SOP RSC 7.1 Storage and Disposal of Radioactive Waste

Version and Date of Issue: V6 October 2025
Written by: Radiation Safety Committee
Review due date: October 2028

BACKGROUND

This document describes appropriate methods for the storage and eventual disposal of waste radioactive material. Legislation requires that the Radiation Management Licence Holder is the responsible person for this waste from the time of acquisition, and this responsibility cannot be delegated. However, the Principal Investigator must ensure that the correct procedures are followed for storage and disposal of radioactive waste.

The International Commission on Radiological Protection (ICRP) has three waste concepts as follows:

- Delay and decay (applicable to radionuclides with short half-lives)
- Concentrate and contain (applicable to all radioactive waste)
- Dilute and disperse (possible, but discouraged and without great care could be in breach of the Regulatory Guidelines. Regulatory authorities may apply a limit of 1 Bq/L (above background) to the sewerage system, above which double delay tanks with other restrictions may be required.)

NOTE:

Half Life	**Radionuclide**
Five days or less:	Na-24, K-42, Cu-64, Tc-99m, Mo-99
Five days to two months:	P-32, Cr-51, Fe-59, 1-125, 1-131, Cs-131
Two months to one year:	S-35, Ca-45, Sc-46, Sn-113
Greater than one year:	H-3, C-14, Na-22, CI-36, Co-57, Co-60, Cs-137

NOTE: The EPA's *Waste Classification Guidelines Part 3: Waste Containing Radioactive Material: October 2013*, must be adopted into the waste procedures. This document is enacted through the *Protection of the Environment Operations Act 1997.*

NOTE: Radioactive Waste is classified as the following:

- Liquid or non-liquid wastes with a specific activity greater than 100 Becquerels per gram and consisting of, or containing more than, the prescribed activity (see Appendix 18.1) of a radioactive element in Schedule 1 of the Radiation Control Regulation 2025, whether natural or artificial, must be classified as *hazardous* wastes.
- For liquid or non-liquid wastes with a specific activity of 100 Becquerels per gram or less and/or consisting of, or containing, the prescribed activity or less of a radioactive element in Schedule 1 of the Radiation Control Regulation 2025, whether natural or artificial, the *total activity ratio* and *specific activity ratio* must be calculated according to the mathematical expressions below:

  Total activity ratio is calculated using the expression:
  Total activity ratio = $(A1 \times 10^{-3}) + (A2 \times 10^{-4}) + (A3 \times 10^{-5}) + (A4 \times 10^{-6})$
  where A1 to A4 are the total activity of Group 1 to Group 4 radionuclides, as set out in Column 1 of Schedule 1 of the Radiation Control Regulation 2025.

Specific activity ratio is calculated using the expression:
Specific activity ratio = $SA1 + (SA2 \times 10^{-1}) + (SA3 \times 10^{-2}) + (SA4 \times 10^{-3})$

where SA1 to SA4 are the specific activity (of the material) of Group 1 to Group 4 radionuclides, as set out in Column 1 of Schedule 1 of the Radiation Control Regulation 2025.

DEFINITIONS

Specific activity is defined in the *Code of Practice for the Safe Transport of Radioactive Materials* (Australian Radiation Protection and Nuclear Safety Agency 2008) as follows:

- 'Specific activity of a radionuclide shall mean the activity per unit mass of that nuclide.
- The specific activity of a material shall mean the activity per unit mass of the material in which the radionuclides are essentially uniformly distributed.'

Non-liquid wastes must be classified as *restricted solid waste* unless:

- other characteristics of the waste mean that it must be classified as *hazardous waste* (for example, it may be pre-classified as *hazardous waste* in accordance with Step 3 of Part 1 of the *Waste Classification Guidelines* [EPA 2008]; or
- it contains chemical contaminants that will lead to its assessment as *hazardous waste* (see Step 5 of Part 1 of the *Waste Classification Guidelines)*.

NOTE: Where the *specific activity ratio* and *total activity ratio* are equal to or less than one, the waste must be classified according to its other characteristics in line with Part 1 of the *Waste Classification Guidelines*.

