Radiation Local Rules - Work Instructions

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Contents

Introduction

This document is the local Rules as compliance with the Ionising Radiations Regulations 2017 for work with such ionising radiations and also the Environmental Authorisation (Scotland) Regulations 2018 for the use and disposal of radioactive materials.

This document provides the working instructions for specific activities which are undertaken at the University of St Andrews.

This document will also describe the health and safety management system for working with ionising radiation. It will also provide a series of work instructions for specific activities which will form the Local Rules for Work with Ionising Radiation as required by the Ionising Radiations Regulations 2017.

University of St. Andrews

Guidelines For Commencing Work With Ionising Radiation

Research Worker or Student

Attend Radiation Protection Course or go through Moodle training at https://moody.st-andrews.ac.uk/moodle/course/view.php?id=2905 and pass the test at the end of the programme by 60% or greater

Consult project supervisor about the scope of the work – Register on the RadProt Management programme at:

Member of Staff

Meet the DRPS to discuss the following aspects of the project:

1. Where the work can be carried out;
2. Check whether the radionuclide(s)/quantity are within the Building's SEPA Permit;
3. Check that there is an appropriate SEPA Permit for the disposal of the radionuclide(s)/quantity and for the route of disposal.

Does the radionuclide(s) and quantity to be used in the work comply with the SEPA Permit for the storage, use and disposal of radioactivity ?

NO

If the project **exceeds** limits set by the SEPA Permit for the Building, then **WORK CANNOT PROCEED.**

You **must** then consult the Head of EHSS or their Depute

YES

Have you worked with Ionising radiation before ?

NO

You must attend the University Radiation Protection Course or complete the Moodle Radiation Protection Course at URL: https://moody.st-andrews.ac.uk/moodle/course/view.php?id=2905 .You must also pass the test on the Moodle course by 60% or greater.

YES

You should provide the URPA with evidence of:

1. Suitable training in Radiation Protection;
2. If requested, the dose records from your previous employer.

The following forms should now be completed:

- Personal Registration Form on Radprot at https://portal.st-andrews.ac.uk/radprot/open/

AND

- Appropriate risk assessment form on the RadProt system at https://portal.st-andrews.ac.uk/radprot/open/

Project Supervisors/Workers/DRPS will be notified when the URPA approves their project and advised that the project can commence.

If deemed necessary by the URPA/DRPS, an appropriate personal dosimeter will be supplied to the worker.

Training in the School/Unit procedures for handling, using and disposal of radionuclide(s) will be provided locally. Workers should familiarise themselves with the School/Unit Rules for Working with Ionising Radiation.

The University undertakes an annual review of all ratified ionising radiation projects.

University of St. Andrews

Guidelines For Commencing Work With X-ray Generators

Research Worker or Student

Consult project supervisor about the scope of the work activity

Member of Staff

Meet the DRPS to discuss the following aspects of the project:

1. Where the work can be carried out;
2. The equipment that will be used
3. The procedures that will carried out using the equipment

Check the X-ray equipment complies with the Health and Safety Executive's 'Prior Authorisation for the Use of Electrical Equipment Intended to produce X-rays' **http://www.hse.gov.uk/radiation/ionising/authorisation.htm**

NO

If NO, then **WORK CANNOT PROCEED.**

You **must** then consult the URPA.

YES

Have you worked with Ionising radiation before ?

YES

You should provide the URPA with evidence of:

1. Suitable X-ray awareness training in Radiation Protection;
2. Complete the test at the bottom of the Moodle Radiation Protection Programme at https://moody.st-andrews.ac.uk/moodle/course/view.php?id=3506
3. Pass the test on the radiation protection by 60% or greater
4. If requested, the dose records from your previous employer.

NO

Then you must attend the School/Unit training course on the use of X-ray equipment **OR** pass the through the Moodle Programme at https://moody.st-andrews.ac.uk/moodle/course/view.php?id=3506 You must complete the Test on the Moodle Programme before you can start

The following forms should now be complete:

- Personal Registration Form on RadProt system at https://portal.st-andrews.ac.uk/radprot/open/ **NOTE:** You will only be allowed to be registerd to use radioactivity if you have completed the Moodle test https://moody.st-andrews.ac.uk/moodle/course/view.php?id=3506 **AND**
- Appropriate Project Assessment Form on the RadProt system https://portal.st-andrews.ac.uk/radprot/open/

These forms will be sent to the DRPS and the University Radiation Protection Officer for approval.

Project Supervisors/Workers/DRPS will be notified when the URPA ratifies their project and advised that the project can commence.

If deemed necessary by the URPA/DRPS, an appropriate personal dosimeter will be supplied to the worker.

Training in the School/Unit procedures for the use of X-ray equipment will be provided locally. Workers should familiarise themselves with the School/Unit Rules for Working with Ionising Radiation.

The University undertakes an annual review of all ratified ionising radiation projects.

1. Work Instruction 1 - Management of Work with Ionising Radiations at the University of St Andrews

Work Instruction 01 Management of Work with Ionising Radiations at the University of St Andrews

1.1 Preface

Ionising radiations are a natural component of the environment in which we live. They come from constituents of the air we breathe, the ground we walk on and the food we eat. We are also bombarded by a never-ending stream of cosmic radiation from the sun and space. Today, we may also be exposed to varying levels of man-made radiation, the most significant of which is medical X-rays, and everyone appreciates the benefits which they have brought us. You, by the nature of your work, may be exposed to higher levels of radiation than the general public, and an important principle of radiation protection is that the benefits of the work that you do should far outweigh any risks involved.

The University has outlined how it will comply with relevant health and safety legislation and guidance in this Work Instruction. The purpose of this instruction is to provide radiation workers at the University with useful information on ionising radiations and details of the procedures they should follow to ensure safe working practices and compliance with the law. If the procedures are strictly adhered to, then the risks associated with your work with ionising radiations and your exposures to them should be minimal.

Guidance on other relevant health and safety matters is provided on the Environmental, Health and Safety Services website at http://www.st-andrews.ac.uk/staff/policy/healthandsafety/publications/

1.2. Legislation & Codes of Practice

Work with ionising radiations is now covered by three main Acts of the UK and Scottish Parliaments and their accompanying regulations. These are:-

(a) Health and Safety at Work etc. Act 1974 -

(b) Ionising Radiations Regulations 2017;

(c) Environmental Authorisations (Scotland) Regulations 2018 and

(d) The transport of radioisotopes is covered by the Carriage of Dangerous Goods Regulations 2009 + amendments

The Health and Safety at Work etc. Act 1974 introduced the concept of risk assessment into safety legislation, for the first time. In this, the employee as well as the employer has responsibilities to himself and to others who may be affected, not only by the work he/she performs, but also by any failure to perform his duties. It is expected that this be fully complied with at all times and is not subject to obtaining any form of permit.

Ionising Radiations Regulations 2017 The detailed requirements for work with ionising radiations under the Health and Safety at Work etc. Act are provided by the Ionising Radiations Regulations 2017 and the Approved Code of Practice for the protection of persons against ionising radiations arising from any work activity. This guidance can be found at: http://www.hse.gov.uk/pubns/priced/l121.pdf

Under the regulations some form of permit must be obtained from the HSE to cover all exposures to ionising radiations as defined in the regulations.

