IMPLEMENTATION

3.30 RADIATION SAFETY MANAGEMENT

3.30.1 Objectives

- To ensure that ionizing radiation is managed safely.
- To minimise exposure to radiation to a level as low as reasonably achievable by using appropriate control measures.
- To meet the requirements of the Health, Safety and Wellbeing (HSW) Policy and relevant sections of the legislation. (see section 3.30.17)

Note: this HSW Handbook chapter constitutes the University Radiation Safety Manual that is required under Regulation 11 of the *Radiation Protection and Control (Ionizing Radiation) Regulations 2000*.

3.30.2 Scope

This document is applicable to all persons taking part in any University activity that involves ionizing radiation in teaching and research activities. The document also applies to ionizing radiation apparatus; radioactive sources (sealed and unsealed); radiation monitoring equipment; and protective/ warning devices.

This document does not cover non-ionizing radiation (e.g. ultraviolet or microwaves) any apparatus that produces ionizing radiation incidental to its function (including electron microscopes), and 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 6 of the *Radiation Protection and Control (Ionizing Radiation) Regulations 2000)*.

3.30.3 Process : General

Person Responsible		Actions
3.30.3.1	Head of School/ Branch	☐ Ensure, as far as reasonably practicable, that no individual receives an exposure of greater than 1mSv (millisievert) in any year. ☐ Ensure that where assistance with meeting obligations in this HSW Handbook chapter is required, a Local Radiation Administration Coordinator is appointed and name and contact details communicated to the Health, Safety and Wellbeing (HSW) Team. (Refer to the HSW website http://www.adelaide.edu.au/hr/ohs/contact/lrac for information on the role.) ☐ Ensure that before any work listed on the Prescribed List (Appendix A) is undertaken for the first time, the HSW Team is consulted and the relevant legislation is complied with. (See section 3.30.17)
3.30.3.2	Supervisor (referred to in the rest of this document as Licensed Supervisor)	☐ Ensure you are licensed for the work conducted by all individuals under your supervision. ☐ Ensure, as far as reasonably practicable, that no such individual receives an exposure of greater than 1mSv in any year.

3.30.3 Process : General (Continued)

Person Responsible		Actions
3.30.3.3	Local Radiation Administration Coordinator (there is no requirement for a School/ Branch to have a LRAC)	☐ Assist the Head of School/Branch and Licensed Supervisors to administer the radiation processes in accordance with this HSW Handbook chapter.
3.30.3.4	Staff, Higher Degree Students and Visitors	☐ Ensure work does not affect the safety of other staff, students or the public by any action or inaction. ☐ Ensure others are not exposed to radiation. ☐ Work in accordance with this HSW Handbook Chapter (which is equivalent to the University Radiation Safety Manual.) ☐ Comply with the local rules of the laboratory.
3.30.3.5	Manager HSW	☐ Ensure that radiation management is audited. ☐ Ensure that the University Radiation Safety Officer is meeting the regulatory duties. ☐ Ensure, as far as reasonably practicable, that no individual receives an exposure of greater than 1mSv in any year.
3.30.3.6	University Radiation Safety Officer (URSO)	☐ Ensure that the University is complying with the requirements of the Act and Regulations (refer to section 3.30.17). ☐ 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 (1998) and in the Regulations, and include advice, training, waste management and general supervision of radiation safety in the university. ☐ Ensure, as far as reasonably practicable, that no individual receives an exposure of greater than 1mSv in any year.

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

3.30.4.1	Head of School/Branch (Any or all of these tasks can be delegated to School/ Branch staff (i.e. the Local Radiation Administration co-ordinator), however the Head of School/Branch must monitor the required actions on a regular basis to ensure they are being met.)	☐ Ensure all staff/students working with ionising radiation in a Type C registered premise are licensed or supervised by a licensed person. ☐ Ensure all staff and postgraduate students 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. ☐ Ensure that licence renewals are listed on the School Training Needs Analysis (TNA). Continued

3.30.4 Process : New Radiation Workers, Changed Radiation Work & Licences
(see the Lifecycle of a Radiation Worker Form for a visual explanation of the process)

Person Responsible	Actions
3.30.4.1 Head of School/Branch (or delegate and monitor as above)	Note - Undergraduate Students The University has been exempted from the obligation to register as radiation workers undergraduate students working with ionizing radiation in laboratory classes, but special care must be taken when undergraduates use ionizing radiation. ☐ Ensure that all work by undergraduates with ionizing radiation is conducted under the supervision of a licensed demonstrator or instructor. ☐ Ensure that the quantities of radioactive materials used are kept to a minimum and specific instruction on handling radioactive materials is provided. ☐ Ensure that undergraduates do not use X-ray analysis apparatus unless these are fully enclosed X-ray apparatus and the work is under continuous supervision. ☐ Ensure that dental and veterinary students do not use X-ray diagnostic apparatus unless the work is conducted under continuous supervision.
3.30.4.2 Licensed Supervisors	☐ Ensure that a Worker Registration Form is submitted to the HSW Team for all staff/graduate students using radiation for the first time or when currently registered workers use new/changed radiation sources. ☐ Ensure that the HSW Team are advised when a radiation worker leaves the University or no longer uses radiation.
3.30.4.3 Health, Safety and Wellbeing (HSW) Team/University Radiation Safety Officer (URSO)	☐ URSO: Review new Worker Registration Forms to determine requirements for licensing (and personal monitoring – see section 3.30.8.1). ☐ HSW: Ensure that the worker is informed if they are required to obtain a licence and send them the relevant EPA web link to the application form. (Application for a licence to use or handle a radioactive substance (section 28) or Application for a licence to operate ionizing radiation apparatus (section 31) ☐ HSW: Advise any new applicant to leave payment section blank (Condition of payment by the University, is where the University is the principal employer i.e. greater than 50%). ☐ HSW: Review licence application form for completeness, complete payment section (where required) and send to the Radiation Protection Branch of the EPA. ☐ URSO: Provide assistance (where requested), to applicants preparing for a licence exam. ☐ URSO: Arrange with the EPA (where requested) to conduct an exam with the licence applicant. ☐ HSW: Maintain a database of radiation workers, including nuclide activities, exposure levels and incidents relating to radiation.