Restricted solid waste

- Currently, no wastes have been pre-classified by the EPA as 'restricted solid waste.' Restricted solid waste, therefore, only includes wastes assessed and classified as such in accordance with the procedures in Step 5 of this guide.
- However, the EPA may classify waste as restricted solid waste from time to time by a notice published in the *NSW Government Gazette*. All currently gazetted restricted wastes will be listed on EPA's website at www.environment.nsw.gov.au/waste/wastetypes.htm.
- According to the Protection from Harmful Radiation Act 1990 and Protection from Harmful Radiation Regulations 2025 (and all subsequent amendments) for the Radiation Management Licence Holder to dispose of radioactive waste, they must have received written authority from the Director-General to date, the D-G has not had any need to give such authority to an institute and therefore to be compliant, the radioactive waste must be stored by the licence holder, with the only legal requirement being that complete records of disposal are maintained.

RESPONSIBILITIES

Generators of Radioactive Waste

Generators of radioactive waste (researchers, students, laboratory personnel, etc.) must:

- collect the radioactive waste as it is being generated;
- appropriately package and store waste for the short term;
- label waste containers [trefoil, date, generator, generator's location, contact phone number, isotope, mass, estimated activity];
- complete all required documentation and local records;
- when the waste container is full, or it is appropriate time for the waste to be processed by the University, complete the waste form and contact the Faculty of Science Technical Support Unit to arrange the transfer to the University central Radioactive Waste Store;
- complete all necessary disposal and transfer forms and advise the RSC accordingly;

- Disposal will then be the responsibility of the Radiation Management Licence holder who will delegate the management to the WHS Unit (and the RSC) for final management and disposal (if possible).

Principal Investigators

Principal investigators that are responsible for projects and procedures that generate radioactive waste must:

- inform and obtain permission from the Radiation Safety Committee or their delegate before storing or disposing of radioactive waste;
- ensure compliance with current legislation regarding storage and disposal of radioactive waste;
- ensure that others involved with the project or procedure comply with the current legislation regarding storage and disposal of radioactive waste;
- ensure that themselves or others who generate radioactive waste record the nature and storage of such radioactive waste in the logbook provided in the facility or storage area;
- ensure that all dealings with radioactive waste storage or procedures are kept in a written form (could be electronic) and the documents stored for at least 5 years and destroyed only if permission is gained from the Director-General of the EPA; and
- ensure that personnel involved with the project or procedure are properly trained and wear personal protective equipment (PPE), appropriate to the hazard.

Central Store Manager

The person responsible for the central store will ensure:

- that the storage area or facility complies with legislation; and
- a logbook of stored radiation material is available and kept in the storage area or facility.

Radiation Management Licence Holder

Radiation Management Licence Holder must ensure that:

- all radioactive waste is stored or disposed of in accordance with the current legislation;
- all dealings with radioactive waste storage or procedures are kept in a written form (could be electronic) and documents stored for at least 5 years and destroyed only if permission is gained from the Director-General of the EPA; and
- a store or storage area for radioactive sources within the premises is constructed of durable materials, is lockable and secure.

NOTE: Requirements for an approved radiation waste store or storage area

The radiation level in any store or storage area or any accessible surface on the outside the store or storage area must not exceed the dose limits in Schedule 5 of the Radiation Control Regulations, the dose constraint for the general public detailed in NSW Guideline 7 and be in accordance with the concepts as detailed in ARPANSA RPS16 *Predisposal Waste Management*. The accepted conservative limits, based on these concepts, as being:

- If only occupationally exposed persons have access to the area of the storage then the dose rate at 5cm from the outside surface of the storage unit must be at or below 5 µSv/hr.

- If any person who is not an occupationally exposed worker has access to the near vicinity of the storage, then the dose rate at 5cm from the outside surface of the storage unit must be at or below 0.5 µSv/hr.

Radiation Safety Committee

The Radiation Safety Committee (acting as the delegate of the RML holder) must:

- ensure that logbook, labels and records of transfer documentation are correct;
- ensure that the package(s) are verified in terms of dose rate (activity and specific activity); and
- sign off that the records pertaining to all of the radioactive waste are correct and up-to-date.

