Ionising Radiation Safety Management

IMPLEMENTATION

Aim

To prescribe the responsibilities and actions required for the safe management of radiation on University premises and/or during University related activities to ensure the University meets the requirements of the Health, Safety and Wellbeing (HSW) Policy, Radiation Protection Control Act 1982 (SA), Radiation Protection and Control (Ionising Radiation) Regulation 2015 (SA) and the relevant sections of the Work Health and Safety Act 2012 (SA).

This procedure should be read in conjunction with the HSW Plant/Equipment Safety Management Procedure.

Note: this HSW procedure constitutes the University Radiation Safety Manual as required under Regulation 10 of the Radiation Protection and Control (Ionising Radiation) Regulation 2015 (SA).

1 Objectives

1.1 To ensure that the risks of radiation activities, are identified, assessed and the appropriate control measures are in place to prevent an injury and minimise exposure.

1.2 To ensure that:

- all radiation related incidents and safety issues have been investigated;
- control measures have been reviewed before the activity is conducted again; and
- corrective action(s) have been implemented where required to prevent a recurrence.

2 Scope and application

2.1 Inclusions

This procedure applies to:

- all persons taking part in any University activity that involves ionising radiation in teaching and research activities;
- University premises where radiation is used;
- University ionising radiation apparatus; and
- University radioactive sources (sealed and unsealed).

2.2 Exclusions

This procedure does not apply to:

- non-ionising radiation (e.g. ultraviolet, microwaves or lasers);
- any apparatus that produces ionising radiation incidental to its function (including electron microscopes);
- apparatus (including cathode ray tubes or an electronic valve) if the apparatus in normal operating conditions does not cause an equivalent dose rate exceeding 1 microsievert per hour at a distance of 0.1 metre from the surface of the apparatus (Regulation 5 of the Radiation Protection and Control (Ionising Radiation) Regulation 2015); and
- substances which are exempt from the Radiation Protection and Control (Ionising Radiation) Regulation 2015 according to Regulation 7.

3 Process: General

Person Responsible		Actions
3.1	**Licensed Supervisors**	☐ Ensure you are licensed by the Radiation Protection Branch of the Environment Protection Authority (EPA) (South Australia) for the work you conduct, including the supervision of unlicensed individuals working with radiation and those practising as dentists and veterinary surgeons. ☐ Ensure that workers under your supervision are: ☐ licenced (where applicable) and registered with the University in accordance with section 4 of this procedure, ☐ provided with information, instruction or training as per, section 5 of this procedure, ☐ monitored in accordance with section 8 of this procedure, ☐ not exposed to greater than 20milliSv in any year by reviewing dose reports and participating in any investigation initiated by Human Resources. ☐ Ensure that Human Resources is consulted and the relevant legislation is complied with (see section 16) before any work listed on the Prescribed List (Appendix A) is undertaken for the first time.
3.2	**Radiation workers**	☐ Ensure your work activities do not affect the safety of other staff, students or the public by any action or inaction. ☐ Ensure you and others are not exposed to more radiation than necessary (a principle referred to as “ALARA” or “as low as reasonably achievable”). ☐ Work in accordance with this HSW procedure (which is the University Radiation Safety Manual). ☐ Comply with the local rules of the laboratory, store or clinic.
3.3	**Audit and Compliance Manager**	☐ Ensure that radiation management is audited in accordance with the licence to possess. ☐ Ensure that the University Radiation Safety Officer (URSO) is meeting regulatory duties. ☐ Ensure that an investigation occurs if an individual is likely to receive an exposure of greater than 5milliSievert (milliSv) in any 12 month period (Refer to Appendix H – Radiation Incident Investigation). ☐ Ensure that the URSO is recognised by the Radiation Protection Branch of EPA as a Radiation Safety Adviser. ☐ Ensure the Contract Services Agreement for the URSO is current.
3.4	**University Radiation Safety Officer (URSO)**	☐ Ensure that the University is complying with the requirements of the Act and Regulations (refer to section 16). ☐ Advise the University on all aspects of radiation safety. ☐ Carry out the duties as set out for a Radiation Protection Adviser in Australian Standard 2243.4 (2018) and in the Regulations, and include advice, training, waste management and general supervision of radiation safety in the University.

4 Process: New Radiation Workers, Changed Radiation Work & Licences

Person Responsible	Actions
4.1 Licensed Supervisors	☐ Ensure that a Worker Registration Form is submitted to Human Resources for all radiation workers under your supervision using radiation for the first time at the University or when currently registered workers use new/changed radiation sources (excluding veterinarians, veterinary nurses, veterinary students, dental students and casual dental teaching staff who will be identified through other University systems). ☐ Ensure that you and staff/students under your control, record your radiation licence on Staff Services online or provide a copy of the obtained licence to Human Resources (students). ☐ Ensure all staff/students under your control working with ionising radiation in a Type C registered premise or an enclosed XRD/XRF are licensed or supervised by a licensed person. ☐ Ensure all staff and postgraduate students under your control using sealed sources, X-ray analysis (open beam and partly enclosed) or x-ray diagnostic apparatus (plain and fluoro) or working in a Type B registered premise are licensed. Note - Undergraduate Students The University has been exempted (South Australian Gazette 24 August 2006) from the requirement to license undergraduate students working with ionising radiation in laboratory classes, however these students must be enrolled in a specified course (see Appendix B note 6)and the licenced supervisor must provide direct supervision(see table in Appendix B). ☐ Ensure that all work by undergraduates with ionising radiation is conducted under direct supervision of a licensed supervisor (refer to Appendix B – Supervision, Information, Instruction and Training). ☐ Ensure that the quantities of radioactive materials used are kept to a minimum and specific instruction on handling radioactive materials is provided to radiation workers. ☐ Ensure that undergraduates do not use X-ray analysis apparatus unless these are fully enclosed X-ray apparatus and the work is under supervision of a licensed supervisor (refer to Appendix B – Supervision, Information, Instruction and Training.) ☐ Ensure that dental and veterinary students do not use X-ray diagnostic apparatus unless the work is conducted under continuous supervision of a licensed supervisor. ☐ Ensure that Human Resources are advised when a radiation worker leaves the University or no longer uses radiation. (continued)

4 Process: New Radiation Workers, Changed Radiation Work & Licences (Continued)

Person Responsible		Actions
4.2	**Audit and Compliance Manager** (or delegate)	☐ Assess completed Worker Registration Forms to determine the requirements of licensing and personal monitoring for each person (see section 3.30.8.1) and communicate the outcome to the radiation worker and licensed supervisor. ☐ Ensure once a quarter Landauer participant list for the veterinary nurses and surgeons is obtained and records are updated and filed. ☐ Ensure once a year all dentistry students and staff details are updated and filed in the central records management system. ☐ Ensure completed Worker Registration Forms are filed in the central records management system. ☐ Maintain records of radiation workers, including isotope activities, exposure levels and incidents relating to radiation.
4.3	**University Radiation Safety Officer (URSO)**	☐ Where requested, aid applicants to prepare for a licence exam.
4.4	**Radiation Worker**	If advised by Human Resources that a licence is required: ☐ Ensure that radiation work (see definitions) is not commenced until the appropriate licence is obtained. Note that if you have an interstate or overseas licence you will be required to reapply (and sit an exam) to obtain a South Australian licence from the Radiation Protection Branch of the EPA. ☐ Complete the relevant licence application (Application for a licence to use or handle a radioactive substance (section 28) or Application for a licence to operate ionising radiation apparatus (section 31)) and return to Human Resources. ☐ Arrange a time with the Radiation Protection Branch of the EPA to sit the exam (within 4 months of the application being submitted to the Radiation Protection Branch of the EPA). The University Radiation Safety Officer can also aid in preparing for the exam if required. Note: Dentists providing evidence of Australian Health Practitioner Regulation Agency registration as a dentist, and veterinary surgeons providing qualifications and Veterinary Board Number are not required to sit the EPA exam in order to obtain a licence. ☐ Ensure that you and staff/students under your control, record your radiation licence on Staff Services online or provide a copy of the obtained licence to Human Resources (students). ☐ Comply with the conditions of the licence (refer to the second side of your EPA licence).

5 Process: Training/Induction

Person Responsible		Actions
5.1	Licensed Supervisors	☐ Ensure that you are trained and licensed for all activities under your control. ☐ Ensure that all radiation workers working under your licence are provided with suitable supervision, information, instruction and training and instruction and training records maintained (hard copy of electronic) (Refer to Appendix B – Supervision, Information, Instruction and Training).
5.2	Radiation Worker	☐ Undertake and record local area induction and training on local procedures and activities before working with radiation. (Refer to Appendix B – Supervision, Information, Instruction and Training).