3.30.4 Process : New Radiation Workers, Changed Radiation Work & Licences
(see the Lifecycle of a Radiation Worker Form for a visual explanation of the process)

Person Responsible	Actions
3.30.4.4 Radiation Worker	☐ Only undertake radiation work when the appropriate licence is obtained (if advised by the HSW Team that a licence is required) ☐ Complete the relevant licence application and return to the HSW Team. (The EPA link is sent by the HSW Team or refer to the EPA website (Application for a licence to use or handle a radioactive substance (section 28) or Application for a licence to operate ionizing radiation apparatus (section 31) (Leave the payment section blank if the University is paying. See 3.30.4.3 above.) Note - The Radiation Protection Branch will contact the applicant and send a copy of the syllabus for the relevant exam (dentists providing qualifications and Dental Board Number and vets providing qualifications and Vet Board Number are not required to sit exam in order to obtain a licence). ☐ Arrange a time with either the Radiation Protection Branch or the University Radiation Safety Officer to sit the exam (within 4 months of the application being submitted to the Radiation Protection Branch through the HSW Team). The University Radiation Safety Officer can also provide assistance in preparing for the exam. ☐ Provide a copy of the obtained licence to the HSW Team. ☐ Comply with the conditions of the licence. ☐ Ensure that the licence is renewed annually in accordance with the requirements communicated by the HSW Team. ☐ Advise the EPA (radiationprotection@epa.sa.gov.au) within 14 days of change of address (using change of address section on licence).

3.30.5 Process : Training/Induction

Person Responsible	Actions
3.30.5.1 Head of School/Branch (or delegate and monitor as above)	☐ Ensure all new radiation workers attend Radiation Safety Training.
3.30.5.2 Licensed Supervisors	☐ Ensure that you are trained and licensed for all activities under your control. ☐ Induct and train new radiation workers in local procedures and activities. ☐ Ensure that all work is directly supervised until the radiation worker is considered to be proficient.
3.30.5.3 Radiation Worker	☐ Attend Radiation Safety Training as instructed by your Licensed Supervisor. ☐ Undertake local area induction and training on local procedures and activities before working with radiation.

3.30.5 Process : Training/Induction (Continued)

Person Responsible		Actions
3.30.5.4	Local Radiation Administration Coordinator	☐ Attend Local Radiation Administration Coordinator training.
3.30.5.5	University Radiation Safety Officer	☐ Must be licensed, have an extensive knowledge of the use of ionizing radiation within the tertiary sector, and be recognised by the EPA as a Radiation Safety Adviser.

3.30.6 Process : Hazard Management

Person Responsible		Actions
3.30.6.1	Head of School/Branch (or delegate and monitor as above)	☐ Ensure that staff and students conducting activities involving radiation have risk assessed the activities and apply the ALARA principle to minimise exposure. (See Information Sheet Hazard Management for information on controlling radiation hazards.) ☐ Ensure that all controls identified in the risk assessment are being implemented.
3.30.6.2	Licensed Supervisors	☐ Ensure that all monitoring devices identified in the risk assessment are ordered and used by the radiation worker under your supervision. ☐ Ensure that any new work or altered procedures identified during the hazard management process are communicated to the Local Radiation Administration Coordinator. ☐ Ensure that activities that have a residual risk of "high" are not undertaken unless appropriate approvals have been obtained from the Head of School/Branch. ☐ Ensure that any changes (e.g. nuclides, sealed sources disposal/purchases) are communicated to the HSW Team.
3.30.6.3	Radiation Worker	☐ Be familiar with hazard management requirements in Information Sheet Hazard Management. ☐ Follow local area rules, procedures and instructions from Licensed Supervisors. ☐ Refer to Information Sheet Pregnancy if you are pregnant.
3.30.6.4	HSW Team	☐ Ensure that any changes (e.g. nuclides, sealed sources disposal/purchases) are communicated to the University Radiation Safety Officer. ☐ Coordinate any changes requiring licence or registration updates.

3.30.7 Process : Monitoring

Person Responsible	Actions
3.30.7.1 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 B - Monitoring – Unsealed Sources, Sealed Sources & X-ray Apparatus. ☐ Ensure that actions are taken to eliminate or reduce contamination if detected (see Appendix B - Monitoring – Unsealed Sources, Sealed Sources & X-ray Apparatus and Appendix Emergencies & Accidents)
3.30.7.2 University Radiation Safety Officer	☐ Conduct 6-12 monthly wipe-testing of sealed radioactive sources and maintain record of testing.

3.30.8 Process : Personal Monitoring
(see the Lifecycle of a Radiation Worker Form for a visual explanation of the process)

Person Responsible	Actions
3.30.8.1 Health, Safety and Wellbeing (HSW) Team and University Radiation Safety Officer (URSO)	☐ Review completed Worker Registration Forms to determine requirements for personal monitoring (and licensing, see section 3.30.3). ☐ Request dosimeter for radiation worker from ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) as required. ☐ Distribute new dosimeters to Local Radiation Administration Coordinator / Licensed Supervisors before each monitoring period and return all dosimeters to ARPANSA at end of each monitoring period. ☐ Monitor the dose reports to ensure that no radiation worker exceeds 1 millisievert (mSv) per year. ☐ Distribute dose reports from ARPANSA to the Local Radiation Administration Coordinator/ Licensed Supervisor. ☐ Conduct an investigation if any quarterly report exceeds 200 microsieverts (µSv). ☐ Ensure that a radiation worker is informed to cease or modify radiation work (and the supervisor is notified) once it is identified that 1mSv yearly dose may be achieved. ☐ Maintain a record of all personal monitoring exposures.