PROCEDURE

Storage Procedures (Identification, Location, Record Keeping)

3.1.1. Radioactive waste must:

(a) have appropriately shielded and labelled waste containers dedicated to the project

(b) NOT be mixed with waste from other projects

(c) be stored in appropriately shielded and labelled containers in an area approved for storage of radioactive material

(d) be clearly identified with the University Radioactive Waste Label (see Appendix 18.2)

(e) NOT be stored with explosive, combustible or corrosive material

3.1.2. Sharps (e.g. needles or needles with syringes attached) which may be contaminated with radioactivity must be stored in a trefoil labelled sharps container. The sharps containers must not be overfilled and labelled with the University Radiation Waste Label.

3.1.3. If the radioactive waste includes another type of hazardous waste (e.g. biological waste), then storage must comply with the conditions for radioactive waste storage and for the storage conditions for the other hazardous waste.

NOTE: Mixed waste is defined as a waste that is both radioactive and contains a non-radioactive contaminant that is itself considered a hazardous material, such as biological waste. Such wastes are subject to regulation for both hazards, which adds to their complexity when dealing with them. For this reason, mixed wastes should be avoided, but with research and teaching this is often unavoidable.

3.1.4. Scintillation Fluids – Used scintillation vials are not to be decanted of their contents before disposal. The used vials should be stored in a plastic pail of no more than 15 litres. This is to reduce the risk of manual handling problems and to minimise the time required dealing with used scintillation vials. The pail should be labelled as per 4.1.1 and have a lid that will seal the pail. DO NOT OVERFILL these pails: the lid must properly close and seal the container.

Once the pail is filled, the principal investigator of the project will organize for the qualified and authorise Faculty staff member to measure the activity and determine the disposal or storage procedure to be followed.

3.1.5. Where possible, containers should be stored within a secondary container or bunded area.

Mixed Waste Hazards

Mixed waste is defined as a waste that is both radioactive and contains a non- radioactive contaminant that is itself considered a hazardous material, such as biological waste. Such wastes are subject to regulation for both hazards, which adds to their complexity when dealing with them. For this reason, mixed wastes should be avoided, but with research and teaching this is often unavoidable.

Waste Material Destined for the University Radioactive Store

(Conditioning/packaging of radioactive waste for long term storage)

The University will adhere to the principles associated with Annex E of the Safety Guide for the Predisposal Management of Radioactive Wastes (RPS 16) for management of medical and laboratory radioactive waste (Appendix 18.2). This will be done in consultation with the RSC.

Disposal procedures

User licence personnel shall follow the following steps:

(a) If a waste container is full, or it is appropriate time for the waste to be processed by the University, or a project is completed (whichever the sooner defined in the risk assessment approved by RSC), then the generator of the waste will contact the CSU RSC to approve or confirm procedures for waste storage or disposal based on the waste categories (e.g., Very Short-Lived Waste, Low-Level Waste, etc.) as per ARPANSA's classification system..

(b) The generator of the waste will complete all necessary disposal and transfer forms.

(c) For items that are determined to be placed in the University central Radioactive Waste Store, the CSU RSC will determine the procedure for transfer to the University central Radioactive Store.

NOTE: The type of waste generated can take the following forms:

- airborne wastes such as radioactive gases, vapours, or particulate material;
- liquid radioactive wastes: These include animal excreta and aqueous solutions of radionuclides or suspensions of radioactive material in water or water-miscible liquid(s). Another category of liquid wastes is that of organic solvents which, because they are flammable or toxic, usually require special methods of disposal such as incineration in an approved incinerator (currently no Environmental Permit or Licence has been issued to a waste facility for such purposes);
- solid wastes include liquid in solid containers, sealed sources and rubbish. Sealed sources are generally in the form in which they were originally purchased; whilst rubbish includes contaminated packing materials, laboratory glassware, pipette tips, plastic vials and trays, paper tissues, used syringes, etc; and
- radioactive animal carcasses (from research activities) need special consideration. Carcasses of small animals such as mice and rats, and excised organs of larger animals, will need to be kept frozen until such time as the carcass and the associated radioactive contamination is deemed acceptable for disposal. The nature and quantity of radioactivity involved should be taken into account in selecting the appropriate option. Larger animals contaminated with radioactive materials are

definitely a major problem. Please contact the WHS Unit and the University RSC while in the planning stages for this work.