The Environmental Authorisations (Scotland) Regulations 2018 are designed to control the use and disposal of all radioactive materials used in relevant University buildings. The University holds Permits to work and dispose of radioactive materials under this legislation which are issued to them by the Scottish Environment Protection Agency (SEPA). These identify the radionuclides which are allowed to be used and the amounts which can be held in store at any one time. The SEPA permit also controls the disposal of radioactive waste, placing limits on the amounts which can be disposed of at any one time, and also specifying the permitted means of disposal. The permits now come with a standard set of rules for compliance with these permits (see URL: https://www.sepa.org.uk/media/372003/easr-standard-conditions.pdf)

All School/Units requiring to use radionuclides as sealed or unsealed sources will be given an allocation from the University SEPA permit, and this allocation along with the permit should be prominently displayed in the appropriate work area within the University. It is important that all School/Units keep within the limits of their allocation but, if necessary, these can be revised, with the help of the Radiation Protection Service.

Carriage of Dangerous Goods Regulations 2009 and associated 2019 amendment – These Regulations enacts the Pan-European ADR Transport Guidance into legislation. This guidance is used to enact European standards for the transport of all hazardous materials including radioactive materials. The 2023 ADR guidance can be found at the following website:

http://unece.org/transport/standards/transport/dangerous-goods/adr-2023-agreement-concerning-international-carriage

The regulations controlling the transport of radioactive materials and sources are subject to regular review and change such that before any radioactive material or source is moved from a University premise the University Radiation Protection Officer must be consulted, even if the movement was authorised historically.

The enforcement agencies - The Health and Safety Executive (HSE) and Scottish Environment Protection Agency (SEPA) - at intervals inspect work with ionising radiations at the University to ensure that the Regulations and permit conditions are complied with. They have the power to enter premises unannounced, to withdraw permits or issue prohibition notices if they find an unsatisfactory situation and to prosecute in extreme cases.

1.3. Radiation Safety Organisation and Individual Responsibilities

1.3.1 Management of Radiation Protection within the University

The ultimate responsibility for radiological protection within the University lies with the Office of the Principal. This responsibility derives from the Health and Safety at Work etc., Act 1974 and cannot be devolved.

The University is legally required to appoint a qualified and accredited Radiation Protection Adviser (URPA) under the Ionising Radiations Regulations 2017. The duties of the URPA are defined in Appendix 1

A University Radiation Protection Service is organised by the Head of Environmental Health and Safety Services (EHSS) or a named Depute from the EHSS. The head of the EHSS is responsible for ensuring that the duties of the service are fully and properly carried. The leader of the service is the University Radiation Protection Officer (URPO), the deputy head of the EHSS. The URPO is the contact person for day to day queries regarding ionising radiations in the

University. In his/her absence the RPA can be contacted directly. The duties of the URPS are defined in Appendix 2.

It is the responsibility of the Head of the School/Unit to ensure that all University policies and guidance on ionising radiations are implemented within their School/Unit.

The Head of School/Unit can delegate some of these duties to a Departmental Radiation Protection Supervisor who can provide advice and monitor work activities in the School/Unit. The duties of a DRPS is given in Appendix 3 of this document.

The development and approval of Radiation policies is undertaken by the Radiation Hazards Management Group. The remit for this Group is given in Appendix 4 and the members of the Group are given in Appendix 5. The Radiation Hazards Management Group also undertakes the monitoring of governance of radiation risks at the University through reports by the URPO and URPA. Where identified as necessary the group will report relevant findings to the Head of a School/Unit or directly to the Office of the Principal. A meeting of this group will be convened by the head of the EHSS at least once a year.

In addition to the Health and Safety at Work etc. Act, the Environmental Authorisations (Scotland) Regulations 2018 and the Ionising Radiations Regulations 2017 require the University to establish an administrative structure to ensure that the radiation exposure of workers and the general public alike is kept as low as reasonably achievable (ALARA). This structure is shown below in Figure 2.1.

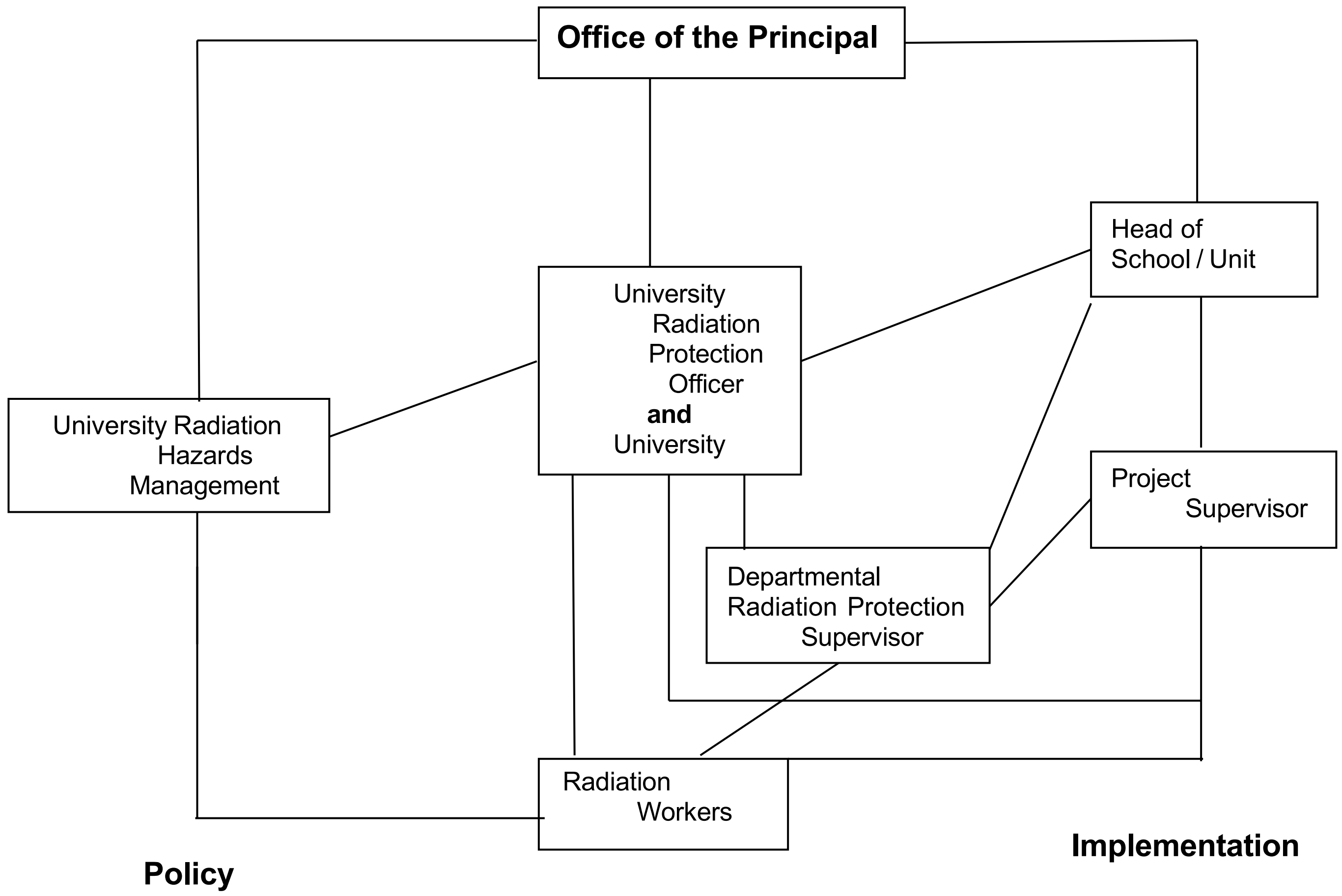

Figure 2.1 - University Radiation Protection Administration Structure

All employees and students have a responsibility to look after their own safety and the safety of others by their acts or omissions. They also have a responsibility to comply with management instructions, wear personal protective equipment issued under appropriate risk assessments and notify the University employer of any radiation hazard which they consider has not been suitably assessed for risk.