3.30.8 Process : Personal Monitoring (Continued)

Person Responsible	Actions
3.30.8.2 Licensed Supervisors	☐ Return dosimeters from all radiation workers in research groups to HSW Team at end of each monitoring period. ☐ Ensure that all radiation workers under your control know the rules regarding wearing and storage of dosimeter (See Appendix C Personal Monitoring). ☐ Participate in any investigation conducted by HSW Team if a radiation worker receives an abnormal dose report (i.e. any quarterly report exceeded 200 µSv). ☐ Ensure that radiation workers under your control cease or modify radiation work once it is identified that the 1mSv yearly dose may be achieved.
3.30.8.3 Radiation Worker	☐ If required, wear a dosimeter at all times when using radiation. ☐ Ensure that you follow the requirements regarding correct wearing and storage of dosimeters (See Appendix C Personal Monitoring). ☐ Participate in any investigation conducted by the HSW Team if you receive an abnormal dose (i.e. any quarterly report exceeding 200 µSv). ☐ Ensure that you cease or modify radiation work once it is identified that the 1mSv yearly dose may be achieved.

3.30.9 Process : Registering premises, sealed sources and apparatus

Person Responsible	Actions
3.30.9.1 Head of School/Branch (or delegate and monitor as above)	☐ Ensure that any premises in which unsealed substances are handled or stored, any sealed radioactive sources, and any ionizing radiation apparatus are registered with the EPA. ☐ Ensure premises meet requirements and sealed sources and apparatus are managed according to Appendix D Management of Facilities, Storage, Transportation and Record-Keeping, and upon the receipt of advice from the HSW Team, URSO and the EPA. ☐ Ensure conditions of registration for premises, sealed sources and apparatus are complied with (listed on reverse of EPA registration document).

3.30.9 Process : Registering premises, sealed sources and apparatus

Person Responsible		Actions
3.30.9.2	Licensed Supervisors	☐ Submit applications for registration of apparatus, sealed sources or premises in which unsealed sources will be handled or stored to the HSW Team (leave first section, payment and signature sections blank). Apparatus: Application to register an ionizing 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 29) ☐ Place a copy of registration conditions for premises or equipment at entrance to laboratory. ☐ Inform the HSW Team within 10 days if the location of an already registered ionizing radiation apparatus or sealed source changes.
3.30.9.3	Health, Safety and Wellbeing (HSW) Team/University Radiation Safety Officer (URSO)	☐ HSW: Complete first section, payment and signature sections on application, sign and forward to the Radiation Protection Branch of EPA. ☐ URSO: Inspect premises undergoing registration to determine if requirements are being met and provide advice to applicant if necessary. ☐ HSW: Confirm with Schools which premises and apparatus require registration renewal and ensure that registration is renewed before the expiry date. ☐ HSW: Maintain a register of all the University's sealed sources and apparatus (including those in "waste storage"). ☐ HSW: Provide a copy of the EPA registration for premises and apparatus to the relevant School. ☐ HSW: Advise the EPA within 14 days if the location of an already registered ionizing radiation apparatus changes.

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

Person Responsible		Actions
3.30.10.1	Head of School/Branch (or delegate and monitor as above)	☐ Ensure that facilities, sealed & unsealed sources and apparatus are managed in accordance with Appendix D Management of Facilities, Storage, Transportation and Record-Keeping.
3.30.10.2	Licensed Supervisors	☐ Ensure that staff and students are storing or transporting radiation sources or apparatus and keeping records in accordance with Appendix D Management of Facilities, Storage, Transportation and Record-Keeping. ☐ Ensure all staff/students comply with the conditions of registration detailed on the EPA registration document.

3.30.10 Process : Management of Facilities, Storage, Transportation and Record-Keeping (Continued)

Person Responsible		Actions
3.30.10.3	Radiation Worker	☐ Comply with requirements of Appendix D Management of Facilities, Storage, Transportation and Record-Keeping and the conditions of registration detailed on the EPA registration document.

3.30.11 Process : Disposal

Person Responsible		Actions
3.30.11.1	Licensed Supervisor	☐ Ensure unsealed sources are disposed of in accordance with Appendix E Disposal (see 3.30.12 for decommissioning of sealed sources). ☐ Provide details of expected purchase/waste disposal to HSW Team 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 the HSW Team 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 nuclides bought and sent for disposal is kept. ☐ Ensure disposal records of unsealed radioactive materials to the sewer are kept.
3.30.11.2	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. ☐ Send relevant details of the approval to dispose of unsealed radioactive substances plan to licensed supervisors.

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

Person Responsible		Actions
3.30.12.1	Licensed Supervisors	☐ Ensure that where registered premises, sealed sources or apparatus are no longer required to be used that the HSW Team is requested to decommission. ☐ Following inspection by the University Radiation Safety Officer, undertake any actions required to decommission and decontaminate the facility or equipment.

3.30.12 Process : Decommissioning and Decontamination Laboratories, Sealed Sources and Apparatus (Cont)

Person Responsible		Actions
3.30.12.2	Health, Safety and Wellbeing (HSW) Team/University Radiation Safety Officer (URSO)	Decommissioning Apparatus ☐ HSW Team or URSO: Disable equipment (usually by cutting the cord) so that equipment is no longer functional and cannot be reconnected. ☐ HSW Team or URSO: Advise users on the management of remaining hazards and final disposal of equipment (consider sending to metal recycling). ☐ HSW Team: Inform the EPA of decommissioning. Decommissioning Sealed Sources ☐ URSO: Decommission equipment and transfer the source to long term storage or alternative arrangements made as required. ☐ URSO or HSW Team: Advise user that remainder of equipment can be disposed of (consider sending to metal recycling). Decommissioning Registered Premises ☐ URSO: Inspect, looking particularly for any radioactive material that has been left behind, and remove signage. ☐ URSO: Survey surfaces, sinks and laboratories. (If the room was used for P32 and not used for 3 months then testing not required). ☐ URSO: Sign checklist with a declaration that the area is no longer radioactive and send form to HSW Team for records.