Minimisation, Segregation and Disposal

The effective management of low and intermediate level waste depends on knowledge of the waste characteristics and the contained radioactivity. The volume of radioactive waste should be kept to a minimum and should be categorised according to its method of disposal at as early a stage as possible. Non-radioactive waste and very low-level waste (that is, below the exemption levels set by the regulatory authority) should be kept separate from waste that needs to be disposed of as radioactive waste. This waste should be monitored by the RSC to confirm its status before being removed from a controlled area. It is useful to segregate radioactive waste on the basis of half-life in order to facilitate appropriate storage and disposal. For example, waste can be segregated into short-lived and long-lived radionuclide bins. The bins should be well shielded and the content disposed of when the activity drops to a sufficiently low level such that it is indistinguishable from background when measured with an area radiation monitor. Care must be taken to remove or deface any indications that the disposed waste is radioactive.

If possible, sealed sources (see Section 16 - Safety with Sealed Sources) should be returned to the supplier when no longer required. Prior to purchasing a sealed source, purchase contracts should include the provision that the manufacturer will accept return of the source at the end of its useful life.

REQUIREMENTS FOR AN APPROVED RADIATION WASTE STORE

The radiation level in any store or storage area or any accessible region outside the store or storage area must not exceed the dose limits in the Protection from Harmful Radiation Regulations 2025. The accepted limits measured regularly with calibrated Geiger meter are:

- If only occupationally exposed persons have access to the area of the storage then the dose rate at 5cm from the surface of the storage unit must be at or below 5, then the dose rate at 5cm from the surface of the storage unit must be at or below 5 μSv/hr.
- If any person who is not an occupationally exposed worker has access to the near vicinity of the storage, then the dose rate at 5cm from the surface of the storage unit must be at or below 0.5μSv/hr.

All storage facilities must meet the appropriate requirements of the legislation and ARPANSA RPS11. Sealed sources and premises that are registered under the Radiation Management Licence, must meet the conditions of their registration, in addition to the requirements of this procedure.

EMERGENCY MANAGEMENT

Emergency procedures must be prepared in accordance with the Emergency Plan which incorporates AS 3745.2010 Planning for Emergencies in Facilities.

For life threatening situation call 000.

If there is an incident that requires an emergency response, call Security ext. 400 or 1800 931 633 who will assess the situation and escalate to the Emergency Management team where appropriate

DOCUMENTATION

Registers of radioactive substances

Waste storage and disposal records

AUDIT

Every year

REFERENCES

None

REVISION & APPROVAL HISTORY

Date	Revision No.	Author and Approval
Dec 2014	Version 1	William Bartolo, Bartolo Safety Management Service
May 2016	Version 2	William Bartolo, Bartolo Safety Management Service
Dec 2016	Version 3	Radiation Safety Committee, Charles Sturt University
Jan 2017	Version 4	William Bartolo, Bartolo Safety Management Service and Radiation Safety Committee, Charles Sturt University
Nov 2022	Version 5	Radiation Safety Committee, Charles Sturt University
Oct 2025	Version 6	Dr Sajid Latif; Radiation Safety Committee, Charles Sturt University

