioactive waste disposal from section 25 of the UOW Radiation Safety Guidelines has been transferred to these guidelines to avoid duplication.
9	May 2016	Manager WHS	Guidelines have been significantly rewritten, mainly to include information on segregation, packaging, labelling and documentation of waste and clarification of the use of the Radioactive Waste Store. Added Appendix 1, 2 & 3, revised Appendix 4 & 5.

Appendix 1: Prescribed Activity of a Radioactive Substance

Source: Adapted from NSW Radiation Control Regulation 2013, Schedule 1

GROUP 1 - 40 kilobecquerels

^{227}Ac	^{241}Am	^{243}Am	^{249}Cf	^{250}Cf	^{252}Cf	^{242}Cm	^{243}Cm
^{244}Cm	^{245}Cm	^{246}Cm	^{237}Np	^{231}Pa	^{210}Pb	^{210}Po	^{238}Pu
^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{223}Ra	^{226}Ra	^{228}Ra	^{227}Th
^{228}Th	^{230}Th	^{230}U	^{232}U	^{233}U	^{234}U		

Any alpha emitting radionuclide that is not included in any other Group in this Schedule, eg ^{225}Ac, ^{213}Bi, ^{229}Th

GROUP 2 - 400 kilobecquerels

^{228}Ac	^{110m}Ag	^{211}At	^{140}Ba	^{207}Bi	^{210}Bi	^{249}Bk	^{45}Ca
^{115m}Cd	^{144}Ce	^{l36}C	^{56}Co	^{60}Co	^{134}Cs	^{137}Cs	^{152}Eu
^{154}Eu	^{68}Ge	^{181}Hf	^{124}I	^{125}I	^{126}I	^{131}I	^{133}I
^{114m}In	^{192}Ir	^{54}Mn	^{22}Na	^{230}Pa	^{212}Pb	^{224}Ra	^{106}Ru
^{124}Sb	^{125}Sb	^{46}Sc	^{89}Sr	^{90}Sr	^{182}Ta	^{160}Tb	^{127m}Te
^{129m}Te	^{234}Th	^{204}Tl	^{170}Tm	^{236}U	^{91}Y	^{95}Zr	

Any radionuclide that is not alpha emitting and is not included in any other Group in this Schedule

GROUP 3 - 4 megabecquerels

^{105}Ag	^{111}Ag	^{41}Ar	^{73}As	^{74}As	^{76}As	^{77}As	^{196}Au
^{198}Au	^{199}Au	^{131}Ba	^{133}Ba	^{7}Be	^{206}Bi	^{212}Bi	^{75}Br
^{76}Br	^{82}Br	^{47}Ca	^{109}Cd	^{115}Cd	^{141}Ce	^{143}Ce	^{38}Cl
^{57}Co	^{58}Co	^{51}Cr	^{129}Cs	^{131}Cs	^{136}Cs	^{64}Cu	^{67}Cu
^{165}Dy	^{166}Dy	^{161}Er	^{169}Er	^{171}Er	^{152m}Eu	^{155}Eu	^{18}F
^{52}Fe	^{55}Fe	^{59}Fe	^{67}Ga	^{72}Ga	^{153}Gd	^{159}Gd	^{175}Hf
^{195m}Hg	^{197}Hg	^{197m}Hg	^{203}Hg	^{166}Ho	^{123}I	^{130}I	^{132}I
^{134}I	^{135}I	^{111}In	^{115}In	^{115m}In	^{190}Ir	^{194}Ir	^{42}K
^{43}K	^{85m}Kr	^{87}Kr	^{140}La	^{177}Lu	^{28}Mg	^{52}Mn	^{56}Mn
^{99}Mo	^{24}Na	^{93m}Nb	^{95}Nb	^{147}Nd	^{149}Nd	^{63}Ni	^{65}Ni
^{239}Np	^{185}Os	^{191}Os	^{193}Os	^{32}P	^{33}P	^{233}Pa	^{203}Pb
^{103}Pd	^{109}Pd	^{147}Pm	^{149}Pm	^{142}Pr	^{143}Pr	^{191}Pt	^{193}Pt
^{197}Pt	^{81}Rb	^{86}Rb	^{183}Re	^{186}Re	^{188}Re	^{105}Rh	^{220}Rn
^{222}Rn	^{103}Ru	^{105}Ru	^{97}Ru	^{35}S	^{122}Sb	^{47}Sc	^{48}Sc
^{75}Se	^{31}Si	^{151}Sm	^{153}Sm	^{113}Sn	^{121}Sn	^{125}Sn	^{85}Sr
^{91}Sr	^{92}Sr	^{96}Tc	^{97}Tc	^{97m}Tc	^{99}Tc	^{125m}Te	^{127}Te
^{129}Te	^{131m}Te	^{132}Te	^{231}Th	^{200}Tl	^{201}Tl	^{202}Tl	^{171}Tm
^{239}U	^{48}V	^{181}W	^{185}W	^{187}W	^{135}Xe	^{87}Y	^{90}Y
^{92}Y	^{93}Y	^{175}Yb	^{62}Zn	^{65}Zn	^{69m}Zn	^{97}Zr	