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

Person Responsible		Actions
3.30.13.1	Licensed Supervisors	☐ Submit Notification of Sale, Installation or Relocation of X-ray apparatus form to HSW Team within 10 days of sale or disposal of an X-ray apparatus. ☐ If a sealed source is sold or gifted, advise the HSW Team within 4 days.
3.30.13.2	Health, Safety and Wellbeing (HSW) Team	☐ 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.

3.30.14 Process : Emergency contingencies

Person Responsible		Actions
3.30.14.1	Head of School/Branch (or delegate and monitor as above)	☐ Ensure that areas are storing radioactive materials and using radiation develop, implement and test contingency plans in accordance with Appendix F Emergencies & Accidents. ☐ Ensure that appropriate spill kits are available for the hazards in the areas.
3.30.14.2	Licensed Supervisors	☐ Ensure that personnel are trained on the use of spill kits. ☐ Ensure incidents and accidents are managed and reported in accordance with Appendix F Emergencies & Accidents.
3.30.14.3	Radiation Worker	☐ Report to their supervisor any unsafe work conditions or incidents/accidents.
3.30.14.4	Health, Safety and Wellbeing (HSW) Team/University Radiation Safety Officer (URSO)	☐ Ensure all incidents and accidents are investigated and, where required, reported to the EPA. ☐ Maintain a register of radiation incidents.

3.30.15 Performance Measures

The HSW Team will use the performance measures listed below to assist identify areas of success and/or where corrective action is required to meet the objectives of this process. The level of compliance will be determined during the internal audit process.

	Target/Measure	Objective Evidence	Accountable Person(s)
3.30.15.1	No radiation worker receives an occupational exposure greater than 1 mSv per year (1/20th the dose limit set by NHMRC and EPA)	Dose reports from ARPANSA	Head of School/Branch Manager, HSW URSO
3.30.15.2	All activities involving radiation have a documented risk assessment.	Risk assessments in RMSS and/or hard copy	Head of School/Branch
3.30.15.3	All activities have been assessed for potential emergencies and all radiation workers have been trained on what to do in an emergency situation.	Risk assessments in RMSS and/or hard copy Training needs analysis	Head of School/Branch

3.30.15 Performance Measures (Continued)

	Target/Measure	Objective Evidence	Accountable Person(s)
3.30.15.4	Supervisors are licensed for all activities under your control. All new radiation workers are inducted and trained in local procedures and activities. All work is supervised until the radiation worker is considered to be proficient.	EPA licences for all supervisors of radiation workers. Records of training and Training Needs Analysis	Head of School/Branch Licensed supervisors

3.30.16 University related documents and Policies

- Appendix A - Prescribed List
- Appendix B - Monitoring – Unsealed Sources, Sealed Sources & X-ray Apparatus
- Appendix C - Personal Monitoring
- Appendix D - Management of Facilities, Storage, Transportation & Record-Keeping
- Appendix E - Disposal
- Appendix F - Emergencies and Accidents – Unsealed Radioactive Material, Sealed Sources & Apparatus
- Information Sheet 1 - Hazard Management
- Information Sheet 2 - Pregnancy
- Information Sheet 3 - General Information
- Forms - Radiation Worker Registration Form

3.30.17 Related Legislation

Acts and Regulations

- Radiation Protection and Control Act 1982
- Radiation Protection and Control (Ionizing Radiation) Regulations 2000
- Radiation Protection and Control (Transport of Radioactive Substances) Regulations 2003

Codes of Practice and Australian Standards

- *Radiation Protection Series (ARPANSA)* http://www.arpansa.gov.au/Publications/Codes/rps.cfm
- *Recommendations for Limiting Exposure to Ionizing Radiation (1995) and National Standard for Limiting Occupational Exposure to Ionizing Radiation (republished 2002)*
- *Code of Practice for the Safe Transport of Radioactive Material (2008 Edition)*
- *Safety Guide for the Safe Transport of Radioactive Material (2008 Edition)*
- *Code of Practice and Safety Guide for Portable Density/Moisture Gauges Containing Radioactive Sources (2004)*
- *National Directory for Radiation Protection, Edition 1.0 (2004)*
- *Code of Practice for the Exposure of Humans to Ionizing 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 2243.4-1998 " Safety in laboratories - Ionizing Radiation"

3.30.18 Useful Web-links

- Environment Protection Authority, Radiation Protection Division (http://www.epa.sa.gov.au/radiation.html)
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (http://www.arpansa.gov.au)
- International Commission on Radiological Protection (http://www.icrp.org/)
- International Atomic Energy Agency – (http://www.iaea.org/)
- General discussions of the principles and philosophy of radiation protection, and data and models for dose limits, can be found in the publications of the IPRC (International Commission on Radiological Protection - http://www.icrp.org/) and the IAE (International Atomic Energy Agency - http://www.iaea.org/).

3.30.19 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.

Becquerels (Bq): per second is a measure of radiation emitted by a source.

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

Effective dose/ Absorbed dose/ Equivalent dose – see Information Sheet General Radiation Information

Ionizing radiation: is defined as the radiation which produces electrically-charged particles called ions in the materials it strikes. This process is called ionization.

Millisieverts (mSv): per year is a measure of a dose of radiation that a radiation worker receives.

Proficiency based training (refer to http://www.adelaide.edu.au/hr/ohs/handbook/training/
HSW Training chapter of the HSW Handbook

Radiation emitters: are categorised into 3 areas:

- Apparatus e.g., X-ray unit
- Sealed sources e.g., soil moisture probes
- Unsealed sources e.g., phosphorus 32 (P32) are usually stored and used in a laboratory

(Requirements do not apply to apparatus that produce ionizing radiation incidental to its function (e.g. electron microscopes and apparatus containing a cathode ray tube or an electronic valve) if the apparatus does not, in normal operating conditions, cause an equivalent dose rate exceeding 1 microsievert per hour at a distance of 0.1 metre from any accessible surface of the apparatus).