Appendix 18.1

Prescribed Activity of a Radioactive Substance

Column 1					**Column 2**
Group 1					
Ac227	Am241	Am243	Cf249	Cf249	40 kilo-becquerels
Cf250	Cf252	Cm242	Cm243	Cm244	
Cm245	Cm246	Np237	Pa231	Pb210	
Po210	Pu238	Pu239	Pu240	Pu241	
Pu242	Ra223	Ra223	Ra226	Ra228	
Th227	Th228	Th230	U230	U232	
U233	U234				
Any alpha emitting radionuclide that is not included in any other Group in this Schedule					
Group 2					
Ac228	Ag110m	At211	Ba140	Bi207	400 kilo-becquerels
Bi210	Bk249	Ca45	Cd115m	Ce144	
Cl36	Co56	Co60	Cs134	Cs137	
Eu152	Eu154	Ge68	Hf181	I124	
I125	I126	I131	I133	In114m	
Ir192	Mn54	Na22	Pa230	Pb212	
Ra224	Ru106	Sb124	Sb124	Sb125	
Sc46	Sr89	Sr90	Ta182	Ta182	
Tb160	Te127m	Te129m	Th234	T1204	
Tm170	U236	U236	Y91	Zr95	
Any radionuclide that is not alpha emitting and is not included in any other Group in this Schedule					
Group 3					
Ag105	Ag111	Ag111	Ar41	As73	4 mega-becquerels
As74	As76	As77	Au196	Au198	
Au199	Ba131	Ba133	Be7	Bi206	
Bi212	Br75	Br76	Br82	C14	

Ca47	Cd109	Cd115	Ce141	Ce143	
Cl38	Co57	Co58	Cr51	Cs129	
Cs131	Cs136	Cu64	Cu67	Cu67	
Dy165	Dy166	Er161	Er169	Er169	
Er171	Eu152m	Eu155	F18	Fe52	
Fe55	Fe59	Ga67	Ga68	Ga72	
Gd153	Gd159	Hf175	Hg195m	Hg197	
Hg197m	Hg203	Ho166	I123	I130	
I132	I134	I135	In111	In115	
In115m	Ir190	Ir194	K42	K43	
Kr85m	Kr87	La140	Lu177	Mg28	
Mn52	Mn56	Mo99	Na24	Nb93m	
Nb95	Nd147	Nd149	Ni63	Ni65	
Np239	Os185	Os191	Os193	P32	
Pa233	Pb203	Pd103	Pd109	Pm147	
Pm149	Pr142	Pr143	Pt191	Pt193	
Pt197	Pt197	Rb81	Rb86	Re183	
Re186	Re188	Rh105	Rn220	Rn222	
Ru103	Ru105	Ru97	S35	Sb122	
Sc47	Sc48	Se75	Si31	Sm151	
Sm153	Sn113	Sn121	Sn125	Sr85	
Sr91	Sr92	Tc96	Tc97	Tc97m	
Tc99	Te125m	Te127	Te129	Te131m	
Te132	Th231	Ti200	Ti201	Ti202	
Tm171	U239	V48	V48	V48	
W181	W185	W187	Xe135	Y87	
Y90	Y92	Y93	Yb175	Zn62	
Zn65	Zn69m	Zr9			
Group 4					
Ar37 Cu62	C11 Ga68	Co58m Ge71	Cs134m H3	Cs135 I129	40 mega-becquerels

In113m	Kr81m	Kr85	N13	Nb97	
Ni59	O15	Os191m	Pt193m	Pt197m	
Rb87	Re187	Rh103m	Se73	Sm147	
Sr85m	Sr87m	Tc96m	Tc99m	Th nat	
Th232	U nat	U235	U238	Xe131m	
Xe133	Y91m	Zn69	Zr93		

Appendix 18.2

Note: *Text that is crossed out is not relevant to a University but is maintained for completeness of the document and to act as reference information.*

Extract of Annex E of the Safety Guide entitled Predisposal Management of Radioactive Wastes (RPS 16)

PRETREATMENT

The first pretreatment operation should be to collect the radioactive waste and segregate items on the basis of radiological, physical, chemical and pathogenic properties. Waste containing predominantly short-lived radionuclides should not be mixed with long-lived waste.

Segregation is only worthwhile if the segregated wastes will be treated differently as they move through the waste management steps to disposal or if waste acceptance criteria for disposal are likely to be different.

Knowledge of the processes generating the waste may provide adequate knowledge of the radioactivity and radionuclides in the waste. If this is not sufficient the waste should be characterised. The initial characterisation could be based on knowledge of the process generating the waste and the radionuclides involved in the process, combined with dose rate and perhaps preliminary gamma spectroscopy. This initial characterisation could provide enough information to allow disposal or storage options to be determined.