6 Process: Hazard Management

Person Responsible		Actions
6.1	Licensed Supervisors	☐ Ensure that activities involving radiation are risk assessed prior to being undertaken in accordance with the HSW Handbook Hazard Management procedure and apply the "as "low as reasonably achievable" ("ALARA") principle to minimise exposure (also refer to FAQs Radiation Safety Management and Radiation General for information on controlling radiation hazards). ☐ Ensure that staff and students undertaking the work are aware of all of the required controls identified in the risk assessment and ensure that these are being implemented. ☐ Ensure that all monitoring devices e.g. Geiger counter, identified in the risk assessment are used by the radiation worker under your supervision ☐ Ensure that any new or altered work procedures identified during the hazard management process are communicated to the relevant radiation workers under your supervision. ☐ Ensure that any changes to the radioactive materials being used (e.g. radionuclides, sealed sources disposal/purchases) are communicated to Human Resources.
6.2	Radiation Worker	☐ Ensure there is a completed risk assessment for all radiation tasks you undertake in accordance with the HSW Handbook Hazard Management Procedure. ☐ Implement the controls required by the risk assessment. ☐ Follow local area rules, procedures and instructions from Licensed Supervisors. ☐ For information regarding working with radiation and potential impacts on fertility and pregnancy please refer to FAQs Reproductive Toxicity.

7 Process: Area, Apparatus and Source Monitoring

Person Responsible		Actions
7.1	**Licensed Supervisors**	☐ Ensure that monitoring for contamination of laboratories, leakage contamination of sealed sources, or monitoring and safety checks for X-ray analysis units are carried out in accordance with Appendix C - Monitoring – Unsealed Sources, Sealed Sources & X-ray Apparatus. ☐ Ensure that actions are taken to eliminate or reduce contamination if detected (Appendix C - Monitoring – Unsealed Sources, Sealed Sources & X-ray Apparatus and Appendix G Emergencies & Accidents) ☐ Ensure that any leakage of radiation is reported to Human Resources.
7.2	**University Radiation Safety Officer**	☐ Conduct 12 monthly wipe-testing of sealed radioactive sources and maintain records of testing. ☐ Conduct an investigation in consultation with the licenced supervisor and Human Resources where an abnormal result is found and record the outcome of the investigation findings in the University's records management system.

8 Process: Personal Monitoring

Person Responsible		Actions
8.1	**Licensed Supervisors**	☐ Return all dosimeters, including the control, to the monitoring provider or Human Resources at end of each monitoring period. ☐ Ensure that all radiation workers under your control know the rules regarding wearing and storage of a dosimeter (Appendix D Personal Monitoring). ☐ Participate in any investigation conducted by Human Resources if a radiation worker under your supervision is identified as possibly achieving a 5milliSv in a 12-month period. ☐ Ensure that radiation workers under your control modify radiation work once it is identified that the 5milliSv dose may be reached in a 12-month period. ☐ Ensure that radiation workers under your control cease radiation work for the next 12 months once it is identified that their 12 monthly dose has, or is likely to have, reached 20milliSv.
8.2	**Audit and Compliance Manager** (or delegate)	☐ Distribute new dosimeters to the school. ☐ Monitor the dose reports to ensure that no radiation worker exceeds 5milliSv per year. ☐ Distribute dose reports from the monitoring provider to the Licensed Supervisor. ☐ Ensure that the relevant HSWO completes an investigation once it is identified that 5milliSv dose may be reached in a 12-month period (refer to Appendix H – Radiation Incident Investigation). ☐ Ensure that a radiation worker is informed to modify radiation work (and the supervisor is notified) once it is identified that 5milliSv dose has, or is likely to have been, reached in a 12-month period. ☐ Maintain a record of all personal monitoring exposures and cumulative dose reports (in the University's records management system) for each radiation worker.

8 Process: Personal Monitoring (Continued)

Person Responsible		Actions
8.3	**University Radiation Safety Officer (URSO)**	☐ Conduct an investigation (where required) in consultation with Human Resources, once HR determines that 5milliSv dose may be achieved in a 12-month period (if requested by the University) (refer to Appendix H – Radiation Incident Investigation).
8.4	**Radiation Worker**	☐ Wear the supplied dosimeter supplied to you at all times when using radiation. DO NOT wear dosimeters allocated to other staff or students. ☐ Ensure that you follow the requirements regarding correct wearing and storage of dosimeters (Appendix D Personal Monitoring). ☐ Participate in any investigation conducted by-Human Resources if you are identified as achieving a 5milliSv dose in a 12-month period. ☐ Ensure that you modify radiation work once it is identified that the 5milliSv dose has, or is likely to have been, reached in a 12-month period. ☐ Ensure that you cease radiation work (for the next 12 months) once it is identified that the 20milliSv dose has or is likely to have been achieved in a 12-month period.

9 Process: Registering premises, sealed sources, apparatus and the licences to possess

Person Responsible		Actions
9.1	**Licensed Supervisors**	☐ Ensure that any premises in which unsealed substances are handled or stored, any sealed radioactive sources, and any ionising radiation apparatus are registered with the Radiation Protection Branch of the EPA. ☐ Ensure premises meet requirements and sealed sources and apparatus are managed according to Appendix E Management of Facilities, Storage, Transportation and Record-Keeping. ☐ Ensure conditions of registration for premises, sealed sources and apparatus are complied with (listed on reverse of EPA registration document). ☐ Complete and submit applications for registration of apparatus, sealed sources or premises in which unsealed sources will be handled or stored to Human Resources. Forms are as follows: ☐ Apparatus: Application to register an ionising radiation apparatus (section 32) - new apparatus and transfer of ownership ☐ Sealed sources: Application to register a sealed radioactive source (section 30) - new sources and transfer of ownership ☐ Premises: Application to register premises in which unsealed radioactive substances are handled or kept (section 29A) ☐ When advised by the Radiation Protection Branch of the EPA, organise compliance testing for Apparatus. ☐ Place a copy of the registration conditions for the premises or the equipment at the entrance to the laboratory. ☐ Inform Human Resources within 10 days if the location of an already registered ionising radiation apparatus or sealed source changes.

9 Process: Registering premises, sealed sources, apparatus and the licences to possess (Continued)

Person Responsible		Actions
9.2	**Audit and Compliance Manager or delegate**	☐ Forward any registration forms to the Radiation Protection Branch of EPA. ☐ Advise the Radiation Protection Branch of the EPA within 14 days if the location of an already registered ionising radiation apparatus changes. ☐ Confirm with Schools which premises and apparatus require registration renewal and ensure that registration is renewed before the expiry date. ☐ Ensure that the Radiation Protection Branch of the EPA have the correct details of all current sealed sources, premises and ionising apparatus. ☐ Ensure that an annual source audit and a Licence to possess audit is conducted and the University applies to the EPA for the Licence to Possess. ☐ Ensure that the Radiation Management Plan is submitted to the Radiation Protection Branch of the EPA by 31 August annually. ☐ Maintain a register of all the University's sealed sources and apparatus (including those used as "waste storage"). ☐ Provide a copy of the EPA registration for premises and apparatus to the relevant Schools/Branches. ☐ Ensure that the University complies with the conditions of the permit to possess nuclear material from The Australian Safeguards and Non-proliferation Office. This requires the University to annually: 1. audit and submit an inventory (ASO311); and 2 submit "Addition Protocol" (ASO316) for nuclear material.
9.3	**University Radiation Safety Officer (URSO)**	☐ Ensure that all new radiation premises are inspected to determine if requirements are being met and provide advice to applicant if necessary.

10 Process: Management of Facilities, Storage, Transportation and Record-Keeping

Person Responsible		Actions
10.1	**Licensed Supervisors**	☐ Ensure that the following are managed in accordance with Appendix E Management of Facilities, Storage, Transportation and Record-Keeping. ☐ radiation facilities or premises; ☐ sealed & unsealed sources; ☐ apparatus; ☐ transportation and storage; and ☐ records. ☐ Ensure all staff/students comply with the conditions of registration detailed on the EPA registration document.
10.2	**Radiation Worker**	☐ Comply with requirements of Appendix E Management of Facilities, Storage, Transportation and Record-Keeping and the conditions of registration detailed on the EPA registration document.
10.3	**Audit and Compliance Manager or delegate**	☐ Ensure that all relevant documents received centrally under this procedure are kept in the central records management system.

11 Process: Disposal

Person Responsible		Actions
11.1	**Licensed Supervisor**	☐ Ensure sealed and unsealed radioactive material and apparatus are disposed of in accordance with Appendix F Disposal (see 3.30.12 for decommissioning requirements). ☐ Provide details of expected unsealed radiation purchases/waste disposal to Human Resources as requested (for the annual Waste Management Plan for Approval to Dispose of Unsealed Radioactive Substances). ☐ Ensure that only approved disposal of unsealed substances is conducted (contact Human Resources if unapproved disposal is required and an amendment to the Waste Management Plan can be sought from the EPA (Environment Protection Authority). ☐ Ensure a record of radionuclides bought and sent for disposal is kept. ☐ Ensure that disposal records are kept for all radioactive waste leaving the laboratory.
11.2	**University Radiation Safety Officer (URSO)**	☐ Submit annual Waste Management Plan for Approval to Dispose of Unsealed Radioactive Substances to the Radiation Protection Branch of the EPA by 1st of October annually.
11.3	**Audit and Compliance Manager or delegate**	☐ Send relevant details of the approval to dispose of unsealed radioactive substances plan to licensed supervisors.