1.4 Appointments

1.4.1 University Radiation Protection Adviser (URPA)

The University Radiation Protection Adviser (URPA) is appointed in writing with a copy of the duties expected by the Office of the Principal. A copy of this appointment and the acceptance by the RPA(s) must be held by the URPO.

1.4.2 University Radiation Protection Officer

The URPO is appointed in writing by the head of the EHSS to carry out the duties of the URPS as identified in Appendix 2.

1.4.3 Departmental Radiation Protection Supervisor

A DRPS is appointed by the relevant Head of Department using the form in Appendix 6. A copy of this appointment must be held by the URPO.

The name of the DRPS should be included in the local School/Unit health and safety policy.

Each DRPS is required to attend the necessary training in radiation protection as required by the University RPA and the University Radiation Protection Officer. The DRPS must familiarise himself/herself with all ionising radiation work taking place within the School/Unit or with specified work as described in their terms of reference. The DRPS will advise the Head of the School/Unit on routine matters of radiation safety.

1.4.4 Project Supervisor

It is the responsibility of all Project Supervisors/Principal Investigators who wish to use ionising radiations to be a registered radiation worker. The Project Supervisor/Principal Investigator has the following additional responsibilities:

- Register and undertake a risk assessment of the work involved on the project by completing the relevant form on RadProt (https://portal.st-andrews.ac.uk/radprot/open/). Approval of such work will automatically be sought by the system when the project is submitted.
- Obtaining prior approval from the University Radiation Protection Service for any significant changes to a previously approved ionising radiations project;
- To ensure that the experimental procedures used by those under his/her supervision conform to the University and School/Unit Rules;
- To ensuring workers under his/her supervision have received suitable and sufficient training and instructions in the techniques that will be used.
- To suitably monitor the activities of those under their control to ensure they are using best practices and are complying with legislation as well as University policies and guidances.
- Notify the DRPS of any incidents involving radioactivity as soon as reasonably practicable

1.4.5 Radiation Worker

It is the duty of a radiation worker to carry out their work in a responsible manner with due consideration to others. The worker must never knowingly expose himself/herself or other persons to a significant level of ionising radiation. The working procedures used shall be designed to ensure that the radiation dose exposure is kept as low as reasonably achievable (ALARA). The duties of a Radiation Worker are given in Appendix 7.

Each radiation worker must be familiar with:

(i) The appropriate safety procedures applicable to the work being carried out;

(ii) The emergency procedures to be implemented in the event of an accident;

(iii) The notification procedure to be followed in the event of the loss of a quantity of radioactive substance or of its release into the atmosphere, or spillage or theft.

For a worker to be able to be registered as a user of radioactive substances, they must complete the test on the Moodle University Radiation Protection Course programme at: https://moody.st-andrews.ac.uk/moodle/course/view.php?id=2905 and pass the test by 60% or greater. Once they have undertaken this test, they should register their name on the 'Registration Details' section of the RadProt programme at: https://portal.st-andrews.ac.uk/radprot/open/

Once the user is a 'Registered Worker' with ionising radiations, they should ask their Supervisor to add their name to an approved project, or they should complete the Assessment form on RadProt themselves. This assessment must include a .pdf copy of these working Instructions, the Site Specific Local Rules as well as the detailed risk assessments for the type of work as identified in the Site Specific Local Rules uploaded onto the RadProt Programme.

This will then be submitted to the University Radiation Protection Service for monitoring and approval process.

NOTE: Expectant mothers who are radiation workers are subject to more stringent radiation dose limits and should notify the University Radiation Protection Service, via the DRPS, of their pregnancy without delay. Strict confidentiality will be respected. It is not a legal requirement that expectant mothers inform the Head of the School/Unit and they can choose to keep this information private, however, in our view, it is not in your best interests to do so as some radionuclides or labelled compound are selectively concentrated in a foetus and the Protection Service will take these into account when carrying out a new risk assessment for the work.

1.4.6 Visiting Radiation Workers

All visiting radiation workers come into the category of University of St. Andrews Registered Radiation Worker. Approval of registration and permission to carry out specified work within University premises must be sought from the University Radiation Protection Service well in advance of the proposed starting date.

Only persons who have been designated as 'Classified Workers' by their own employer may act as Classified Workers within the University. Visiting 'Classified Workers' should have a suitable radiation dose 'passport' which details the dose received by that person. Such persons must provide the University Radiation Protection Service with a copy of their current radiation dose 'passport'.

Visiting research workers should complete the RadProt-Reg-1 form (see Appendix 8) which should then be signed by the local DRPS. They will then be registered on the RadProt programme like any other worker and will be required to keep the appropriate records of their radioactive material use.

These can be seen below.

It should be noted that it is expected that visiting researchers must also undergo the Moodle programme entitle 'University Radiation Protection Course' (URL: https://moody.st-andrews.ac.uk/moodle/course/view.php?id=2905) The process of becoming a radiation worker is given in the flow charts below.

The URPO must be kept informed of any plan to use ionising radiation by a School/Unit or other person working within University premises.

1.4.7 Flow charts for the process of carrying out ionising radiation work are shown at the beginning of this document

1.4.8 University of St. Andrews Radiation Workers Visiting Other Establishments

Radiation workers who intend to carry out work involving the use of ionising radiations in premises other than those of the University of St. Andrews should notify the local RPA of this intention and provide such information as the RPA may require. You should also notify this University's Radiation Protection Service and the local DRPS here. In compliance with Regulation 16 of the Ionising Radiations Regulations 2017, the URPO will arrange with the Controlling Authority to supply information concerning the worker's designation and current radiation dose record.

1.5 OUTSIDE WORKERS

1.5.1 Service Engineers

Several items of equipment which produce high dose rates of radiation are subject to regular maintenance by external contractors. These contractors must work under their own Local Rules when undertaking this work. They must also demonstrate that their employer holds a relevant permit from the HSE. Responsibility for the equipment/area of work that they are working in must be transferred to them using the form in Appendix 9 prior to them starting work. On completion of the work responsibility of the equipment/area of work must be transferred back to the University.

1.5.2 Maintenance Engineers

Routine facility maintenance in a radiation area can only take place with the agreement of the URPO. The DRPS and URPO must be made aware of the requirement for entry into these areas by the Estates Office. Any permits issued allowing the work to be undertaken must also be signed by the DRPS or URPO.

2. Work Instruction 02 Radiation Areas Incidents

2.1 Areas involving Radioactive Substances or Sources

Accidental spillage, fire or explosion in an area where work with radioactive substances or sources is performed may give rise to internal and external radiation hazards.

No attempt should be made to remove radioactive substances or sources from the School/Unit in the event of a fire or flood. The area/building should be cleared of all unnecessary personnel. In the event of a fire or flood, the Fire Service should be warned of the presence, the radionuclides present, the activities of the sources and location of radioactive sources. All this information is available on the RadProt programme which can be opened on laptops, Tablets or Smartphones.

2.2 Areas Involving X-ray Generating Equipment

In the event of a fire or flood the equipment must be immediately switched off at the mains electricity supply. The area/building should be cleared of all unnecessary personnel. The Fire Service should be told that all units are deactivated and any radiation warning signs in the area can be ignored.