Wastes of different types and radioactivity concentrations (or total radioactivity in the case of sources) may be segregated (Section 4.3) to facilitate waste management according to the overall waste management strategy and the available facilities.

Considerations for segregation include:

• radioactivity concentration: higher radioactivity waste separated from lower radioactivity waste;

• radioactive decay: waste containing long-lived alpha emitters should be separated from waste with no alpha emitters;

• form: solid, gaseous and liquid wastes are treated separately;

• combustible or non-combustible;

• compressible or non-compressible;

• metallic or non-metallic;

• fixed or non-fixed surface contamination;

• materials and objects that are pyrophoric, explosive, chemically reactive or otherwise hazardous;

- items containing free liquids or pressurized gases;
- waste containing infectious agents or is regulated as medical waste; and
- animal carcasses and putrescibles materials.

A more definitive characterisation should be undertaken prior to any treatment and/or conditioning. This characterisation should be sufficiently comprehensive to provide adequate information for assessing treatment steps and demonstrating compliance with the Transport Code (ARPANSA 2008) and disposal waste acceptance criteria.

If all radionuclides in a waste package have half-lives less than about a year, consideration should be given to storing the waste in a storage facility approved by the regulatory authority until radioactivity has decayed to exemption levels.

Other actions undertaken in pretreatment could be to adjust the characteristics of the waste to make it more amenable to further processing and to reduce or eliminate certain hazards posed by the waste owing to its radiological, physical, chemical or pathogenic properties.

Larger items with limited contamination can sometimes be decontaminated to reduce the volume of waste. Mechanical, chemical and electrochemical methods can be used to remove surface contamination from a large item. The decontamination process should be planned to ensure that the characteristics of the secondary waste are compatible with the requirements for future management. The assessment as to whether to undertake decontamination should take into account the total amount of waste that will be generated by the decontamination (including any plastic sheeting, cleaning equipment, and liquid waste) and doses to workers from the decontamination.

Some items can be disassembled to remove smaller radioactive components or contaminated items from a larger volume of non-radioactive material.

Waste acceptance criteria for disposal are likely to contain exclusions for PCBs, hazardous materials, infectious waste, putrescible waste and explosive materials; and limits on some combustible materials, lead and lead compounds, surfactants, flammable liquids, pressurised gases, chelating agents, organic liquids and free liquids. Estimates of these and similar hazardous and/or toxic components should be determined from process knowledge or direct measurement, and the information documented and stored with the inventory so that it is available when the waste is sent for storage and disposal.

LIQUID WASTE

Liquid radioactive waste can be generated in laboratory or medical applications of radioactive materials. Limited quantities of aqueous liquids with low concentrations of radioactive material may be suitable for discharge to the sewer, under the requirements and limits for discharge of radioactive waste by the user proposed to be included in Schedule 8 of the *National Directory for Radiation Protection*. Liquid waste potentially containing radioactivity which would cause the discharge exemption limit to be exceeded should be collected and stored for decay or other treatment determined by the chemical, physical and biological hazards of the liquid including the radionuclide half-life.

Where aqueous liquid radioactive waste is regularly produced in a laboratory at a level where the effluent from laboratory sinks may conceivably cause the discharge to the sewer to exceed the proposed exemption level, sinks should be connected to a holding or delay tank system and these

sinks should be restricted to uses involving radioactive materials. Where the volume of liquid radioactive waste is small, a labelled screw top container in the working area may be adequate.

Holding tanks for short-lived radionuclide wastes are usually constructed in sets of two or more, so that one may be filling while the contents of a full one may be discharged after sampling or elapse of a sufficient period for radioactive decay.

Tanks for temporarily holding liquid waste should:

- be leak-free;
- have visual indicators of the volume of the contents and warning devices to indicate when the tank is almost full;
- be enclosed in a secondary enclosure of sufficient volume to hold the contents if at any time there should be a loss of tank contents;
- have facilities to monitor the amount of radioactivity or to allow easy withdrawal of representative samples;
- have a means to allow inspection of build-up of deposits on the base or sides and to allow access for clearing (incorporation of mechanical agitators may reduce the incidence of deposits); and
- have sanitary controls and methane monitoring if the tank holds human or animal wastes.