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

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).

Thermoluminescent dosimeter badge: (TLD) measures the radiation dose absorbed from an ionizing radiation source.

X-ray analysis apparatus: an apparatus that is used to analyse the properties or composition of materials by the techniques of X-ray fluorescence or X-ray diffraction;

X-ray diagnostic apparatus: an apparatus that is used to irradiate of any part of the human body for the purpose of diagnosis or visualisation

Appendix A

PRESCRIBED LIST

Before undertaking any of the following activities for the first time the HSW Team must be consulted.

The relevant section of the legislation (Radiation Protection and Control (Ionizing Radiation) Regulations 2000) must be complied with.

Activity	Legislation
Bore hole logging	Sections 152-154
Chiropractic radiography	Sections 93, 104, 107, 110
Construction of a new radiation laboratory	
Fluoroscopy	Sections 100, 101, 108
Human brachytherapy	Section 166
Irradiation of humans for research purposes (if process not being managed through a hospital)	Section 45
Mammography or soft tissue radiography	Section 99, 104, 107, 109, 110
Radiation therapy	Sections 103-105, 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)	Sections 81-90, 155-162
Uranium ore mining or milling	Sections 179-180, 184

Appendix B

MONITORING FOR RADIATION

MONITORING UNSEALED SOURCES

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

- measurement of the **external radiation field** (which should be less than 2 μSv per hour at the body). This corresponds to an exposure time of 500 hours for the University constraint of 1 mSv per year. Such an exposure time is unlikely.
- measurement of the **contamination** of benches, equipment and workers by the radioactive material (normally less than 100 cpm/100 cm^2).

(Monitoring of **external** radiation fields is not necessary in laboratories where only H3, C14, and S35 are used.)

Monitoring for contamination should be carried out routinely to ensure that surface contamination levels are lower than the limits in Information Sheet – General Information, Properties Of Some Commonly Used Nuclides, and especially to check that hands have not been contaminated.

Monitoring should be carried out with a survey meter suitable for the type of radiation being used. In some cases contamination will have to be checked using a **wipe test** (see section at end of this document).

It is essential that each laboratory and area have ready access to a detector that can be used to monitor surface contamination and spills.

Note: Contamination should be seen in context. The ALIs for the 1mSv constraint level for H3, C14 and P32, for example are 20MBq, 2MBq and 0.4 MBq. In an experiment using 10MBq P32 it would be necessary to spill and then ingest 4% of the total P32 to reach 1 ALI (1mSv). It is unrealistic to see a contamination level of 100 cpm (16 counts per second) from P32 as a matter of concern due to the radiation hazard. Allowing for a detection efficiency of only 1% (in fact more like 5-10%) this would represent 1.6k Bq or one two hundred and fiftieth of the University ALI. It is apparent that a surface contaminated at this level does not constitute a major risk.

Monitoring Techniques

External radiation fields

- ☐ 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 be less than 2 μSv per hour but needs to be considered in relation to the time taken for the operation. If it is more than expected consult your supervisor.
- ☐ Monitors should be checked before use in a low background area and with a known source to verify their proper operation.
- ☐ If the radiation field is much greater than expected do not continue the survey. Back off, close off the area and seek help from your supervisor or the University Radiation Safety Officer.

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 link between the measurement in counts per second and the activity in disintegrations per second is complicated by the sensitivity of the detector for the radiation and the detection efficiency.

For routine surveys it is normally sufficient to check that there is no gross contamination and a rough efficiency factor for the counter can be estimated by measuring a known source of the radionuclide. Efficiencies will in general be between 0.5% and 5%. Detection of X-ray and γ emitters is generally more efficient using scintillation detectors rather than Geiger-Muller (G-M) counters. For P32, a counting efficiency of about 10% or more is normally obtained with a G-M counter.

For very low energy beta emitters such as H3 the wipe test is the only satisfactory check for contamination.

Appendix B

MONITORING FOR RADIATION (Continued)

MONITORING UNSEALED SOURCES (Continued)

Monitoring Techniques (continued)

- A contamination monitor must be available for area and personal contamination checking and to detect spills.
- The monitor must have the correct energy sensitivity for the radionuclide being monitored.
- Work areas must be regularly monitored for contamination.
- For routine monitoring purposes, contamination should be averaged over an area of 50 to 100 cm^2. If local hot spots are detected, the monitoring should be done over a smaller area.
- The surface contamination of surfaces must be kept below the limits listed in Information Sheet – General Information, Properties Of Some Commonly Used Nuclides.
- Remember that contamination is most common on the hands and can usually be removed by washing if detected early enough.

Objectives of Surface Monitoring

The main objectives of monitoring for surface contamination are:

- to assist in preventing the spread of contamination,
- to detect failures of containment or operating procedures,
- to restrict surface contamination to levels at which a general standard of good housekeeping is sufficient to keep exposures as low as reasonably achievable and ingestion below the ALI.

Area, Equipment and Personal Surveys

- Always measure the contamination levels after you have finished work – check trays, work benches, equipment and anything that may have become contaminated.
- Always check your gloves before removing them (with P32 a contaminated glove may give a large radiation dose to the skin).
- The monitor should be held over an area for a few seconds so that it has time to respond to count rates which may be as low as few counts per second.
- The probe should be held as close as practical to the surface being monitored to increase the efficiency and to best define the contaminated area.
- Avoid contaminating the probe by letting it touch the contaminated surface. Cover the probe with a thin plastic cover which can be easily replaced if it becomes contaminated
- Monitors should be checked before use in a low background area to verify their proper operation.