2.3

2.3 Reporting Accidents and Dangerous Occurrences/Near Misses

The University has a policy of reporting all actual incidents and near misses. The latter are important as this may prevent a more serious event in the future.

All incidents that may have exposed an individual to ionising radiation or a Dangerous Occurrence/Near Miss should be reported to the DRPS or URPO as soon as possible. If he/she is not available then contact the Head of EHSS as soon as reasonably practicable. The URPO will take charge of such emergencies. Examples of such accidents include:

- An incident, however minor, in which it is suspected that a person may have been exposed to above expected levels of ionising radiation;
- Any incident in which a person or his clothing may have been significantly contaminated;
- An incident where this is a possibility of radioactive material having entered a worker through an open wound, ingestion or inhalation;
- An incident involving a fire or explosion with damage to the fabric of a room in which radioactive materials are stored;
- A spill involving an activity of > 1 MBq.

Records of all such accidents, Dangerous Occurrences/Near Misses and any subsequent decontamination procedures must be kept.

2.4. Immediate Actions

2.4.1 Radiation Exposure

The possibility of a person receiving a significant exposure dose in the University is extremely small and limited to persons carrying out an identified practice for which a detailed risk assessment together with its associated actions has been made. Any one who suspects that they may have received a significant exposure dose must immediately bring it to the attention of the DRPS or URPO. The circumstances of the exposure should be written down without delay. This information should include (i) the position of the person when exposed, (ii) the duration of the exposure, (iii) the instrument settings if the source is a radiation generator. Following discussion with the RPA and, if necessary, the University medical adviser further medical advice can be sought.

2.4.1.1 - Exposure to High Energy Isotopes

Exposure to high energy isotopes like 32P have the potential to cause a significant dose. Appendix 12 shows the potential dose rates from a 5% spillage of different isotopes. A spillage of such an amount of 32P onto the skin (even though covered by a disposable nitrile gloves and thus with the potential for rapid removal of the isotope) could cause a dose rate of 1.89 mSv/h per $kBq.cm^{-2}$. Thus an accidental spillage could produce a dose rate greater than 7.5 mSv/hr on the skin thus has the potential to cause a significant dose to the skin (Legal Maximum dose to the skin in Ionising Radiation Regulations 2017 is set at 500 mSv per annum).

All work with high energy radionuclides must be undertaken behind an appropriate screen (eg Perspex for 32P or Lead glass for 125I) with appropriate screens on other equipment eg pipettes. Workers should wear a finger dosimeter badge (as well as a whole body dosimeter badge) and two layers of disposable nitrile gloves. If there is evidence that there has been a spillage of 32P or other high energy radionuclides, then the gloves and any other contaminated clothing must be removed as soon as practicable. See appropriate risk assessment.

Where there has been an exposure on the skin as measured by a Geiger Muller Probe contamination monitor of 3 x background, the DRPS and URPO must be informed as soon as is reasonably practicable and an investigation of the event causing the contamination.

2.5 Contingency Plans

Contingency plans are based on the requirements of Regulation 13 of the Ionising Radiations Regulations 2017 and the requirements of the SEPA Permit for compliance with the Environmental Authorisations (Scotland) Regulations 2018. In the event of an emergency situation you should call the following numbers:

- The local DRPS - See Site Specific Local Rules for this
- The University Radiation Protection Officer - Dr Paul Szawlowski - E-mail pwss@st-andrews.ac.uk Tel; (01334 46) 2753
- The University Radiation Protection Adviser - Aberdeen Radiation Protection Services E-amil: arps@ Tel:

2.5.1 - Who is responsible for the plan - The University Radiation Protection Officer URPO is responsible for the implementation of the plan. The Universdity RPA will be responsible for ensuring it is adequate and that suitable training is provided by the URPO.

2.5.1.1 - Training - An annual contingency plan training exercise will be undertaken by the URPO with DRPS and staff on the different foreseeable incidents.

2.5.2 Unsealed Radioactive Sources Incidents

The following foreseeable incidents have been identified and the appropriate actions taken.

Foreseeable Unsealed Radioactive Source Incident	Actions Taken
Loss of source or theft of source	If it is suspected that there has been a loss of a radioactive source, you should double check the area to see if it can be found. If not you must notify the DRPS and URPO as soon as is reasonably practicable. A search will then be commenced for the source. If it cannot be immediately found then the matter has to be reported to Police Scotland, SEPA and HSE. This will be done by the URPO
Fire	In the event of a fire in a room with unsealed sources, evacuate the room (helping any injured person out of the room), activate the fire alarm to evacuate the building. Call the Fire Service on 999 or 112 and tell them there is a fire and that the fire is in a room with radioactive materials. Wait for the fire service to arrive and then give details of the incident. Notify the URPO and DRPS and Head of School about the fire as soon as possible.
Flood	If the flood can be easily stopped, it should be. If there is a flood in a room with unsealed radioactive sources, evacuate the room. Notify the URPO, DRPS and Building Safety Co-ordinator during normal working hours. Call Security and Response if out of hours.
Injured person	If there is an injured person, check that they are not contaminated (using a Geiger Muller probe contamination monitor and a scintillation probe contamination monitor). If they are not contaminated then they should be removed from the area. If they are contaminated, a judgement has to be used in terms of the risk of spread of contamination compared to the risk to the health of the individual. If they are contaminated take the injured person to an area as close to the incident. Then call for an Ambulance and notify them that the person may be contaminated with radioactive materials.
Spillage of a small quantity of radioactive materials	Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers). The immediate area where there has been a spillage should be identified using contamination monitors. Absorbent material should be placed over any liquid spillage. The material should then be removed and disposed of in an appropriate contaminated material bin. The area should then be scrubbed using a detergent and disposable cloth. The area should be monitored with a Geiger Muller probe and Scintillation probe contamination monitors until there is no evidence of contamination. A written record of the levels of contamination found, the level of contamination after cleaning, the date and who undertook the work should be kept.

Foreseeable Unsealed Radioactive Source Incident	**Actions Taken**
Spillage of a large quantity of radioactive materials	Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers). Check for personal contamination (see section 2.6.2). Check for contamination of hands, clothing, shoes and floor with a Geiger Muller Probe and a Scintillation contamination probe. If there is no personal contamination, you should leave the room and call the DRPS and URPO who will clean up the room. A written record of the decontamination will be kept and an investigation of the incident will be undertaken by the URPO
Arrival of a source which has contamination on the outside of the package	Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers). The DRPS or a depute will be the only person who can accept a package of radioactive materials. If the packaging is contaminated or the bottle is cracked and leaking then the area should be isolated and room locked. The URPO or URPA should be called to determine the actions to be taken. The supplier must be notified immeduiately as well as the transport courier to determine if their vehicles are contaminated.
Equipment Failure	Where equipment failure leads to radioactive contamination (eg failure of a centrifuge tube), the equipment should be switched off and then a notice posted on it to say that equipment must not be used. The DRPS and if appropriate URPO should be notified. If the spillage is minor (<x3 background), the user can undertake the cleanup. A more serious spillage (eg x3 background) will be cleaned up by the DRPS or the URPO. For minor spillages, firstly put on appropriate Personal Protective Equipment (PPE) (disposable nitrile gloves, Laboratory coat, eye protection. The immediate area where there has been a spillage should be identified using contamination monitors. Absorbent material should be placed over any liquid spillage and the area wiped clean. The material should then be removed and disposed of in an appropriate contaminated material bin. The area should then be scrubbed using a detergent and disposable cloth. Be aware that some equipment is sensitive to certain detergents, thus you should check which detergent to use. The area should be monitored with a Geiger Muller probe and Scintillation probe contamination monitors until there is no evidence of contamination. A written record of the levels of contamination found, the level of contamination after cleaning, the date and who undertook the work should be kept.
Determination of exposure to dose	In the event of a potential exposure to a dose of radiation, the URPO will calculate the possible dose exposure. This will be compared to the whole body dosimeter reading and if available, a finger dosimeter reading.