Liquid waste should be characterised on the basis of process knowledge and preliminary measurement. Mixing liquid waste streams should be limited to those streams that are radiologically similar and chemically compatible. It is usually preferable to treat a small amount of more concentrated liquid waste rather than treat the large volume created when the more concentrated liquid is mixed into a larger volume of liquid with low or very low levels of radioactivity.

Aqueous liquid waste streams should not be mixed with organic liquid waste. Organic liquid waste may be flammable, and its collection and storage should incorporate provisions for adequate ventilation and fire protection.

The non-radiological characteristics of liquid waste should be assessed to determine if there are other hazardous components in the waste that limit the management options for the waste.

TREATMENT

Treatment of laboratory waste may include:

- volume reduction by compaction of solid waste, by disassembly of bulky waste components or equipment, and by incineration of combustible waste;
- concentration and collection of radionuclides from liquid and gaseous waste streams by evaporation or ion exchange for liquid waste streams and filtration of gaseous waste streams; and
- change of form or composition by chemical processes such as precipitation, flocculation and acid digestion as well as chemical and thermal oxidation.

In general, treatment of radioactive waste requires approval from the regulator before any treatment or conditioning is undertaken. In some cases, this could already be included under an existing licence; in others, specific approval will be required.

Compaction can be an effective method for reducing the volume of a compressible waste. The characteristics of the material to be compacted and the desired volume reduction should be well

defined and controlled. Issues to be taken into consideration in assessing the safety of compaction should include:

- possible release of volatile radionuclides and other airborne radioactive contaminants as gases or dust;
- possible release of contaminated liquid during compaction;
- chemical reactivity of the material during and after compaction; and
- potential fire and explosion hazards due to pyrophoric or explosive materials or pressurized components.

Disassembly and other size reduction techniques may be used for waste that is bulky or oversized in relation to the intended processing. Processes for size reduction can include sawing, hydraulic shearing, abrasive cutting, plasma arc cutting and cutting with high temperature flames. Preventing the spread of particulate contamination should be considered in the choice of method and in the operation of the equipment.

Combustible solid waste and radioactive organic liquids may be incinerated, calcined or treated with other advanced oxidation techniques suitable for reducing the volume of waste and producing a stable waste form. After incineration, calcination or advanced oxidation, radionuclides from the waste are distributed between the residue, the products from cleaning the exhaust gases and any stack discharges. The distribution of radioactivity and other combustion products to each of these waste streams should be assessed for all normal and abnormal conditions. Any proposal for incineration, calcination or other advanced oxidation technique should be referred to the regulator for approval.

If the radioactive waste contains fissile material, the potential for criticality should be evaluated and eliminated by means of design features and administrative controls.

Used filters from treating gases at facilities using radioactivity are a solid radioactive waste. Care should be taken to ensure that radioactive materials trapped on filters are not dispersed during handling the filters or the subsequent treatment of filters. Many filters will have only low levels of radioactivity, and it may be worth assessing whether the level of radioactivity is below the exemption levels given in the *National Directory for Radiation Protection* (ARPANSA 2004). Filters containing radioactivity can usually be compacted to reduce the volume of radioactive waste to be managed.

For any waste management process that potentially leads to airborne emissions, stack discharges should be monitored to ensure that the concentrations and amounts of radionuclides discharged are within the limits specified by the regulatory body and are consistent with the parameters modelled in the safety assessment.

Animal carcass waste might be incinerated or treated with lime and absorbent. Specific absorbents are available for dealing with biological material, and the specific instructions should be followed.

TREATMENT OF LIQUIDS

Long-lived liquid radioactive waste requiring storage should be converted to solid form as soon as practicable. Solid waste is easier to store safely and, as shown in Annex G, a repository for waste disposal is likely to only accept solid waste with limits on the amount of free liquid.