Wipe Tests

- Gloves should always be worn when carrying out a wipe test.
- A wipe or smear sample can be taken from the surface using a tissue or filter paper (wet or dry).
- Wipe the surface gently with the paper and then place the paper wipe in liquid scintillant in a scintillation vial for counting with the scintillation counter. The detection efficiency is good and this is the best method for checking for surface contamination from low energy emitters.
- A wipe test may remove any fraction up to 100% of the contamination present on the surface. Generally a removal factor of 10% is assumed if no other information is available.
- Wetting the wipe with water or solvent is likely to increase the amount of contamination removed.
- An area 10 cm x 10 cm should be wiped if the results need to be compared with the contamination limits.

Appendix B

MONITORING FOR RADIATION (Continued)

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 1 μGray per hour.
- ☐ Regular radiation monitoring of the x-ray analysis units is required at 6 monthly intervals.
- ☐ Monitoring must be done every time the experimental arrangement changes.
- ☐ Monitoring must be done after any radiation incident or accident involving the apparatus.
- ☐ 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 SEALED SOURCES

External Radiation

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 the small size and portability can aggravate the external radiation hazard, so that misplaced, lost or stolen sources are a potential hazard.

Contamination

If the sealed capsule is corroded or broken the radioactive material can leak out. The activity and the specific 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.

Maintenance and Checking of Sealed Sources

Because of the relatively long life and the inclusion in equipment or shielded housings, sealed sources may be included in plans for alterations, repairs or maintenance. A number of serious radiation accidents have occurred due to sealed sources being machined or opened and the health and contamination consequences can be extremely serious.

No Repairs

- ☐ 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, has given explicit written permission for the work.

Wipe Tests

- ☐ The integrity of the encapsulation of sealed sources must be checked regularly. This can be done by a wipe test of the source, or of the region of the source container most likely to be contaminated if the source is leaking. Wipe tests are conducted every 12 months by the University Radiation Safety Officer, normally at the time of renewal of the source registration.

Monitoring

Monitoring for scattered radiation must be part of the regular checking of sealed sources such as the fixed neutron source and portable neutron moisture probes. Neutron sources should be regularly checked for the gamma radiation component. If this is unexpectedly high arrangements should be made for the neutron dose rate to be measured. For most americium-241/beryllium neutron sources the total effective dose rate (gamma plus neutron) is about twice the gamma dose rate.

The purpose of monitoring the source is to make sure that the shielding is intact and the source is properly housed inside the shield. The moisture probe should be monitored:

- ☐ Whenever it is removed from its carrying case.
- ☐ When first used each day, check the dose rate in the closed and operational positions and that the mechanical operation is normal.

MONITORING FOR RADIATION (Continued)

MONITORING SEALED SOURCES (Continued)

- ☐ At the end of a day's operations when it is returned to the carrying case.
- ☐ Records must be kept of the monitoring program.

Maintenance

- ☐ A program of routinely checking that the source mechanics are working correctly must be implemented. 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.

Appendix C

PERSONAL MONITORING

- The Regulations require the monitoring of the radiation dose of all registered workers. The University has an exemption from this requirement where no simple personal monitoring devices exist (low energy radiation) and where there is a very small risk that radiation workers will receive a radiation dose more than one-tenth of the annual limit for workers.
- People working with very low energy sources such as tritium, carbon-14, and sulfur-35 and those with a very small chance of receiving a dose greater than 1 mSv in a year (determined by the type and the maximum quantity of radionuclide they are handling) are not normally issued with a monitor. The dose of 1 mSv per year is one-twentieth of the annual dose limit for workers. Examples of maximum quantities of other nuclides which do not require a worker to be monitored are 40 MBq of P32 or I125.
- Monitors are issued to users of open-beam and partly enclosed X-ray apparatus and sealed sources such as moisture probes because the risk of a significant dose is higher with these sources.
- The URSO determines (from the information provided in the Worker Registration Form) if a personal monitor is required.
- Any person who believes they should be issued with a monitor should contact the HSW Team.
- Wearers of personal dosimeters are monitored by the HSW Team and informed of the doses received through their Licensed Supervisor or Local Radiation Administration Coordinator.
- All of the monitors issued will be accumulating background radiation from the time of issue. Accordingly, it is essential that monitors not be retained for periods much longer than the end of the monitoring period so that the accumulated background reading will be kept to a minimum.
- The University has set a dose constraint/limit at 1 mSv in a year. This means that no individual should receive an occupational dose greater than 1 mSv a year. After investigation, an individual may be required to modify or be prevented from doing radiation work before they reach 1mSv.

Wearing and Storing Radiation Monitors

- The rules for wearing personal monitors are set down by the supplier of the service (ARPANSA) and must be followed. For the full paper see the ARPANSA website http://www.arpansa.gov.au/Services/prms/instructions.cfm

Wearing of Monitors

- Before starting an operation all individuals participating must ensure they are wearing their TLD badges.
- The monitor is worn at waist or chest height and underneath protective devices such as lead rubber or lead plastic aprons.
- Do not to place objects such as coins, pens, etc in front of TLD badges.
- A monitor is only to be worn by one person. You must never wear a monitor assigned to another person.
- Where the dose to a particular region of the body needs to be determined the monitor should be worn as close as possible to the area of interest. This should be indicated on the Monitor Details Forms when returning them to HSW.

Storage of Monitors

- The “control” dosimeter measures background radiation and should be stored where background radiation levels are low and away from direct fluorescent light (i.e. a drawer).
- When not in use the TLD should be stored with the “control”.
- “Controls” must be returned to HSW Team with the batch of TLDs with which they are issued.

Appendix D

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING
(UNSEALED SOURCES, SEALED SOURCES APPARATUS)

D.1	Unsealed Sources	D.1.1	Facilities
		D.1.2	Storage
		D.1.3	Record-keeping
D.2	Sealed Sources	D.2.1	Facilities
		D.2.2	Transportation
		D.2.3	Record-keeping
D.3	Apparatus	D.3.1	Facilities
		D.3.2	Storage
		D.3.3	Transportation
		D.3.4	Record-keeping

D.1 UNSEALED SOURCES

D.1.1 Facilities

- ☐ All laboratories in which radioactive nuclides are used must be classified as Type C or Type B according to the requirements in Information Sheet 3 – General Information, Classification of Radionuclides and Laboratories and registered with the EPA. Note: the HSW Team must be consulted when planning work that needs to be undertaken in a Type B 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.
- ☐ 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 that 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 is carried out in a laboratory, a fume cupboard or total enclosure that complies with this regulation 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.
- ☐ Visitors should be warned not to touch anything that may cause contamination.
- ☐ If possible the laboratory should be locked when no registered radiation workers are present.