2.5.2.1 Personal Contamination

When handling radioactive materials, workers should be wearing the appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection). The DRPS and URPO should be informed immediately if a person has been contaminated. For all personal decontamination, the possible need to seek medical advice should be borne in mind. All areas potentially contaminated should be immediately dabbed dry with a dry tissue. Only localised skin decontamination on the forearms and hands should be attempted. If more extensive decontamination is required, it should be undertaken at the A& E Department at Ninewells hospital. The ambulance service should be contacted and told that there is a potentially radioactive material contaminated casualty. They will be able to inform the hospital to allow them to prepare to receive the casualty. You should ensure that the relevant risk assessment goes with the casualty to the ambulance and the hospital. No attempt should be made to have a total shower as this can spread the contamination possibly into body orifices.

For contamination of the skin on arms and hands, the first step is to wash the affected area with soap and water as normal over a wash hand basin. If the contamination persists, it should be washed and scrubbed gently, using a soft brush, with a deep cleansing soft soap or liquid soap e.g. 'Clearasil' or 'Dermactyl'. Care must be taken not to break the skin. If this is not successful, the casualty should be taken to the A&E department as above.

2.5.3 - X-Ray Equipment Incidents

The following foreseeable incidents have been identified and the appropriate actions taken.

Foreseeable X-ray Incident	Actions to be taken
Fire	In the event of a fire in a room with X-ray equipment, press the emergency stop button and the equipment switched off by removing the key to the power source (if this is feasible). Then evacuate the room (helping any injured person out of the room), closing the door (and following the Fire Action Notice, activate the fire alarm to evacuate the building). Call the Fire Service on 999 or 112 and tell them there is a fire and that the fire is in a room with a X-ray generator. Wait for the fire service to arrive and then give details of the incident. Notify the URPO and DRPS and Head of School about the fire as soon as possible.
Flood	In the event of a flood in a room with X-ray equipment, press the emergency stop button. Depower the equipment and then remove the key to the power source. Evacuate every body in the room, seal the room and then call the DRPS or URPO urgently. Contact ERstates with regard to dealing with the flood. Do not let anybody into the room until the flood has been dealt with.
Electrical Issue	In the event of an issue which is deemed an electrical problem, press the emergency off button and switch the power off to the equipment. A notice to say the equipment cannot be used and is 'Out of Service'. A specialist engineer should be called for as soon.

Foreseeable X-ray Incident	Actions to be taken
X-ray radiation detected outside the interlocked shielded cabinet/enclosure	If any X-ray radiation is detected outside the interlocked shielded cabinet/enclosure. Press the emergency stop button (or emergency shutter release). Depower the equipment and remove the keys for activating the equipment. Shut the room and do not allow access to the equipment. Call the specialist maintenance engineers. Notify the local DRPS and the URPO of this situation
X-ray radiation detected when interlocked shielding has been bypassed cabinet/enclosure	If any X-ray radiation is detected when the interlocked shielding has been bypassed for a cabinet/enclosure. Press the emergency stop button (or emergency shutter release). Depower the equipment and remove the keys for activating the equipment. Shut the room and do not allow access to the equipment. Call the specialist maintenance engineers. Notify the local DRPS and the URPO of this situation
Somebody has been exposed to the direct X-ray Beam	If any X-ray radiation is detected when the interlocked shielding has been bypassed for a cabinet/enclosure. Press the emergency stop button (or emergency shutter release). Depower the equipment and remove the keys for activating the equipment. Call an ambulance immediately stating that a person has received an X-ray Burn. Please take risk assessment for the work and any other information about the type of X-ray, the dose they may have received. You must inform the DRPS and URPO as soon as possible about such an exposure
The interlocks on the X-ray equipment fail	If the interlocks on the X-ray equipment fail such that the X-ray beam remains on when the door to the cabinet/enclosure is opened, then the shielded door should be closed immediately, the emergency stop button pressed, and the equipment depowered with the key to the power source removed. The equipment should be taken out of service immediately and the door to the room with the equipment should be locked. A specialist repair engineer should then be called. The Head of EHSS and the URPO as well as local DRPS must be notified as soon as practicable
Emergency X-ray shutter does not work and beam still active	In this situation, press the emergency stop button and depower the system. Remove the key for the power source. Lock the room. Inform the Head of EHSS and the URPO as soon as practicable
The lights showing the status of X-ray beams fails	The equipment must be taken out of service immediately, depowered and the key to the power source removed. The lights should then be repaired by a suitably trained individual

2.5.4 Sealed Sources

The following foreseeable incidents have been identified and the appropriate actions taken.

Foreseeable Sealed Source Incident	Actions to be taken
Theft or loss of source	The URPO should be notified as soon as is reasonably practicable. A search will be instigated to try and locate the relevant sources. If the sources cannot be found, the URPO will notify Police Scotland, SEPA and HSE
Terrorist Action	If there is evidence of a terrorist action against the sealed source, ,then the Head of University Security must be informed who will notify Police Scotland with the Head of EHSS and URPO
Failure of Shielding	If during use or an inspection a significant dose is detected outside the shielding of the equipment source with a high activity, then the equipment must be taken out of service and the room locked. The URPO and the University RPA must be told of this who will take the appropriate actions
Leakage from the Sealed Source	If during the annual wipe test of sealed sources it is determined that the sealed source is leaking from its protective cover, then the sources made safe where this is possible an the room must be locked. The URPO must be notified as soon as practicable who will arrange for disposal of the source.
Fire	In the event of a fire in a room with sealed sources, evacuate the room (helping any injured person out of the room), activate the fire alarm to evacuate the building. Call the Fire Service on 999 or 112 and tell them there is a fire and that the fire is in a room with radioactive materials. Wait for the fire service to arrive and then give details of the incident. Notify the URPO and DRPS and Head of School about the fire as soon as possible.
Flood	If the flood can be easily stopped, it should be. If there is a flood in a room with sealed radioactive sources, evacuate the room. Notify the URPO, DRPS and Building Safety Co-ordinator during normal working hours. Call Security and Response if out of hours.

2.6 **Dose Estimation after an Incident/Emergency**

The University RPO will make an estimation of the dose a person may have received for any incident. This dose will be determined from information in Appendix 12, measuring the site with a compensated GM dose rate meter, the amount of counts identified at the incident as well as whole radiation dosimeter badge readings and if available finger badge radiation dosimeter badges. This will be part of the incident investigation.

An investigation of any incident which is liable to have caused a person to have been exposed to a dose of 0.5 mSv/2month period or having been exposed to a dose greater than 7.5 μSv/hr will be investigated and a formal written report produced and kept for 30 years.