12 Process: Decommissioning and Decontamination of Laboratories, Sealed Sources and Apparatus

Person Responsible		Actions
12.1	**Licensed Supervisor** (or where no longer employed by the University the Head of School/Branch)	☐ Ensure that where registered premises, sealed sources or apparatus are no longer required to be used that Human Resources is requested to assist with the decommissioning process.
12.2	**University Radiation Safety Officer (URSO)** or Human Resources (as the URSO delegate).	**Decommissioning Apparatus** ☐ Disable equipment so that equipment is no longer functional and cannot be reconnected. ☐ Advise users on the management of remaining hazards and final disposal of equipment (consider sending to metal recycling). ☐ Inform the EPA of decommissioning within 14 days. **Decommissioning Sealed Sources** ☐ Decommission equipment and transfer the source to long term storage or make alternative arrangements as required. ☐ Advise user if the remainder of equipment can be disposed of. (continued)

12 Process: Decommissioning and Decontamination of Laboratories, Sealed Sources and Apparatus (Continued)

Person Responsible		Actions
12.2	**University Radiation Safety Officer (URSO)** or Human Resources (as the URSO delegate). (Continued)	**Decommissioning Registered Premises** ☐ Inspect, looking particularly for any radioactive material that has been left behind, and remove signage. ☐ Survey and wipe test surfaces, sinks and laboratories. ☐ Photograph the areas surveyed and wipe tested and mark out on a layout map of the area that can be cross referenced to the wipe tests. ☐ Send a declaration that the area is no longer radioactive to the Radiation Protection Branch of the EPA and provide a copy to Human Resources for recording including wipe testing results and associated documents.

13 Process: Sale or Relocation of X-ray Apparatus, Sealed or Unsealed Sources

Person Responsible		Actions
13.1	**Licensed Supervisor**	☐ If a sealed source is going to be sold or gifted, advise Human Resources in advance. ☐ Submit Notification of Sale, Installation or Relocation of X-ray apparatus form to Human Resources within 10 days of sale or disposal of an X-ray apparatus.
13.2	**Audit and Compliance Manager or delegate**	☐ Review for completeness and submit the Notification form to the Radiation Protection Branch within 14 days of sale or disposal of an X-ray apparatus. ☐ Advise the EPA within 7 days of the sale/gifting of a sealed source. ☐ Retain records for all sales/disposal/gifting of apparatus and sealed sources.

14 Process: Emergency Management

Person Responsible		Actions
14.1	**Licensed Supervisors**	☐ Ensure that all incidents or safety issues (including using apparatus that is not registered, or person has used radiation unlicensed, or unsealed sources found in unlicensed premises) are reported in the University HSW reporting system. ☐ Ensure that areas which are storing radioactive materials and using radiation develop, implement and test contingency plans in accordance with Appendix G Emergencies & Accidents. ☐ Ensure that appropriate spill kits are available . ☐ Ensure that radiation workers are trained in the use of spill kits, where unsealed sources are used. ☐ Ensure incidents are managed and reported in accordance with Appendix G Emergencies & Accidents.
14.2	**Radiation Worker**	☐ Report all incidents or safety issues to your licenced supervisor and into the University HSW reporting system.

14 Process: Emergency Management (Continued)

Person Responsible		Actions
14.3	**University Radiation Safety Officer (URSO)**	☐ Ensure any major incidents are investigated and, where required, reported to the Radiation Protection Branch of the EPA.
14.4	**Audit and Compliance Manager or delegate**	☐ Assist in incident and safety issue investigations and, where required, report to the Radiation Protection Branch of the EPA. ☐ Maintain records of radiation incidents.

15 Performance Measures

Human Resources will use performance measures to assist in identifying areas of success and/or where corrective action is required to meet the objectives and targets of this process.
The level of compliance with the procedure and effectiveness will be determined during the internal audit process.

16 Useful information and resources

16.1	**University related documents and resources** • HSW Handbook Hazard Management • HSW Handbook Plant/Equipment Safety Management Procedure • Reproductive toxicity FAQs • Radiation safety management FAQs • Radiation General FAQs
16.2	**Related Legislation** • Radiation Protection and Control Act 1982 • Radiation Protection and Control (Ionising Radiation) Regulations 2015 • Radiation Protection and Control (Transport of Radioactive Substances) Regulations 2018 • Radiation Protection Series (ARPANSA) • Recommendations for Limiting Exposure to Ionising Radiation (1995) and National Standard for Limiting Occupational Exposure to Ionising Radiation (republished 2002) • *Code of Practice for the Safe Transport of Radioactive Material (2019 Edition)* • *Code of Practice and Safety Guide for Portable Density/Moisture Gauges Containing Radioactive Sources (2004)* • *National Directory for Radiation Protection (2014)* • *Code of Practice for the Exposure of Humans to Ionising Radiation for Research Purposes (2005)* • *Code of Practice and Safety Guide for Radiation Protection in Dentistry (2005)* • *Code of Practice for the Security of Radioactive Sources (2007)* • Code of Practice and Safety Guide for Safe Use of Fixed Radiation Gauges (2007) • Safety Guide for the Predisposal Management of Radioactive Waste (2008) • Code of Practice and Safety Guide for Radiation Protection in Veterinary Medicine (2009) • AS 2243.4-2018 Safety in laboratories - Ionising Radiation
16.3	**Useful Web-links** • Environment Protection Authority, Radiation Protection Branch • Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) • General discussions of the principles and philosophy of radiation protection, and data and models for dose limits, can be found in the publications of ICRP(International Commission on Radiological Protection) and IAEA (International Atomic Energy Agency)

17 Definitions

ALARA: an acronym for the principle "as low as reasonably achievable", which means to manage and control occupational and public exposure at levels as low as reasonably achievable, taking into account economic and social factors.

Annual limit on intake (ALI): a quantity of a radionuclide which, if taken into the body during one year, would lead to a committed effective dose equal to the annual effective dose limit for a radiation worker.

Approved personal dosimeter badge: (formerly known as TLD) are devices worn by radiation workers to measure their effective dose.

Becquerels (Bq): is a measure of the radioactivity of a source.

Bremsstrahlung: is a type of "secondary radiation", in that it is X-ray produced as a result of rapidly stopping (or slowing) the primary radiation beta particles.

Environment Protection Authority (EPA): are the Government Department who regulate the use of ionising radiation in medical, research, industrial and mining organisations, including use of X-rays, and the safe use, transport, storage and disposal of radioactive substances in South Australia.

Effective dose/ Absorbed dose/ Equivalent dose: see Radiation General FAQs The probability of a harmful effect from radiation exposure depends on what part or parts of the body are exposed.

Ionising radiation: the radiation which produces electrically charged particles called ions in the materials it strikes. This process is called ionisation.

Licenced Supervisor: a person who has an EPA licence for the activity being undertaken and is responsible for supervising unlicensed workers who use ionising radiation.

Millisieverts (mSv) and Microsieverts (uSv or µSv): a measure of a dose of radiation that a radiation worker receives.

Radiation Incident: is defined as any abnormal event involving ionising radiation.

Radiation Work: is defined as all work involved with ionising radiation. For example, purchasing, using, and disposal of sealed, unsealed and x-ray apparatus.

Radiation Worker: is defined as all staff, students, visitors and volunteers working with ionising radiation.

Safety Issue
Any safety concern (hazard, near miss, injury/illness) that occurs in an area or location that the University controls or owns or is an activity that the University directly controls (such as a field activity).
It can be an issue involving staff, volunteers, students, members of the public or contractors**.**

Sealed radioactive material: (a sealed source) includes low activity calibration sources, irradiators and neutron sources, and may be fixed or portable (neutron soil moisture probes and soil density gauges).

Type of Premises (e.g. Type C): a classification of premises depending on the group(s) of radionuclide which is kept or handled. In the University the majority of types are C which is the lowest classification (for more information refer to Schedule 3 Radiation Protection and Control Regulations 2015.

University Radiation Safety Officer (URSO): a person who conducts the duties as set out for a Radiation Protection Adviser in Australian Standard 2243.4 (1998) and in the Regulations, and include advice, training, waste management and general supervision of radiation safety in the University and is recognised by the Radiation Protection Branch of the EPA as suitably qualified to conduct these activities.