Treatment of organic liquid waste, e.g. contaminated oil, depends on the organic liquid involved so relevant advice on treatment options should be sought. Methods for converting radioactive aqueous liquid waste to a solid form include:

- chemical precipitation, for example precipitating the radioactive component as hydroxide by raising pH;
- evaporation of liquid and management of the residue as solid radioactive waste;
- incorporation into a matrix, e.g. added to a sand cement mortar, bitumen polymer, ceramics or glass;
- adsorption of radioactivity onto a solid, e.g. alum followed by centrifuging to separate the solids from the liquid;
- the use of ion exchange resin; and
- filtration, ultrafiltration and reverse osmosis.

Chelating agents, organic liquids or oil and salt content in liquid waste may also be of concern in some conditioning processes.

CONDITIONING

Conditioning laboratory waste may include the conversion of the waste to a solid waste form, enclosure of the waste in containers, and, if necessary, provision of an overpack. Conditioning could also be encapsulation of contaminated items in an inert matrix, such as a cement or mortar.

Twenty litre, 60 litre and 205 litre steel drums are the preferred package sizes for laboratory radioactive waste. Galvanised or stainless steel drums have greater resistance to corrosion and may be preferred. A safety assessment should be performed to ensure that the drum selected is suitable for the particular waste type. Other sized packages or type of package should be used if the safety assessment demonstrates a significant advantage in doing so. A generator producing small amounts of radioactive waste might use smaller packages, but the smaller packages selected should be able to be packed into larger drums for ease of subsequent handling. If larger packages are indicated, future transport and handling requirements should be considered before deciding to use larger packages. Consideration should be given to cutting larger items to fit into a 205-litre drum.

The dose rate on the outside of the package containing radioactive waste should be measured to ensure the package is suitable for the storage facility and the proposed mode of transport. Some waste may need to be encapsulated in cement mortar to reduce the contact dose rate on the outside of the package. Alternatively, additional temporary shielding and control procedures could be used to control access to areas with higher dose rates.

Waste packages produced by conditioning should satisfy the criteria for transport, storage and disposal. To the extent practicable, conditioning of radioactive waste should produce a waste package with the following characteristics and properties:

- physical and chemical properties of the waste are compatible with any matrix materials and the container;
- low voidage;
- low permeability and leachability;
- chemical, thermal, structural, mechanical and radiation stability will be maintained for the required period of time;
- resistant to chemical substances and organisms;

- suitable for retrieval at the end of the storage period;
- suitable for transport to and handling at a disposal facility.
- Some materials require specific assessment before being encapsulated in concrete. Aluminium, magnesium and zirconium are known to react with the alkaline water of a cement slurry or water diffused from a concrete matrix to produce hydrogen.

The container may also need to provide radiation shielding. The selection of materials for the container and its outer surface finish should consider the ease of decontamination. An additional container or an overpack may be needed to meet the acceptance criteria if the container does not meet the relevant criteria for transport, storage or disposal. Any such package should be designed to maintain integrity and containment of the radioactivity for an extended period of storage if there could be a significant delay before an acceptable disposal route becomes available.

REVISION & APPROVAL HISTORY

Date	Revision No.	Author and Approval
Dec 2014	Version 1	William Bartolo, Bartolo Safety Management Service
May 2016	Version 2	William Bartolo, Bartolo Safety Management Service
Dec 2016	Version 3	Radiation Safety Committee, Charles Sturt University
Jan 2017	Version 4	William Bartolo, Bartolo Safety Management Service and Radiation Safety Committee, Charles Sturt University
Nov 2022	Version 5	Radiation Safety Committee, Charles Sturt University
Oct 2025	Version 6	Dr Sajid Latif; Radiation Safety Committee, Charles Sturt University

Appendix 18.3

Sample Radioactive Waste Label

RADIATION WASTE DISPOSAL IDENTIFICATION LABEL

Charles Sturt University

Waste Generator Information

Department: _____

Date: _____/_____/_____ **Extension:** _____

Name: _____

Supervisor (if applicable) _____

Isotope: _____

Description: _____

Precautions: _____

Activity: _____

Decay Date (disposal date): _____/_____/_____

Waste Register Number: _____

Waste Owner Signature: _____