3. Work Instruction 03 - Records

The following describe the records which must be kept for the Ionising Radiations Regulations 2017 and the Environmental Authorisations (Scotland) Regulations 2018 as well as for transport regulations

	Record	Who Keeps Records	Minimum Time Record to be Kept
1	Appointment of Radiation Protection Adviser, Radiation Waste Adviser and local Radiation Protection Officer and Radiation Protection Supervisors	University Radiation Protection Officer	Kept while person is appointed and then for 5 years afterwards
2	A copy of the Permit issued by SEPA under the Environmental Authorisations (Scotland) Regulations 2018 must be posted in all work areas where radioactive materials are stored, used and disposed.	School/Unit responsible for posting certificates	5 years after Permit has been modified or revoked
3	A relevant HSE Consent, or Registration or Notification for work will be posted in all relevant work areas. Replaced when there is a modification or revokation.	School/Unit responsible for posting certificates	5 years after Permit has been modified or revoked
4	A risk assessment must be produced and kept for all work with ionising radiations. These project based risk assessments and general risk assessments must be kept while project work continues. Also, the generic work practice risk assessments for the Ionising Radiations Regulations also must be kept for the time the documents are valid plus 10 years after they have been revoked or revised	University Radiation Protection Officer Responsible for maintaining systems. Staff in Schools/Units responsible for keeping records	For at least 5 years after the risk assessment has been modified or revoked
5	A record of the arrival of any radioactive materials and also testing for leakage from the radioactive source	Schools/Units responsible for keeping records - Record on RadProt	5 years
6	Use of radioactive materials (date and user)	Users of radioactive materials - Record on RadProt	5 years
7	Disposal of radioactive materials (either as solid or liquid waste)	Users of radioactive materials - Record on RadProt	5 years
8	Notification of the loss or theft of a radioactive source - Notification to SEPA and HSE and Police Scotland	University Radiation Protection Officer	10 years after report made to enforcement authorities (or as required by enforcement authorities eg for prosecution)
9	Contamination monitoring of surfaces records	Users of radioactive materials	3 years
10	Calibration of ionising radiation monitors (Geiger counters or scintillation counters) records	University Radiation Protection Officer	Annual Checks - Records kept for 10 years
11	Personal radiation dosimeter badge records	Managed by University Radiation Protection Officer	Records kept for minimum of 30 years
12	Where there are Classified Person appointed to work in Controlled Area, medical surveillance records and Radiation Dosimeter Records	Managed by University Radiation Protection Officer	Records kept for a minimum of 30 years

	Record	Who Keeps Records	Minimum Time Record to be Kept
13	Report of radiation dose above investigation level (0.5 mSv)	Managed by University Radiation Protection Officer	Investigation report kept for 10 years
14	Report to Enforcing Authorities for a dose from whole body dosimeter of 6 mSv or above	Managed by University Radiation Protection Officer	Investigation report kept for 30 years
15	Accidents or spillages of radioactive materials	University Radiation Protection Officer	5years after any report and investigation to SEPA and/or HSE
16	Transport or transfer of radioactive sources to another person	University Radiation Protection Officer	10 years after the transfer is complete
17	Inspection and leakage testing of any High Activity Sealed Source (HASS). Report to be sent to SEPA on an annual basis	University Radiation Protection Officer and local School/Unit	2 yearly leakage testing. Annual report to be sent to SEPA Records to be kept for 10 years
18	All sealed sources to be tested for leakage on an annual basis	University Radiation Protection Officer and local School/Unit	Annual Testing Records kept for annual testing while sources at the University plus 10 years after sources disposed
19	X ray critical examination undertaken on commissioning	School/Unit users	Record kept for lifetime of equipment plus 10 years
20	Monthly X-ray equipment inspections (including testing for X ray leakage)	School/Unit users	Kept for 3 years
21	University Radiation Protection Course (Moodle Course and Test)	University Radiation Protection Officer - On Moodle System	Records kept for 5 years after the person has left the University.
22	University Radiation Protection Course - Refresher Course - Every 5 years	University Radiation Protection Officer - On Moodle System	Records to be kept for 5 years after the person has left the University

All records of the risk assessment for the use of radioactive materials and registration of users of radioactive materials as well as the storage, use and disposal of radioactive materials will be recorded on the University's computerised Radiation Management programme called 'RadProt' which can be found at URL: https://portal.st-andrews.ac.uk/radprot/open/ and guidance on its use can be found on the Moodle site at URL: https://moody.st-andrews.ac.uk/moodle/pluginfile.php/711587/mod_resource/content/2/RadProt-Training-2018.pdf

4. Work Instruction 4 - Handling Unsealed Sources

4.1 Prior to starting work

Work Instruction 1 must be fully complied with before work can commence.
Work Instruction 2 must be read.

4.2 Ordering Radionuclides

All orders for radioactive material must be approved in writing by the local DRPS or a named Depute prior to the order being placed

4.3 Receiving Radionuclides

The supplying company must be made aware of the procedure for depositing the ordered radionuclides in the building concerned.
Deliveries must take place in the working week unless specifically authorised by the URPO.
On delivery of a radioactive sources, the package must be immediately taken to the DRPS or a named Depute who will ensure

i. The correct amount of radioactivity has been delivered
ii. There is no contamination of the packaging
iii. The source container is not leaking
iv. The DRPS or a named Depute will then log the source onto the Radiation Management System (**RadProt**)

'RadProt' can be found at URL: https://portal.st-andrews.ac.uk/radprot/open/ and guidance on its use can be found on the Moodle site at URL: https://moody.st-andrews.ac.uk/moodle/pluginfile.php/711587/mod_resource/content/2/RadProt-Training-2018.pdf

4.4 Storing Unsealed Sources

All radionuclide stock solutions must be stored in the laboratory identified for handling stock solutions in a locked refrigerator or storage container. Details of the limits of storage of specific radionuclides in a Supervised Area is given in Appendix 11. Any stock solutions requiring special storage facilities such as a very low temperature must be identified to the DRPS at the time of ordering and suitable arrangements put in place with the agreement of the URPO. If any sources are found to be missing or significant quantities of radioactivity cannot be accounted for, the Head of EHSS must be notified as soon as practicable

4.5 Expectant or Breast Feeding Mothers

Expectant mothers or breastfeeding mothers are strongly recommended to advise their Supervisor and their DRPS so that an appropriate review of the risk assessment of their work can be undertaken to ensure the safety of the foetus and/or new born child. This is particularly important if working with P-32 or Ca-45 where the ratio of foetus to adult dose coefficient is an order of magnitude higher. During lactation the ratio is less than 1 for the foetus for P-32 and approximately 3 for Ca-45 (similar to iodine-125).

4.6 Contamination Monitors

Suitable contamination monitors or equipment to carry out contamination wipe tests must be available before any work starts.

4.7 Workplace preparation (Dispensing radionuclide laboratory)

All work with volatile solutions or solutions where an aerosol may be produced must be carried out in the fume cupboard.

Other work involving simple liquid transfers must be carried out on a tray sitting on a bench covered with Benchkote (absorbent side up).

Prior to starting work carry out a quick contamination survey of the bench or fume cupboard to confirm the absence of contamination. If any is found contact the DRPS immediately (or URPO if he is not available).

All recommended shields (whole body and syringe) identified by the risk assessment must be in place prior to work starting and all required handling tools must be available.

4.8 Workplace preparation (Radionuclide aliquot handling laboratory)

An area in the laboratory or a fume cupboard must be clearly identified using marking tape on the benches and floor as the "Supervised Radiation Area" for this operation.

The bench surface must be covered with benchkote (the absorbent side up) and the work must be carried out on a tray.

No non-radioactive work is to be carried in this area unless an essential part of the work using radionuclides. All equipment not required for the radioactive work must be removed from the area if possible.