Definitions (continued)

Worker: according to the WHS Act 2012 (SA) a person who carries out work in any capacity for a person conducting a business or undertaking, including work as -
(a) an employee; or
(b) a contractor or subcontractor; or
(c) an employee of a contractor or subcontractor; or
(d) an employee of a labour hire company who has been assigned to work in the PCBU; or
(e) an outworker; or
(f) an apprentice or trainee; or
(g) a student gaining work experience; or
(h) a volunteer; or
(i) a person of a prescribed class.

The person conducting the business or undertaking is also a worker if the person is an individual who carries out work in that business or undertaking. Note - Higher Degree Research students and Academic visitors are likely to be workers under the WHS Act 2012 (SA).

X-ray analysis apparatus: an apparatus that is used to analyse the properties or composition of materials by the techniques of X-ray fluorescence (XRF) or X-ray diffraction (XRD)**.**

X-ray analysis system means apparatus that consists of an X-ray analysis apparatus and ancillary devices or equipment necessary to determine the elemental composition or to examine the microstructure of matter, but does not include power supplies, transformers, amplifiers, readout devices and associated electronics and control panel.

X-ray diagnostic apparatus: an apparatus that is used for imaging humans and animals for the purpose of diagnosis, visualisation or intervention.

PRESCRIBED LIST

Before undertaking any of the following activities for the first time at the University Human Resources must be consulted.

For the various activities specified in the left column of the Table below, the regulation number from the Radiation Protection and Control (Ionising Radiation) Regulations 2015 can be found in the right column.

Activity	Regulation numbers
Bore hole logging	152-154.
Chiropractic radiography	103, 105, 106.
Fluoroscopy	99, 100, 107.
Human brachytherapy	166.
Irradiation of humans for research purposes (if process not being managed through a hospital)	39 – 44.
Mammography or soft tissue radiography	98, 108.
Work with unsealed substances	124-134, 170-178
Radiation therapy	102-104, 110, 163-165
Site radiography/industrial radiography (the process of radiographing the whole or any part of any pipes, welds, vessels, or any other constructed, fabricated or manufactured object or article by the use of a sealed radioactive source or an apparatus other than a cabinet x-ray unit)	80-89, 155-162
Uranium ore mining or milling	182 – 184

SUPERVISION, INFORMATION, INSTRUCTION AND TRAINING

Type	**Requires an EPA licenced supervisor**	**Requires everyone to be EPA licenced**	**General radiation Information** Refer to note 4	**Specific task information**	**Supervision** Refer to note 5	**Support to non-licenced radiation workers** Refer to note 7
Unsealed Sources in a C type lab	Yes	No	Yes	Yes	Directly until sufficient information has been provided on the task to perform it safety	Licenced supervisor is no more than 5 mins away
XRD (enclosed primary beam)	Yes	No	Yes	Yes	Directly until the apparatus has been demonstrated to the worker	Licenced supervisor is no more than 30 mins away
XRF (enclosed primary beam)	Yes	No	Yes	Yes	Directly until the apparatus has been demonstrated to the worker	Licenced supervisor is no more than 30 mins away
XRF (handheld)	Yes	Yes	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators
Sealed sources - probes	Yes	Yes	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators
Sealed sources – other (not radioactive)Refer to note 1	No	No	No	No	NA	NA
Sealed sources – other (Under licensed supervision)Refer to note 2	Yes	No	Yes	Yes	Directly until sufficient information has been provided on the task to perform it safety	Licenced supervisor is no more than 30 mins away
Sealed sources – other (handled by licensed person only) Refer to note 3	Yes	Yes	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators
Undergraduates using ionising apparatus Refer to note 6	Yes	No	Yes	Yes	Directly until sufficient information has been provided on the task to perform it safety	Licenced supervisor has to be in the same location whilst the student is using the ionising apparatus.
DEXA (densitometer for animals or humans)	Yes	Yes Refer to note 6	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators
Xrays used for imaging (operator)	Yes	Yes Refer to note 6	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators	NA only EPA licenced operators Refer to note 7
Xrays used for imaging (Vet nurse/assistant)	Yes	No Refer to note 7	Yes	Yes	Yes at all times Refer to note 8	NA supervision is required at all times Refer to note 7

SUPERVISION, INFORMATION, INSTRUCTION AND TRAINING

Note 1. Not radioactive

- Group 1 less than 5 KBq;
- Group 2 less than 50KBq;
- Group 3 less than 500KBq;
- Group 4 less than 5000KBq (Refer to Regulation 7 of Radiation Protection and Control (Ionising Radiation) Regulations 2015).

Note 2. Conducted under licensed supervisor

- Group 1 greater than 5 KBq but less than 5MBq;
- Group 2 greater than 50KBq but less than 5MBq;
- Group 3 greater than 500KBq but less than 50MBq;
- Group 4 greater than 5000KBq but less than 50MBq (Refer to Regulation 7 and 124 of Radiation Protection and Control (Ionising Radiation) Regulations 2015).

Note 3. Must be licensed

- Group 1 and 2 greater than 5 MBq;
- Group 3 and 4 greater than 50MBq; and
- sources with unknown activities (Refer to Regulation 124 of Radiation Protection and Control (Ionising Radiation) Regulations 2015).

Note 4. General Radiation Information could include (where applicable):

- Radiation basics (properties of ionising radiation);
- Radiation (hazards; effects; dose limits; conversions);
- Measurement (dose rates; quantifying dose; weighting factor; meters; personal dosimeters; exposures);
- Keeping safe (time, distance, shielding);
- Legal requirements;
- University requirements;
- X-ray unit specifics;
- Sealed source specifics;
- Unsealed substances specifics.

Note 5. Supervision and support is required to satisfy the legislative requirements of radiation workers working without an EPA licence. If the requirements set out in the table above for supervision and support cannot be satisfied, then the worker **must** be EPA licenced.

Note 6. There is an exemption for undergraduate students (which includes honours) enrolled in:

- Bachelor of Oral Health conducted by the University of Adelaide;
- Bachelor of Dentistry conducted by the University of Adelaide;
- Bachelor of Medical Radiation in Diagnostic Radiography or Radiation Therapy or a course approved by the Australian Institute of Radiography;
- Bachelor of Medical Radiation in Nuclear Medicine or a course approved by the Australian and New Zealand Society of Nuclear Medicine;
- Certificate III in Dental Radiography conducted by TAFE SA or a course approved by the Dental Assistants Education Council of Australia; and
- Any undergraduate course of study in an Institute of Technical and Further Education or University, where the course of study does not involve irradiation of humans.
- (see 2006 exemption gazetted 24th August 2006)

This exemption allows the students to learn the use of the apparatus. However, students must be directly supervised at all times by an EPA licenced person who is located with them in the x-ray room.

Note 7. Veterinary nurses/assistants are not allowed to operate the apparatus, only an EPA licenced veterinary surgeons or radiographer **are allowed to operate** x-ray apparatus. For veterinary nurses/assistants there is an exception - if the veterinary surgeon or radiographer have to hold the animal during the imaging so they are unable to operate the apparatus, the veterinary surgeon or radiographer may then instruct the nurse/assistant to undertake the radiograph on their behalf.

Note 8. Supervision in this context, is that the veterinary surgeons or radiographers (who are EPA licenced) **must be** present in the x-ray room and are directly conducting the activity.

MONITORING TASKS and EQUIPMENT

MONITORING UNSEALED SOURCES

Two types of monitoring are used in laboratories with unsealed radioactive materials:

- measurement of the external radiation field; and
- measurement of contamination of benches, equipment and workers by the radioactive material.

Monitoring is to be carried out with a survey meter suitable for the type of radiation being used. It is essential that each laboratory and area have ready access to a detector that can be used to monitor surface contamination and spills. In some cases, contamination will have to be checked using a wipe test (see section at the end of this Appendix).

External radiation field

The measurement of the external dose rate should be less than 2microSv per hour at the body.

An exemption from personal monitoring exists for users of certain radionuclides for example H3, C14 and other radionuclides in limited quantities such as S35 (See Appendix D).

Monitoring Techniques for External radiation fields

- Monitors should be checked before use in a low background area and with a known source to verify their proper operation. (Calibration of monitors are to be aligned with the manufacturer's instructions).
- If the radiation field is much greater than expected do not continue the survey. Exit, close off the area and seek help from your licensed supervisor or the University Radiation Safety Officer.
- Always measure the external field from a new supply of radionuclide before opening it. Accidents have occurred due to incorrectly labelled or packaged material.
- Measure the radiation field close to the source and also at the distances where you will be using the material (hands, body).
- Estimate your body dose from the measured dose rate and your expected working time. This should normally be less than 2microSv per hour but needs to be considered in relation to the time taken for the operation. If it is more than expected consult your licensed supervisor.
- Ensure that you have pre-calculated numbers and actions listed on the local working rules.

Contamination

The amount of radioactive material on a surface (contamination) is generally expressed in terms of counts per minute or second. Contamination limits are expressed in Becquerel per square cm.

The measurement of the contamination of benches, equipment and workers by the radioactive material is normally less than 100 counts per minute (cpm)/100 cm^2.