Appendix D

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING
(UNSEALED SOURCES, SEALED SOURCES APPARATUS)

D.1 UNSEALED SOURCES (CONTINUED)

D.1.2 Storage

The rules for the storage of stock materials, waste and material being used in the laboratory are basically the same. The regulations only provide an exemption from labelling where the container is too small to allow labelling.

- ☐ All radioactive materials must be labelled as "Radioactive", with the trefoil and the quantity and type of radioactive material.
- ☐ Radioactive materials must be stored with reasonable precautions against unauthorised access (room locked when unattended)
- ☐ Always store radioactive nuclides according to directions given in specification sheets.
- ☐ Where possible radioactive nuclides should be stored in a double container, with the outer one of plastic in case of breakage.
- ☐ Nuclides must be appropriately shielded with lead or Perspex and lead (bremsstrahlung from GigaBq of P32).
- ☐ Storage areas (including refrigerators) must be marked with the appropriate radiation signs.
- ☐ Never leave radioactive nuclides 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 drink are stored in radiation storage locations.

D.1.3 Record-Keeping

- ☐ A register of unsealed sources must be maintained for each laboratory that contains:
  - The radioactive nuclides 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) must be recorded.
  - The quantities sent to the sewer (through the Radioactive Waste Management Plan) must be recorded.

D.2 SEALED SOURCES

D.2.1 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 as low as reasonably achievable and is not more than 25 microsieverts/h.
- ☐ in order to reduce the possibility of misuse, small sources should be stored inside an appropriately shielded and locked cabinet.

D.2.2 Transportation

The Code of Practice for the Safe Transport of Radioactive Material controls the transport of all radioactive materials. In practice it is only neutron moisture probes that are regularly moved off the campus area. 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.

Only a licensed person can transport sealed sources.

Appendix D

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING
(UNSEALED SOURCES, SEALED SOURCES APPARATUS)

D.2 SEALED SOURCES

D.2.2 Transportation (Continued)

Neutron moisture probes and soil density gauges transport and field rules:

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 "Danger - 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
- ☐ A signed and dated consignment note 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 (8303 5960 / 8379 6839 / 0411 444 895) and the emergency phone number of the Radiation Protection Branch 8463 7826

D.2.3 Record-Keeping

- ☐ Schools must maintain a local source register with the following details:
  - The name of the manufacturer of the source, model or type and serial number.
  - the identifying label of the source.
  - the radioactive nuclide, its activity and the date of measurement.
  - the normal location of the source (storage place).
  - a licensed person must sign out the source when it is removed from the store and record its temporary location, the time and date of removal, and time and date of return.
- ☐ 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.

Appendix D

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING
(UNSEALED SOURCES, SEALED SOURCES APPARATUS)

D.2 SEALED SOURCES

D.2.3 Record-Keeping (Continued)

A special register entry is required when a sealed source is taken off campus (for example, a neutron moisture probe used in the field).

- The register must contain:
  - registered number of the source; and
  - if the source is being moved in a vehicle—the registered number of that vehicle; and
  - the site, district or other locality at which the source is to be used; and
  - if the source is to be used pursuant to a contract between the owner and another person—the name of the other person; and
  - the name of the person who has taken charge of the source; and
  - the date on which the source was taken by the person who has taken charge of the source; and
  - the date on which the source was returned to the premises controlled by the University.
- A person who takes charge of a sealed radioactive source must sign the register on the date on which he or she takes charge of the source.
- 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.

D.3 APPARATUS

D.3.1 Facilities

- The door must carry the radiation warning sign, "Danger - Radiation Area", and the contact details of the licensed supervisor.
- The apparatus must have a sign attached to the controls bearing the words “Radiation Produced When Energised”.
- The working rules and emergency procedures must be displayed in the facilities.
- Visits by people other than authorised radiation workers should be minimised if possible.
- Visitors should be warned not to touch the control panel.
- The facilities should be locked when no authorised radiation worker is present or when the X-ray unit is operating unattended.

D.3.2 Storage

- Unused apparatus must be stored so that unauthorised persons cannot gain access.

D.3.3 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).

Appendix D

FACILITIES, STORAGE, TRANSPORTATION and RECORD-KEEPING
(UNSEALED SOURCES, SEALED SOURCES APPARATUS)

D.3 APPARATUS

D.3.4 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).

Appendix E

DISPOSAL

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:
Gases dispersed via a fume cupboard, material sent for incineration at Kilburn, material allowed to decay to below exemption levels and then sent out as normal waste, and material for which longer decay times are needed in storage.

In the University radioactive waste is classed by three main types
1. Solid waste that is taken into short or long term storage and sent to incineration or out with normal waste.
2. Liquid waste that is miscible with water and is discharged to the sewer.
3. 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:
1. The responsibility for all radioactive waste that leaves the laboratory rests first with the licensed supervisor.
2. Disposal to the sewer is the best disposal method. The EPA considers that if the amounts discharged to the sewers would not raise the activity level at the treatment works above the recommended limit for drinking water, the process is permissible. The dilution provided by Adelaide's total sewage discharges effectively mean that laboratory quantities of materials will be approved for sewerage disposal.
3. All other waste is stored in yellow 20L pails and then
    a. If it has decayed sufficiently (as determined by the URSO) or, if in small enough quantities (below the exempt levels for the nuclides) it can be sent away with normal waste (as it is no longer active).
    b. If it is H3, C14 or S35 waste, or other nuclides in very small quantities, such as that in liquid scintillation vials, it is sent for incineration.
    c. If it is long lived it is stored permanently by the University.
    d. Most importantly the waste stored in the yellow pails must be segregated by nuclide – the amounts of different nuclides that can be handled by the different paths vary and so cannot be mixed.