4.9 Personal Protection

All persons working in the area must wear a buttoned laboratory coat, disposable gloves, and safety glasses.

Any personal dosimeters issued by the URPO must be put in place prior to starting work. If these are not worn work can not commence.

Appendix 12 shows the potential dose received from spillage of specific radionuclides. From this data, it is imperative that all those using 32P radionuclide labelled materials wear extra long gloves to protect against splashes and spillages on the skin due to the dose received in such circumstances. It should be noted that if gloves become contaminated the potential dose to the skin is still high as the gloves provide little protection against high energy beta beta particles. In the event of glove contamination occurring they should be immediately changed.

No eating, drinking or applying cosmetics (such as lip salve) is allowed whilst wearing PPE.

No mouth operations are allowed (such as pipetting etc).

Disposable gloves must be removed before leaving the area (and replaced as necessary) and laboratory coats must be monitored for contamination, taken off if contaminated and left in the area. Hands must be immediately washed on leaving the area.

At the end of each work session the work area must be checked for contamination as described in Work Instruction 6

4.10 Completion of Work

All contaminated items of equipment must be segregated and decontaminated before being removed from the area.

All radioactive materials must be placed in properly labelled containers and stored in a location approved by the DRPS.

All radioactive waste must be disposed of as identified in Work Instruction 6

4.11 Contaminated Areas

Areas of work that are identified as contaminated must be decontaminated as described in Work Instruction 7. Any contamination greater than occasional spots or localised areas must be brought to the attention of the DRPS immediately. If he/she is not available the URPO must be contacted.

5. Work Instruction 05 - Radioactive Waste.

5.1 Waste Disposal

The disposal of radioactive waste of all physical forms is subject to the conditions of the permit granted to the University by SEPA. The maintenance of records to demonstrate compliance with the terms of the permit is kept on the RadProt radiation management programme. All disposals must be recorded. Any discrepancy in the usage should be brought to the attention of your local DRPS immediately. If there are any questions regarding waste disposal, these should be raised with the local DRPS or the URPO.

All waste disposal on the RadProt system will relate to a specific aliquot of radiation taken. Thus, there must be a 'Cradle to Grave' record of all radioactivity used in the University buildings. 'RadProt' can be found at URL: https://portal.st-andrews.ac.uk/radprot/open/ and guidance on its use can be found on the Moodle site at URL: https://moody.st-andrews.ac.uk/moodle/pluginfile.php/711587/mod_resource/content/2/RadProt-Training-2018.pdf

5.2 Solid Waste

All solid waste must be placed in the red specialist radioactive waste bin in the laboratory provided by our specialist waste contractor (Tradebe). No radioactive waste must be placed in any other waste bin or receptacle. As soon as the disposal into the bin takes place the RadProt program must be updated. When full this bin must be clearly labelled with details of School/Unit, radionuclides contained and approximate activities taken from RadProt

When full the URPO must be contacted and he/she will arrange removal and uplift by Tradebe.

5.3 Liquid Waste (Water Soluble)

Only those sinks or sluices specially designated by the URPO for the purpose and appropriately identified, may be used for the disposal of aqueous soluble liquid waste. Non-designated sinks must not be used under any circumstances.

NOTE: The activity of liquid radioactive waste disposed of to drain in a Building must never exceed the limits set by the University from the SEPA Permit. The disposal log sheet must be checked before a discharge to ensure that the monthly limit will not be exceeded.

Where practicable all liquid aqueous soluble wastes must be diluted with the appropriate carrier before disposal. In many instances this may just be water, but some compounds tend to stick to the surface of the drains, and in this case you will need to use a carrier which will help to take up the available sticking sites so that you are not left with a 'contaminated sink or sluice.

The radioactive liquid should be carefully poured into the sink outlet avoiding the liquid touching the bottom of the sink or the sides of the plug hole.
Sinks should be rinsed before and immediately after the discharge, and sluices must be flushed at least three times - once before and twice after. For all materials other than tritium, the sink or sluice must be monitored after disposal, and any residual activity removed if reasonably practicable. When using significant quantities of 3H, then the sink should be swabbed with a paper filter paper, and this counted in a liquid scintillation counter. If the sink is found to be contaminated further flushing should be carried out.

Care should be taken at all times to avoid splashing occurring by using too powerful water jets from the taps.

As with solid wastes all disposals must be immediately recorded onto the RadProt program.

5.4 Liquid Waste (Organic Solvents)
This mainly concerns the disposal of organic scintillant waste in counting vials though may also include organic solvents used to extract radioactive derivatives. On no account must organic solvents be flushed down a sluice or the drain. All such waste should be stored in appropriate containers e.g. vials with scintillant present should be stored in appropriate plastic drums. The contents of the container should described in terms of the radionuclide(s) present, the total activity in it and the date.

The producer of radioactive liquid organic waste should contact the URPO who will collect this waste and put it into the SEPA Registered store. The waste will then be disposed of by a 'Specialist Contractor'.

Collection of bulk radioactive solvent waste is on a 'As Requested' basis and anyone needing collection should make arrangements with URPO at the time.

5.5 Gaseous Waste
At present, the University does not have a Permit for the disposal of gaseous radioactive wastes. If there is an intention to undertake work requiring this means of disposal, the University would have to get a modification of its Environmental Authorisations (Scotland) Regulations 2018 Permit. Workers who may need such a facility must contact the URPO as soon as practicable before the work is planned to start. Work will not be allowed to proceed until the requisite permit is in place which will limit the amount discharged.

All work will be required to take place in a designated fume cupboard. The fume cupboard must always be operated with an air-flow sufficiently great to ensure the contents cannot leak back into the laboratory - normally a minimum of 0.3-0.5 m/s across the face opening is required. The sash must always be kept clear so that it can be closed in the event of an emergency. It should not be assumed that all fume cupboards have an acceptable discharge point and the one used will have to be agreed with the URPO.

Vials containing any isotope that could release volatile compounds during storage should be vented in a fume cupboard before use on the open bench. This can affect the use of H-3, C-14, S-35 and I-125 labelled material.

6 Work Instruction 06 - Contamination Monitoring

6.1 All work carried out under Work Instruction 4 requires that proper monitoring for contamination be carried out. The detection of low levels of contamination requires that the correct contamination meter or monitoring technique be undertaken to detect it. Contamination monitoring equipment for Beta emitters has a lower energy threshold of detection which means it cannot be used to monitor for Tritium and has a limited capability for Carbon 14. Higher energy Beta emitters can all be monitored for successfully, using a proper technique, with a Beta contamination meter. The use of proper PPE should ensure that personal contamination does not occur but on completion of any work with radionuclides, following the removal of PPE, hands must be thoroughly washed. If working with a Beta emitter suitable for monitoring with a meter they should then be checked for contamination.

6.2 ***Contamination Meters***
All contamination meters should be labelled as working correctly by the URPO or a calibration laboratory at least every 12 months. A record of these checks will be held by both the URPO and the DRPS. If an instrument is out with this period, it must not be used, and it should be immediately reported to the DRPS. Prior to use the battery of the instrument must

be confirmed as being sufficiently charged. The background count on the instrument must also be checked as all measurements are made relative to this background count. If no background counts are detected then it should be assumed that the instrument is not working and a replacement instrument obtained. If the background count is higher than normal the instrument should be taken to another area and the reading confirmed. Again, the instrument should not be used, and a replacement instrument obtained. In either event the instrument should be clearly labelled as faulty and the DRPS informed. The URPO should be informed, and he/she will ascertain the cause and the further actions to be followed.
In the unlikely event that an elevated background reading is demonstrated to be associated with a particular area then the area must be vacated and the DRPS immediately told. If the DRPS is not available, the URPO must be approached directly.