Monitoring for contamination should be carried out routinely, determined by the licensed supervisor, to ensure surface contamination levels are lower than the limits in Radiation General FAQs and especially to check that hands have not been contaminated.

If a researcher at the University of Adelaide is using a radiation monitor to detect surface contamination of unsealed radiation, the monitors will only require calibration once every 3 years (based on an assessment of risk by the University Radiation Safety Officer).

Monitoring Techniques for Contamination using a counter
Contamination monitoring is a simple case of seeing if the count rate reaches more than double the background rate.

Monitoring Techniques for Contamination of low energy unsealed sources by Wipe Tests
For very low energy beta emitters such as H3, the wipe test is the only satisfactory check for contamination. For instructions on the technique, refer to Radiation General FAQs

- The results need to be compared with the contamination limits found in. Radiation General FAQs

MONITORING TASKS and EQUIPMENT

MONITORING SEALED SOURCES

General Hazards

In general, sealed sources present an external radiation hazard. With fixed sources, shielding normally reduces the external radiation dose rate to acceptable levels. With portable sources, there may be a conflict between the thickness of the shielding and the portability. Calibration and demonstration sources are weaker but their small physical size and portability can lead to the external dose becoming an issue if they are misplaced, lost or stolen.

If the sealed capsule is corroded or broken the radioactive material can leak out. The activity of the radionuclides in sealed sources are usually much higher than the activities of unsealed radioactive materials used in laboratories, so a leak from a broken source will be a major contamination hazard. It is an event requiring immediate notification to the EPA.

Maintenance and Checking of Sealed Sources

- Never attempt to repair or alter the encapsulation of a sealed source.
- Repairs, maintenance and modifications to sealed sources must never be carried out unless the University Radiation Safety Officer, after consulting the Radiation Protection Branch of the EPA, has given explicit written permission for the work.
- A program must be implemented of routinely checking that the source mechanics (mechanism which returns the source to the shielded area) are working correctly. Mechanical failure can make it impossible for the source to return to its shielded container or cause the source to become loose during transport.
- Do not continue to attempt to use a source that has any difficulties in its operation.
- Report all such operational problems immediately to your licensed supervisor and to Human Resources.

Monitoring and Wipe Tests

The purpose of monitoring equipment containing sealed sources is to make sure that the shielding is intact and the source is properly housed inside the shield. An annual dose rate survey around the source shield using a dose rate meter should be conducted by the licensed supervisor.

Wipe tests will be conducted every 12 months by the University Radiation Safety Officer, normally at the time of renewal of the source registration.

MONITORING TASKS and EQUIPMENT

MONITORING X-RAY ANALYSIS UNITS

- A monitor must be available which is suitable for the X-ray energy and is calibrated so that it can properly identify an absorbed dose of 1microGray per hour.
- Monitoring must be done after any radiation incident or accident involving the apparatus, or after a service.
- Regular radiation monitoring of the x-ray analysis units must be carried out at least every 6 months, in accordance with the manufacturer's instructions.
- Checks of all the interlocks and warning lights must be carried out at least every 6 months.
- A record must be kept of all the radiation surveys, interlock checks and checks of the warning lights.

MONITORING XRD and XRF APPARATUS

- Monitoring or testing of XRD and XRF apparatus is to be carried out by the supplier or EPA accredited testers or competent person using monitoring instrument in accordance with regulation 78 Radiation Protection and Control (Ionising Radiation) Regulations 2015).

- Monitoring of the apparatus and testing of interlocks is to occur at least once every 6 months, and extra monitoring/testing is to occur after:
  - new installation;
  - reassembly; or
  - an incident involving the apparatus.

- Records of all monitoring and testing must be maintained
  - identifies the apparatus involved;
  - the name and date;
  - for monitoring—recording the details of any change in radiation emission was detected;
  - for testing— record the safety device and whether they passed or failed the check; and
  - any action taken as a result of the monitor or check (where applicable).

PERSONAL MONITORING

The Regulations require the monitoring of the radiation dose of all registered workers unless the work falls under the exemption. The exemption (SA Government Gazette 2 Oct 2014) applies where no simple personal monitoring devices exists (low energy radiation) and where there is a very low risk of exposure, as outlined below.

Radiation workers who will not be issued with a monitor, are those:

- using any quantity of H3, C14 and S35;
- in unsealed group 2 and group 3 materials in a C class registered laboratory in quantities **less** than 40 MegaBq (the most common are: Na22, P32, P33, Ca45, Fe55, Zn65, Cd109, Ag110m and I125);
- using radiation gauges where the source is not removed;
- using fully enclosed X-ray analysis apparatus;
- using intra-oral X-ray apparatus;
- using a cone-beam and similar dental apparatus; and
- using XRD, XRF (exemption granted in July 2016)

Radiation workers who will be issued with a monitor, are those:

- in unsealed group 2 and group 3 materials in a C class registered laboratory in quantities **greater** than 40 MegaBq (the most common are: Na22, P32, P33, Ca45, Fe55, Zn65, Cd109, Ag110m and I125);
- who are veterinary radiation workers;
- involved with fluoroscopy;
- using sealed sources (apart from radiation gauges);
- using open-beam and partly enclosed X-ray apparatus;
- using sealed sources such as moisture probes; and
- using CTs.

When registering as a Radiation Worker you will be advised by Human Resources if a Radiation Dosimeter is required for the work you are undertaking.

The cost for the dosimeter will be borne by the Faculty/Division and the Faculty/Division will receive accounts accordingly.

There are two types of personal dosimeters being a body monitor and a finger monitor, the type of monitor you will be issued will depend on the type of work you are undertaking.

Wearing of Radiation Dosimeters

- Before starting an operation all individuals participating must ensure they are wearing their approved personal dosimeters.
- The monitor is worn at waist or chest height and underneath protective devices such as lead rubber or lead plastic aprons.
- Do not-place objects such as coins, pens, etc in front of approved personal dosimeters.
- A monitor is only to be worn by one person. You must never wear a monitor assigned to another person (please contact Human Resources if you do not have an alternative).

Finger Dosimeters

The legislated allowable occupational annual radiation exposure limit for radiation workers is 500 milliSievert (mSv) in **any** calendar year. Using the UoA safety factor, this translates to 25 mSv/year, and approx. 6 mSv per quarter. Therefore, any finger badge dose which receives over 6 mSv in a quarter will be investigated.

PERSONAL MONITORING

Storage of Personal Dosimeters

- The "control" dosimeter measures background radiation and should be stored where background radiation levels are low and away from direct fluorescent light (e.g. a drawer).
- When not in use the approved personal dosimeter should be stored with the "control".
- "Controls" must be returned to the monitoring provider with the batch of approved personal dosimeters with which they are issued.

Storage and handling of Personal Dosimeters during Domestic and International Air travel

- **People working in different locations should have their own control badge (series) even if they are with the one group.**
  - The "control" dosimeter measures background radiation in the area and should be stored where background radiation levels are low and away from direct fluorescent light (e.g. a drawer).
- **Do not** place the dosimeter in checked luggage.
- At the security screening point either:
  a. take the dosimeter out of the baggage and ask the security personnel to pass it around the cabinet x-ray machine; or
  b. transport the assembled dosimeter in the bottom of the carry-on luggage with the front of the dosimeter and "control" facing up towards the X-ray tube. Ensure luggage is placed on the conveyor belt leading to the cabinet X-ray machine so that the dosimeter is at the bottom and facing up. If there is a group of people traveling to the same location, place all the dosimeters in the one bag and ensure that the monitors are on the bottom as described above and are not overlapping each other in the bag.
- When returning the personal monitors to the monitoring provider at the end of the monitoring period, note on the monitor detail form returned with the dosimeters which personal monitors went through carry-on or checked luggage, whether it was for domestic or international flights, and the total times it went through a cabinet x-ray machine.
  - When not in use the approved personal dosimeter should be stored with the "control".
  - "Controls" must be returned to the monitoring provider with the batch of approved personal dosimeters with which they are issued. The personal dosimeters will be adjusted with the recorded reading of the "control" to reflect the actual personal readings for each user.

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING

UNSEALED SOURCES

Facilities

All laboratories in which radionuclides are used and stored must be classified as Type C or Type B according to the requirements in Radiation General FAQs and registered with the EPA.