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.
- ☐ 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 nuclides must be kept in separate pails
- ☐ The pail must be labelled with the nuclide, the 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 http://www.adelaide.edu.au/hr/ohs/docs/radiation_waste_label_yellow_bins.pdf
- ☐ MOST IMPORTANTLY no other labelling or writing can appear on a pail.
- ☐ Do not overfill the pail.

Appendix E

DISPOSAL (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 nuclides 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 the HSW Team if you require access to these storage locations). Roseworthy workers contact the HSW Team 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 the HSW Team 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.

Appendix F

EMERGENCIES AND ACCIDENTS

EMERGENCY NUMBERS:	Contact
Emergency Services (ALWAYS inform them that the emergency is in an area using ionizing radiation or radioactive material)	(0) 000
University Radiation Safety Officer: Dr Gerald Laurence	8303 5960 or 0411 444 895
HSW Team	8303 1111
Radiation Protection Branch of the EPA	8463 7826

UNSEALED RADIOACTIVE MATERIALS EMERGENCY ACTIONS

RADIOACTIVE SPILLS

- ☐ Manage any injury
- ☐ Assess the situation - think before acting, avoid contaminating other areas.
- ☐ Evacuate the area if necessary (also lock and sign the area)
- ☐ Advise – the licensed supervisor and University Radiation Safety Officer (8303 5960 or 0411 444 895)
- ☐ Clean up and decontaminate in the following order:
  - ☐ People
  - ☐ Laboratory
  - ☐ Equipment
- ☐ Record the incident/accident in RMSS including:
  - ☐ The time, date and place
  - ☐ The names of those involved, including anyone who may have been affected by the incident
  - ☐ 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) so that it can be compared with the ALI, and other limits
  - ☐ The length of time the radioactive material was out of control and when it was reported to licensed supervisor.
  - ☐ The probable cause of the incident.
- ☐ The HSW Team and the University Radiation Safety Officer will follow up with an investigation of the incident and report to the EPA where required.

Please note that if an incident causes an exposure close to or over 1mSv the University will not allow the staff/student to continue radiation work for a full year.

Remedial Action

- ☐ Stop and secure the operation that caused the spill.
- ☐ Warn others.
- ☐ Isolate and absorb the spill and secure the spill area.
- ☐ Do not do anything that will spread the material further.
- ☐ Work from the outside in to remove the spill and minimise the spread of contamination.
- ☐ If necessary, temporarily seal the contamination with plastic sheet until ready to decontaminate the area.
- ☐ Treat all cleaning materials as radioactive waste.
- ☐ Check for the contamination of people, then furniture, and finally equipment.
- ☐ Inform your licensed supervisor and the University Radiation Safety Officer (8303 5960 or 0411 444 895).

Appendix F

EMERGENCIES AND ACCIDENTS (Continued)

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 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.

Spill Kit Contents

- PPE – safety glasses and gloves
- Absorbent material of various kinds for liquid spills:
  - Vermiculite (packaged in various ways by vendors – choose that which suits your situation best)
  - Absorbent paper and tissues
  - 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 sulfur. 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 use care as violent methods can cause the contamination to pass 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 rinse in saturated $KMnO_4$ (this removes dead skin – use once only).
- If still contaminated – get advice

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 – don't shower with contaminated hair
- 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

Appendix F

EMERGENCIES AND ACCIDENTS (Continued)

Wounds

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

Ingestion and Inhalation

Internal contamination requires professional medical assistance.
You must call the University Radiation Safety Officer IMMEDIATELY (8303 5960 or 0411 444 895).

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 the University Radiation Safety Officer for advice.

Appendix F

EMERGENCIES AND ACCIDENTS – APPARATUS

If the Emergency Services are called ALWAYS inform them that the emergency is in an area where an X-ray generator 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 the licensed supervisor and University Radiation Safety Officer (8303 5960 or 0411 444 895).
- ☐ 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.
- ☐ Leave a sign on the unit to indicate that the unit should not be used or altered in any way.
- ☐ Disconnect the unit from the power and lock the room.
- ☐ The incident report is to be entered into RMSS and reported (if not already done) to the licensed supervisor, the Head of School, the HSW Team and the University Radiation Safety Officer.
- ☐ Investigation is to be conducted by the University Radiation Safety Officer, the HSW Team and the licensed supervisor
  - ☐ contains details of the incident/accident including: - The time, date and place.
  - ☐ the names of those involved, including anyone who may have been affected by the incident.
  - ☐ description of the incident.
  - ☐ the results of any dose assessments that have been made.

EMERGENCIES AND ACCIDENTS – SEALED SOURCES

LOSS OF CONTROL IN A CLOSED AREA (LABORATORY)

If a sealed source is no longer in its normal shielded container 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.

LOSS OF CONTROL IN A VEHICLE ACCIDENT

Neutron moisture probes are the most likely sealed source 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 motor 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.

Appendix F

EMERGENCIES AND ACCIDENTS – APPARATUS (Continued)

LOSS OF CONTROL DUE TO BREAKDOWN 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 as easily 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 Emergency Services (000), 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.

Preparing Contingency Plans

- The Head of School must ensure that contingency plans are developed and tested which cover the use of ionizing radiation whether from an X-ray apparatus, or the handling, storage or disposal of any radioactive substance (sealed and unsealed) in use in their area.
- The contingency plan must be prepared before the commencement of the kind of operation to which it relates.
- The contingency plan must—
  - take into account every radiation accident and radiation emergency that is reasonably foreseeable; and
  - 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
  - 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 is necessary for the effective operation of the contingency plan is provided and maintained in correct working order.