GROUP 4 - 40 megabecquerels

^{37}Ar	^{11}C	^{14}C	^{58m}Co	^{134m}Cs	^{135}Cs	^{62}Cu	^{68}Ga
^{3}H	^{3}H	^{129}I	^{113m}In	^{81m}Kr	^{85}Kr	^{13}N	^{97}Nb
^{59}Ni	^{15}O	^{191m}Os	^{197m}Pt	^{197m}Pt	^{87}Rb	^{187}Re	^{73}Se
^{73}Se	^{147}Sm	^{85m}Sr	^{87m}Sr	^{96m}Tc	^{99m}Tc	^{nat}Th	^{nat}U
^{nat}U	^{235}U	^{238}U	^{131m}Xe	^{133}Xe	^{91m}Y	^{69}Zn	^{93}Zr

Appendix 2: Half-Life Waste Segregation Categories Appropriate for Typical Medical and Research Applications of Radionuclides

Source: AS2243.4 Safety in laboratories - Ionizing radiations, Table G1

Few days or less

- ^{18}F, ^{24}Na, ^{42}K, ^{64}Cu, ^{82}Br, ^{87}Y, ^{87}mSr, ^{90}Y, ^{99}Mo, ^{99m}Tc, ^{113m}In, ^{123}I, ^{133}Xe, ^{153}Dy, ^{197}Hg, ^{198}Au

Few days to 2 months

- ^{32}P, ^{51}Cr, ^{59}Fe, ^{86}Rb, ^{103}Ru, ^{125}I, ^{127}Xe, ^{131}I, ^{169}Yb

2 months to 1 year

- ^{35}S, ^{45}Ca, ^{46}Sc, ^{54}Mn, ^{57}Co, ^{58}Co, ^{65}Zn, ^{75}Se, ^{113}Sn, ^{192}Ir

Greater than 1 year

- ^{3}H, ^{14}C, ^{22}Na, ^{36}Cl

Appendix 3: Limits for Acceptance into Radioactive Waste Store

Source: Adapted from NSW Radiation Control Regulation 2013, Schedule 2, Appendix F, Table 2

Schedule 1 Group	Low Level Activity Limit[1, 2]	Activity Limit per Package[3]	Examples of Radionuclides from each Schedule 1 Group[4]
1	< 20 MBq	< 20 kBq	^{225}Ac, ^{241}Am, ^{213}Bi, ^{210}Po, ^{226}Ra, ^{229}Th, ^{230}Th
2	< 2 GBq	< 200 kBq	^{60}Co, ^{137}Cs, ^{125}I, ^{131}I, ^{54}Mn, ^{22}Na, ^{90}Sr
3	< 200 GBq	< 2 MBq	^{133}Ba, ^{109}Cd, ^{57}Co, ^{55}Fe, ^{123}I, ^{111}In, ^{42}K, ^{32}P, ^{33}P, ^{86}Rb, ^{35}S
4	< 20 TBq	< 10 MBq	^{14}C, ^{3}H, ^{99m}Tc, ^{nat}U, ^{235}U, ^{238}U

Note 1 - Modifying Factor of x100 applied for Simple Storage (from Schedule 2, Table 1)

Note 2 - The above activity limits apply for aggregate quantities within the Radioactive Waste Store

Note 3 - The University has set these limits to ensure that the Low Level Activity Limit is not exceeded

Note 4 – See Appendix 1 for full listing of Radionuclides in each Schedule 1 Group

Appendix 4: Half-Life of Radionuclides Commonly Used at the University

Radionuclide	Half-life
^{225}Ac	10 days
^{212}Bi	60.55 minutes
^{213}Bi	45.6 minutes
^{14}C	5730 years
^{57}Co	271.8 days
^{51}Cr	27.7 days
^{137}Cs	30.1 years
^{55}Fe	2.7 years
^{3}H	12.3 years
^{125}I	60.1 days
^{131}I	8 days
^{111}In	2.8 days
^{42}K	12.4 hours

Radionuclide	Half-life
^{22}Na	2.6 years
^{32}P	14.3 days
^{33}P	25.4 days
^{226}Ra	1600 years
^{86}Rb	18.6 days
^{35}S	87 days
^{90}Sr	29 years
^{99m}Tc	6 hours
^{229}Th	7340 years
^{230}Th	$7.5x10^{4}$ years
^{235}U	$7x10^{8}$ years
^{238}U	$4.5x10^{9}$ years

Appendix 5: Radioactive Waste Register

(Details shall match the [Radiation Waste Disposal Identification Label] on the container)

Waste Register Number *(YYYY-xx)*	**Waste Generator** *(Name & Extension)*	**Unit/ School**	**Radio-nuclide**	**Date Waste Generated**	**Estimated Current Activity** *(Bq)*[1,2]	**Current Unshielded Dose Rate** *(µSv/hr)*	**Type**	**Description** *(eg scintillation vials, gloves/paper/wipes)*	**Precautions** *(eg non-radiation hazards and controls)*	**Weight/Volume** *(g or mL)*	**Local RSS/ University RSA Signature**	**Waste Cleared** *(University RSA use only)*
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		
							☐ Liquid ☐ Solid ☐ Sharps ☐			☐ Gross ☐ Net		

Note 1 – To convert Curies (Ci) to Becquerels (Bq), multiply by 3.7×10^{10}

Note 2 – To calculate the current activity, use the formula $A_t = A_o \div 2^n$ where "A_t" = current activity, "A_o" = original activity, and "n" = number of half-lives (time passed ÷ $T_{½}$)