- Type B premises: the University Radiation Safety Officer must be consulted when planning work that needs to be undertaken in a Type B premises, as these premises have additional requirements to those listed below for Type C premises.
- All work with unsealed radioactive substances must be carried out in designated areas of the laboratories registered as Type C or B premises.
- All registered laboratories must have a radiation warning sign and contact details of the licensed supervisor(s) on each entrance door; it is also advisable to have the URSO contact details.
- The surfaces of the walls, floors, ceilings and fittings of the laboratory must either be smooth and free from cracks and crevices; or consist of or be covered by a substance that, in the case of bench or floor coverings, prevents the spread of any radioactive liquid beyond the confines of such substance and is readily removable, disposable as radioactive waste and replaceable.
- Drains that are used to carry radioactive effluent must be labelled at all points where there is access to them for the purposes of maintenance with a label that contains the radiation symbol.
- If an operation or process carried out in a laboratory is likely to produce airborne radioactivity in excess of the concentration that could result in a radiation worker receiving an annual limit on intake due to inhalation, a fume cupboard must be provided.
- The working rules and emergency procedures must be displayed in the laboratory.
- Visits by people other than registered radiation workers should be minimised if possible and they should be warned not to touch anything that may cause contamination.
- The laboratory is to be locked when no registered radiation workers are present.

Storage

- All radioactive materials (including waste) must be labelled with “Radioactive”; the quantity, activity and type of radioactive material; the name of the licenced supervisor and date.
- Radioactive materials must be stored within a facility which is licensed by the EPA and have reasonable precautions against unauthorised access (e.g. room locked when unattended).
- Always store radionuclides according to directions given in the manufacturer’s specification sheets.
- Where possible radionuclides should be stored in a double container, with the outer one of plastic in case of breakage.
- Radionuclides must be appropriately shielded.
- Storage areas (including refrigerators) must be marked with the appropriate radiation signs.
- Never leave radionuclides in unsealed containers in cold rooms or refrigerators.
- Make sure that containers that will be frozen are not full and cannot break on freezing. Use an outer container as a precaution.
- Ensure that no food or drinks are stored in radiation storage locations.

Record-Keeping

A register of unsealed sources must be maintained for each laboratory that contains:

- The radionuclides contained in the laboratory and their activity.
- The date to which the activity refers and the date when the substance entered the laboratory.
- The name of the person in charge of the material.
- Material leaving the laboratory (normally as waste).
- The quantities sent for disposal (through the Radioactive Waste Management Plan) including the disposal mode.

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING

SEALED SOURCES

Facilities where sources are used or stored

- The room must be locked unless a licensed person is present.
- The room key should only be available to the people licensed to operate the source.
- The dose rate in areas accessible to members of the public is ALARA and is not more than 25microSv/h.
- In order to reduce the possibility of misuse, small sources should be stored inside an appropriately shielded and locked cabinet.

Transportation

- The Code of Practice for the Safe Transport of Radioactive Material controls the transport of all radioactive materials on public roads. In practice it is only neutron moisture probes that are regularly moved via public roads. The general radiation hazard from these sources could be considerably increased if there is a road accident and emergency services and other aid workers are not aware that a radiation hazard exists.
- It is strongly advised that only a licensed person transports sealed sources.

Transport Arrangements

- A holder for the gauge carrying-case must be securely fixed in the vehicle and the gauge must not be able to break loose in normal situations.
- The holder must be able to be securely locked and carry signs saying "Warning - Radioactive" with the radiation symbol and the name and telephone number of the person responsible for the source.
- The probe or gauge must not be transported in the passenger compartment of the vehicle and must be carried as far away as possible from the driver and any passengers.
- The probe or gauge must be transported in its carrying-case with the source locked in the shielded or “OFF” position.

Temporary Storage

- To prevent unauthorised access to the gauge the vehicle should not be left unattended.
- The source should be removed from the vehicle and stored in a secure, locked location at night.
- If the source must be left in the vehicle overnight, the vehicle should be parked in a locked garage or shed.
- The warning signs required for transport are sufficient when a vehicle is used as a temporary store.

Vehicle Labels and Notices

- The vehicle must be labelled with 3 vehicle labels of the type described in the Code of Practice for the Safe Transport of Radioactive Material. These Class 7 Dangerous Goods placards must be a minimum of 25cm square and the UN number can be written on this in the white space.
- Two signed and dated consignment notes must go with the source. In most cases when a source is transported for university work, the consignor and consignee will be the same.
- A notice must be carried in the glove-box giving details of the source, the phone number of the University Radiation Safety Officer (0410 388 018 or 83134638) and the emergency phone number of the Radiation Protection Branch 8463 7826.

Interstate

All handheld apparatus and sealed sources used interstate must be registered for use in that state. Please contact Human Resources if you are intending to undertake this type of activity.

Record-Keeping

Schools must maintain a local source register with the following details:

- The name of the source manufacturer, model or type and serial number;
- the registered number of the source;
- the identifying label of the source;
- the radioactive nuclide, its activity and the date of measurement;
- the normal location of the source (storage place);
- the name of the licensed person who is responsible for the source.

continued

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING

Record-Keeping (continued)

When the source is taken off campus, then the register must also contain:

- the signature of a licensed person who has taken charge of the source, the time and date of removal and time and date of return to the premises controlled by the University;
- the licence plate registration number of that vehicle where applicable, and
- any temporary location/s, and the site, district or other locality at which the source is to be used;

If sources are used for undergraduate teaching in different laboratories under the supervision of different staff members, one person must be nominated to be responsible for maintaining the register of the day-to-day movements of the sources.

When the source is returned to the premises controlled by the University, the person returning it must:

- sign the register on the date on which it is returned; and
- report in the register details of any abnormal occurrence that may indicate a fault in the source, capsule, container or control mechanism.

APPARATUS (X-ray)

Facilities

- The door must carry the radiation warning sign, state the words "Warning - Radiation Area", and have the contact details of the licensed supervisor.
- The sign must be no less than 4 500 square mm surface area and comply with the requirements of AS 1319-1994 Safety Signs for the Occupational Environment.
- The sign must be legible at a distance of 2m.
- The apparatus must have a sign attached to the controls bearing the words “Radiation Produced When Energised”.
- Visits by people other than authorised radiation workers should be minimised if possible and should be warned not to touch the control panel.
- The facilities must be locked when no authorised radiation worker is present. The X-ray unit must never be left unattended whilst in operation.

Storage

- Unused apparatus must be stored in accordance with manufacturer’s instructions.
- Unused apparatus must be stored so that unauthorised persons cannot gain access.

Transportation

- During transportation ensure no unauthorised access to the equipment.
- Ensure the equipment is secured so as to avoid damage to the source.

APPARATUS (XRF)

Labelling

- All apparatus must have attached to, or adjacent to, the control which actuates the production of ionising radiation a label which:
  - Says "RADIATION PRODUCED WHEN ENERGISED" (or similar) with a radiation symbol, and
  - is clearly legible at a distance of 2 metres.
- Apparatus must also be fitted with an illuminated sign or a combination of a light and sign that clearly indicates that the apparatus is energised.

Facilities

- A sign must be present at the entry to the room where the XRF is installed which:
  - Says “DANGER” and “KEEP OUT”, and
  - is clearly legible at a distance of 2 metres.
- The facilities must be locked when no authorised radiation worker is present. The X-ray unit must never be left unattended whilst in operation.

continued

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING

APPARATUS (XRF) continued

Transportation

- Ensure no unauthorised access to the equipment.
- A special register entry is required when an apparatus is taken off campus (for example, a portable X-ray device is taken to a farm).

Interstate

- All handheld apparatus and sealed sources used interstate must be registered for use in that state. Please contact Human Resources if you are intending to undertake this type of activity.

Record-Keeping

- Schools must maintain a local apparatus register for portable devices with the following details:
  - The identifying details of the apparatus.
  - The normal location of the source (storage place).
- A licensed person must sign out the apparatus when it is removed from the store and record its temporary location, the time and date. On its return it must be signed in with the time and date.
- If apparatus are used for undergraduate teaching in different laboratories under the supervision of different staff members, one person must be nominated to be responsible for maintaining the register of the day-to-day movements of the apparatus.
- A special register entry is required when an apparatus is taken off campus (for example, a portable X-ray device is taken to a farm).

APPARATUS (XRD**)**
Labelling

- All apparatus must have attached to, or adjacent to, the control which actuates the production of ionising radiation a label which:
  - Says "RADIATION PRODUCED WHEN ENERGISED" (or similar) with a radiation symbol, and
  - is clearly legible at a distance of 2 metres.

- Also apparatus must be fitted with an illuminated sign or a combination of a light and sign that clearly indicates that the apparatus is energised.

Facilities

- A sign must be present at the entry to the room where the XRD is installed which:
  - Says "RADIATION AREA" or "X-RAYS" or similar with a radiation symbol, the surface area of the sign must be no less than 4 500 square mm, comply with the requirements of AS 1319-1994 Safety Signs for the Occupational Environment and
  - is clearly legible at a distance of 2 metres.

- The facilities must be locked when no authorised radiation worker is present. The X-ray unit must never be left unattended whilst in operation.

DISPOSAL

UNSEALED SOURCES

Radioactive waste is managed by an annual Radioactive Waste Management Plan that is approved by the EPA.

Waste categories

- The EPA distinguishes different types of radioactive waste as follows:
  a. Low activity gases dispersed via a fume cupboard;
  b. Material allowed to decay to below exemption levels and sent for incineration with the University waste contractor;
  c. Material allowed to decay to below exemption levels and then sent out as normal waste;
  d. Low activity water miscible material suitable for sewer disposal; and
  e. Material for which longer decay times are needed in storage.

- In the University radioactive waste is classed by three main types:
  a. Solid waste that is taken into short or long term storage and subsequently sent out for incineration or disposed as normal waste once decayed below exemption levels;
  b. Liquid waste that is miscible with water and is discharged to the sewer;
  c. Mixed waste, mainly liquid scintillation fluids in vials. These are treated as solid waste, taken into storage, and where possible sent for incineration.

General waste management principles

The general principles for managing the radioactive waste are:

- The responsibility for all radioactive waste that leaves the laboratory rests first with the licensed supervisor;
- All other waste is stored in yellow 20L pails and then if it has decayed sufficiently (as determined by the URSO) or, if in small enough quantities (below the exempt levels for the radionuclides) it can be sent away with normal waste (as it is no longer active);
- If it is H3, C14 or S35 waste, or other radionuclides in very small quantities, such as that in liquid scintillation vials, it is sent for incineration;
- If it is long lived it is stored permanently by the University;
- Most importantly, the waste stored in the yellow pails must be segregated by nuclide – the amounts of different radionuclides that can be handled by the different paths vary and so cannot be mixed. So, where possible, a single yellow pail should not contain more than one nuclide.

Aqueous liquid waste

The EPA requirements for aqueous waste going to the sewer are:

- Activity can only be put into designated and properly labelled sinks;
- A minimum amount of water (15L normally) must accompany each flush;
  - Non-hazardous chemicals which are in aqueous solutions within the pH range of 6 to 10. o
  - Not any concentrated acids or bases;
  - Not highly toxic, malodorous (bad odour), or lachrymatory (produces tears) substances;
  - No substances which might interfere with the biological activity of wastewater treatment plants,
  - No chemicals which could create fire or explosion hazards,
  - No chemicals which could cause structural damage or obstruct flow.
- Each disposal is entered in the record of radioactive waste disposal.

Solid waste

- All waste that is not put down the sink is classed as solid waste. This includes liquid scintillation fluids in the scintillation vials. This waste is handled in the yellow plastic 20L pails.
- Different radionuclides must be kept in separate pails.
  The pail must be labelled with the nuclide, the activity amount, the laboratory from which it came, the worker and the licensed supervisor. This information is entered on the standard A6 label and the label must be taped to the lid of the pail (adhesive tape along one edge only). The radiation waste label is available at Radiation waste label yellow bins. MOST IMPORTANTLY no other labelling or writing can appear on a pail. Do not overfill the pail.

continued

DISPOSAL

Solid waste (continued)

- When a pail is full the lid needs to be hammered down evenly for security.
- The information on the label is entered in the record of radionuclides bought and sent to disposal. This record is subject to EPA audit.
- Store full pails safely in laboratory with label affixed (see solid waste section below) until you are ready to move it to the storage locations at North Terrace or Waite (contact Human Resources if you require access to these storage locations). Roseworthy workers contact Human Resources for advice regarding safe storage and disposal.
- Any waste that is not packaged correctly will have to be returned to the original laboratory for re-packaging.
- Empty yellow pails and black lids are kept in the storage locations for your use. Roseworthy – contact Human Resources if pails and lids are required.
- Important: Tin drums, plastic bags, re-used plastic containers and similar containers may not be used for radioactive waste and any waste of this kind will be returned for repackaging.

Special cases

Some areas have storage space for keeping short-lived waste (mostly P32) until it is below the exempt level and sent out with the normal waste. In these cases the waste need not necessarily be stored in yellow pails, but only solid waste can be treated this way; scintillation fluids must be stored in the liquid-proof pails.

SEALED SOURCES

Please contact Human Resources regarding disposal of sealed sources. Currently these sources cannot be disposed of so are placed into waste stores and are to be registered annually until a waste disposal pathway is found in the future.

APPARATUS (X-ray, XRD and XRF**)**

Please contact Human Resources regarding disposal of x-ray apparatus. These machines will be required to be rendered inactive (which is more than cutting the power cord) and then can be given to scrap metal. The EPA is to be informed regarding the disposal of the apparatus.

EMERGENCIES AND ACCIDENTS

EMERGENCY NUMBERS:	Contact
Emergency Services (**ALWAYS** inform them that the emergency is in an area using ionising radiation or radioactive material)	(0)000
University Radiation Safety Officer: Dr Kent Gregory	0410 388 018
Human Resources	83134638 or 83131111 or 0404489059 or 0410422737
Radiation Protection Branch of the EPA	1800 307 733

Please note that any serious radiation incident will need to be reported by the URSO to the EPA and reported by Human Resources to SafeWork SA.

CONTINGENCY PLANS

- The Licensed Supervisor must ensure that contingency plans are developed and tested in accordance with the HSW Emergency Management Procedure which cover the use of ionising radiation in their area.
- The contingency plan must be prepared and tested before the commencement of the kind of operation to which it relates.
- The contingency plan must—
  a. take into account every radiation incident and radiation emergency that is reasonably foreseeable; and
  b. contain specific instructions as to how each such accident and emergency is to be dealt with, paying particular regard as to how control may be restored and the exposure of persons may be kept to a minimum; and
  c. staff and students must be trained in responding to the foreseeable accidents or emergencies.
- The Head of School must ensure that the equipment and facilities (including any monitoring instrument, detector or alarm) that are necessary for the effective operation of the contingency plan are provided and maintained in correct working order.

UNSEALED RADIOACTIVE MATERIALS EMERGENCY ACTIONS

RADIOACTIVE SPILLS

Note if the incident is **serious** (hospitalisation or clean up requiring MFS) then dual reporting will be required (Radiation Branch of the EPA and SafeWork SA). The site is not to be cleaned until the Radiation Branch of the EPA and SafeWork SA approval is granted.

- Manage any injury (where applicable).
- Assess the situation and avoid contaminating other areas.
- Evacuate the area if necessary (also lock and place a sign in the area).
  Advise – the licensed supervisor, University Radiation Safety Officer and Human Resources.
  (83134638 or 83131111 or 0404489059 or 0410422737).
- Clean up and decontaminate in the following order (treat all cleaning materials as radioactive waste):
  a. People;
  b. Laboratory (only when clean-up is approved);
  c. Equipment (only when clean-up is approved).
- Record the incident in accordance with the HSW Incident Reporting and Investigation Procedure specifically including the following information:
  a. The time, date and place;
  b. The names of those involved, including anyone who may have been affected by the incident;
  c. The quantity of radioactive material involved, its physical and chemical form and the extent of any dispersal of a radioactive substance. It is important to estimate the amount of activity involved in Becquerel (or Curie);
  d. The length of time the radioactive material was out of control and when it was reported to licensed supervisor;
  e. The probable cause of the incident.
- Human Resources and the University Radiation Safety Officer will follow up with an investigation of the incident and report to the Radiation Branch of the EPA and, where required, SafeWork SA.

Please note that if an incident causes an exposure close to or over 20 milliSv the University will not allow the staff/student to continue radiation work for a full year.

EMERGENCIES AND ACCIDENTS

Spill Kit for Unsealed Radioactive Materials

In general, the requirements for a spill kit for unsealed radioactive material are the same as for a chemical spill involving similar chemical forms. The one major difference is where radioactive iodine (I-125 or I-131) is being used. With radioactive iodine it is important that spills do not oxidise the iodide to volatile iodine, and a reducing agent (5% sodium thiosulfate solution) must be included in the spill kit. If an iodine spill does occur, quickly add sodium thiosulphate to the spill (in an equal volume), place a plastic sheet over the top, exit the room and secure it from other workers. Immediately inform Human Resources for assistance. (83134638 or 83131111 or 0404489059 or 0410422737)

Spill Kit Contents

- PPE – safety glasses and gloves.
- Absorbent material of various kinds for liquid spills:
  a. Vermiculite (packaged in various ways by vendors – choose that which suits your situation best);
  b. Absorbent paper and tissues;
  c. Coated bench protector absorbent paper (e.g.'Benchkote').
- Variety of plastic bags for the waste absorbent and paper – these should be suitable for transfer to the yellow waste pails.
- Plastic sheeting (polythene is suitable) for covering contaminated areas until hard clean-up and decontamination can be done.
- Strong adhesive tape for fastening the sheet down on the bench, floor or other surface.
- Decon-90 or other appropriate detergent-based cleaning agent. For unusual chemical forms provide a suitable chemical agent for decontamination.
- For radio-iodine, a 5% solution of sodium thiosulfate to keep the iodine in the reduced iodide ion state. This solution slowly oxidises and precipitates elemental sulphur. It should be freshly made up regularly.
- A small whiteboard and marker pens so that the area can be sign-posted and a notebook and pen for recording the circumstances of the incident.

DECONTAMINATION

Personal Decontamination

When decontaminating people, be as gentle as possible to avoid the contamination passing through the skin.

Skin

- Monitor the skin and get help if necessary; an assistant to monitor the progress is very helpful.
- Remove contaminated clothing if necessary and secure in a plastic bag.
- Rub with paper towels, warm water and mild soap, then monitor again.
- Scrub – soft brush – do not damage the skin, then monitor again.
- Use a decontamination product like 'Count-off'.
- If still contaminated – get advice from licensed supervisor and/or University Radiation Safety Officer.

Face and Eyes

- Wash only with warm water or sterile saline solution.
- Be careful not to swallow or inhale contamination.
- If washing with water does not remove the contamination, call the licensed supervisor and University Radiation Safety Officer.

Other Parts of the Body

- Do not spread contamination.
- If the person's hair is contaminated, keep run off away from nose and mouth when showering.
- Rinse rather than scrub.
- Remove and dispose of all contaminated clothing – do not leave the lab in contaminated clothes but arrange for a new set to be delivered.

Wounds

- Wash only with warm water.
- If washing with water does not remove the contamination, call the University Radiation Safety Officer or the EPA.

EMERGENCIES AND ACCIDENTS

Ingestion and Inhalation
Internal contamination requires professional medical assistance. Ring 0-000?
You must call the University Radiation Safety Officer IMMEDIATELY (0410 388 018 or 83134638).

Laboratory Decontamination
For items like trays, benches, equipment and the floor:

- Restrict access until cleaned up.
- Mop the spill with tissues and dry the surface.
- Monitor.
- Decontaminate any remaining hot spots by working from outside inwards with Decon 90; scrub if needed.
- Do not contaminate the cleaning solution – use paper towels/tissues only once.
- If still radioactive then contact Human Resources for advice 83134638 or 83131111 or 0404489059 or 0410422737.

SEALED SOURCES

Loss of control in a closed area (laboratory)
If a sealed source is no longer in its normal shielded container the dose rates may be high. In these circumstances it is most important to leave the area, secure the door and plan a recovery operation. This may involve locating the source using a radiation monitor. Check the dose rate outside the locked room and place Do Not Enter signage on the door. Estimate the radiation field from the unshielded source – what dose will be received if it is recovered with 1 metre tongs? How long can a person operate in the area?
In the worst case, call for assistance from the University Radiation Safety Officer or the Radiation Protection Branch of the EPA, after making certain that no-one can enter the area.
Record an incident in accordance with the HSW Incident Reporting and Investigation Procedure.

Loss of control in a vehicle accident
Neutron moisture probes are the most likely sealed source to be transported in a vehicle.
The possibility of loss of control of a sealed source in a vehicle accident or emergency is high. The person in charge of the vehicle, or another responsible person, must notify the University Radiation Safety Officer and the Radiation Protection Branch of the EPA as soon as possible.
If the source is properly secured in the vehicle, it will not be a major hazard in most road accidents as it will remain in the holder in its carrying case. Emergency Services are trained to handle a situation involving a radiation source, but they must know there is a source in the vehicle.
Record an incident in accordance with the HSW Incident Reporting and Investigation Procedure.

Loss of control due to a break down in the field
The mechanical breakdown of a moisture probe in the field can be more difficult to handle than the same problem on campus because the proper resources may not be available.
When used in the field:

- Emergency signs and warning tape must be carried so that the source area can be marked off if mechanical failure occurs.
- Mark the area around the broken source as a radiation hazard.
- Inform the University Radiation Safety Officer and the Radiation Protection Branch of the EPA.
- Do not leave the source unattended unless help cannot otherwise be obtained.
- Record in incident in accordance with the HSW Incident Reporting and Investigation Procedure.

EMERGENCIES AND ACCIDENTS

X-RAY UNITS

If the Emergency Services are called ALWAYS inform them that the emergency is in an area where an X-ray unit is normally in use. Make sure they are informed that EITHER the X-ray unit is turned off and is safe or that it is still operational and special precautions will be needed (this should be an extremely rare event).

Summary of Emergency Actions

- Turn off the machine.
- Manage any injury – refer the exposed person for medical examination.
- Advise your licensed supervisor and University Radiation Safety Officer.
- Do not take action to correct the fault that caused the exposure. It will be difficult to estimate the absorbed dose if the fault has been corrected.
- Tag out the unit.
- Disconnect the unit from the power and lock the room.
- Record the incident in accordance with the HSW Incident Reporting and Investigation Procedure and report (if not already done) to the licensed supervisor, the Head of School, Human Resources and the University Radiation Safety Officer.
- The investigation is to be conducted by the University Radiation Safety Officer, Human Resources and the licensed supervisor. An investigation report shall contain:
  a. details of the incident/accident including: - the time, date and place.
  b. the names of those involved, including anyone who may have been affected by the incident.
  c. a description of the incident.
  d. the results of any dose assessments that have been made, and
  e. actions taken to prevent the event from happening again.

XRD and XRF

If a user of X-ray analysis apparatus detects or suspects an unnecessary or unexpected radiation field, they must immediately:

- de-energise the apparatus; and
- notify Human Resources (83134638 or 83131111 or 0404489059 or 0410422737) who will notify the University Radiation Safety Officer of the incident.
- Record the incident in accordance with the HSW Incident Reporting and Investigation Procedure and report (if not already done) to the licensed supervisor.

A person must not re-energise or modify an apparatus that has been de-energised due to a detected or suspected unnecessary or unexpected radiation field until such time as the University Radiation Safety Officer has:

- inspected the apparatus;
- conducted an investigation; and
- approved of any proposed actions.

RADIATION INCIDENT INVESTIGATION

Personal Details	
Name	
Staff or Student number	
Contact No	
Course of Study where applicable EMS Placement host and dates Numbers Mobile and Landline	
Were you working with radiation anywhere, apart from the University of Adelaide, during the monitoring period? (if yes please provide the details)	

Work Details	
Is there a specific Job Safety Analysis or Safe Operating Procedure for the task being undertaken? (If yes attach SOP/JSA)	Attached ☐ Yes ☐ No
Has training been conducted (view records) for the task undertaken	

Incident Details	
What was the dose reading?	
What is the period of dosimeter reading?	
List the type of radiation you used during the period e.g. • unsealed radionuclides (i.e, ^{131}I;^{14}C,^{32}P)? • diagnostic X-ray • CT or a fluoroscope • mobile diagnostic X-ray • Sealed source (i.e. neutron probe)	
Referring to the SOP or activity, can you think of any part of the process that you would have been exposed to radiation? (please record details)	
Can you think of any reason or situation which would have exposed your badge to X-rays or radionuclides?	

RADIATION INCIDENT INVESTIGATION

INCIDENT DETAILS (continued)	
Have you done any work where PPE was not provided and/or used? (provide details)	
What PPE was used? (E.g. lead gowns; lead gloves; thyroid covers; glasses)	
Do you know of any exposures that have imaged any part of your body (Hands etc)?	
Have you been through an airport Scanner with your badge during the period?	
Where do you store your monitor? And where do you store the control?	
Has the equipment been tested i.e. compliance tested, wipe tested or other testing? (Attach a copy)	
Any other comments or notes	
Cessation of radiation work required pending investigation:	
Inform the person that if they continue to get doses they may be stopped from radiation work before they reach 5milliSv in a 12 month period.	

RADIATION INCIDENT INVESTIGATION

CORRECTIVE ACTION TAKEN TO PREVENT A RECURRENCE

- How could the incident have been avoided?
- Is there an existing risk assessment (RA) for this activity? Yes / No
- Identify the hazards/issues/system deficiencies which resulted in the occurrence (e.g. faulty equipment, inappropriate storage, lack of training/skill, risk assessment not completed, poor design, environmental conditions etc).
- Determine how a recurrence would be prevented.
- Determine appropriate recommendations to prevent a recurrence using the Hierarchy of Controls (there may be a combination of control measures, both short and long-term):
  1. Elimination (i.e. is there a permanent solution?)
  2. Substitution (e.g. is it possible to replace the hazard (e.g. chemical) with one that presents a lower risk?
  3. Isolation (e.g. is it possible to place a barrier between the operator and the hazard to prevent exposure?)
  4. Engineering (e.g. is it possible to structurally change the environment or plant and equipment to make it safer?)
  5. Administration (e.g. does the safe operating procedure require review, is additional training required for operators, is signage required?)
  6. Personal Protective Equipment [PPE] (e.g. is there a requirement for gloves, helmets, goggles, safety shoes?).

Contributing factors (including HSW system deficiencies)	Corrective Actions taken (or recommended) to prevent a recurrence (Short term and long term as applicable)	Who by	Time/frame or date action complete
Record corrective action in the University incident recording system			
Attach a copy of this investigation in the University incident recording system	**Attach a copy of this investigation in the central records management system**		