6.3 ***Monitoring for Tritium***

This can only be undertaken by wiping a moistened swab across the surface being monitored and then counting the swab in a liquid scintillation counter. Close to the area of work where it is possible small droplets of liquid may have been deposited then all of the area must be wiped. Away from this area a random wipe covering the area must be made. The area wiped by each swab in this case should not exceed 0.25m^2. When counted a similar swab, moistened but not used should be used to establish the background count. A positive count in excess of three times the background counts per minute from the liquid scintillation counter represents a positive count and decontamination of the area should be undertaken.

6.4 ***Monitoring for Carbon 14***

The most sensitive way of carrying out monitoring for this radionuclide is using the same technique as described for Tritium. If a large area thin end window Geiger counter is available such as a Mini Instrument series 900 meter with an EP15 probe this can be used to monitor a smooth surface. Geiger counters with small area thin end window probes are not suitable for efficient monitoring. Any end cap must be removed from the probe. The probe should be held approximately 3 mm above the surface at a right angle to the surface. It is useful to use the tip of a finger (inside a disposable glove) to maintain the distance across the surface. The direction of monitoring should always be away from the finger so that any areas of high activity are detected before the finger passes over them. The windows of the probes are very delicate and are easily punctured and broken. When moving over a contaminated surface care has to be taken not to contaminate the probe. NO covering can be placed over the probe as even the thinnest plastic film will reduce its sensitivity. The probe must be moved slowly across the surface being measured at approximately 1 cm per second.

6.5 ***Higher Energy Beta emitters.***

These can be successfully monitored using a thin walled Geiger counter as described above for Carbon 14. The monitor with the largest probe available should always be used. (See comment below for scintillation monitor)

6.6 ***Gamma emitters***

If a gamma emitting radionuclide has an energetic beta particle associated with the emission of the gamma ray the most sensitive way of carrying out a contamination survey is often to use a Geiger counter as described above to measure the Beta particle. If an energetic Beta particle is not present a Scintillation Monitor must be used. These are available in relevant departments as a Mini Instruments Series 900 meter with a 44A or 44B probe. It should be noted that both probes, particularly the 44B are sensitive to high energy beta particles from radionuclides such as P-32. This can occasionally lead to misleading identification of the radionuclide producing the contamination. The probes on both instrument are collimated to read through the front face of the detector head so must always be held at right angles to the surface being monitored.

6.7 ***Identification of contamination***

Using an appropriate monitor, check potentially contaminated surface(s) for any radioactive contamination before and after use. All trays and adjacent work surfaces must be monitored and the floor immediately in front of the work area.

Where the counts per second detected is above 3 times background, the surface should be regarded as contaminated and the surface decontaminated using laboratory wipes. If these are not successful it should be reported to the LRPS/DRPS.

If the count rate is more than 40 cps above background this should be immediately reported to the DRPS and the URPO.

6.8 ***Recording of Results***

All contamination monitoring must be recorded on the record sheet in the Appendix 10 to this work instruction. These record sheets must be kept for at least two years after the measurement was made.

7 Work Instruction 07 - Use of unsealed sources by undergraduates

This can only be carried out following a specific risk assessment for the project carried out in conjunction with the URPO and DRPS which will require to demonstrate that the maximum potential dose to the person carrying out the project will not exceed 0.5 mSv. Both internal and any potential external doses must be considered.

Where possible the external dose rate should not exceed 2.5 μSvh^{-1} .

1. Work Instruction 1 must be fully complied with
2. All supervisors must be a registered radiation worker in the University.
3. The student(s) do not require to be registered radiation workers.
4. Students are not allowed to handle stock solutions.
5. Aliquots given to the students must be no greater than required to carry out the experiment.
6. All students must read and sign that they understand Work Instruction 4
7. A suitable explanation of the potential biological hazard must be given by the supervisor.
8. A check must be made, prior to work starting that the student has all the correct PPE.
9. Students must be instructed in the correct way to remove PPE at the end of the work.
10. Students must be supervised at all times when carrying out this work.
11. At the end of the work the supervisor must carry out a full contamination monitoring examination of all work areas.

8 Work Instruction 08 - Use of Small Sealed sources for Teaching

1 Sources can only be used for teaching by a member of the academic staff who has fully complied with Work Instruction 1.

2 When not in use the sources must be securely stored in an identified location which is only accessible by the member of staff concerned or his/her authorised deputy who has also fully complied with WI 1.

3 Although of low activity these sources must always be handled using the tongs provided.

4 Instruction must be issued to all undergraduate students before the experiment is carried out.

5 All undergraduate students must sign that they have read these instructions and agreed to them.

9 Work Instruction 9 - Use of Sources for Luminescence Dating

9.1 General

These sources are sealed sources which are subject to leak testing to ensure they do not leak and produce an internal radiation hazard. The hazard from them is an external hazard. If manipulated or moved by hand they would produce significant skin and finger doses in a very short period of time. They must never be removed from the shielded sample exposure container they are kept in.

The following procedures must be followed.

1. Work Instructions 1 and 2 must always be read and complied with.
2. Only authorised persons are allowed access to the laboratory.
3. All warning signs indicating the presence of radiation sources in the room and the equipment containing them must be maintained and kept clearly visible at all times.
4. Access codes and keys must be kept secure.
5. Local Rules apply in the luminescence laboratory.
6. IRR17 Risk assessment for use of Risø readers must have been read, understood and signed.
7. All sources must be leak tested at least once a year and the record of these tests kept by the DRPS and the URPO.
8. Follow the guidance and best practices for use of the Risø readers set out in the Local Rules and IRR17 risk assessment.
9. The shielding to the sources must never be tampered with.
10. Do not leave the Risø lid open for any length of time.
11. Do not insert fingers into the Elsec Irradiator drawer.

10 Work Instruction 10 - X-Ray Crystallographic Units

10.1 *Introduction*

Particular care is needed in the use of X-ray crystallographic equipment, because the very high dose rates near the target can cause injury in a very short time. An approximation of the dose rate to be found at a distance 'D' cms from the tungsten target of a tube running at 'V' kVp and '1' mA with 1 mm Be filtration is given by the formula:-

$$\text{Dose rate} = 0.5 \times V \times I / D^2 \quad \text{Grays/s}$$

For other targets the expression should be multiplied by Z/74 where Z is the atomic number of the target material.

Typically at 10 cm from a tungsten target with the tube running at 50 kVp and 20 mA, the dose rate in the beam will be approximately 5 Gy/s. Entry into this beam, even if a transient pass through it, will result in a skin burn.

This work instruction applies to commercial X-Ray Crystallographic Units built to conform to IRR17. Any other X ray units are not covered and can not be used without the prior agreement of the URPO after a full risk assessment has been carried out and a work instruction for its use created. All users must be made aware of the significance of warning lights and notices by the DRS before work commences.

10.2 *Procedures*

1. Work Instructions 1 and 2 must be read and fully complied with.
2. All warning notices on entrance doors to the laboratory must be in place.
3. All protective screens around the equipment must be in place and fully closed.
4. All warning lights must be operational.
5. All interlocks on protection screens must be working. If it is possible to by-pass interlocks using a key this key must be kept secure, in the possession of the person authorised to use. If possible, to by-pass interlocks using computer generated instructions, access to this program must be password controlled and only available to the authorised person.
6. A beam stop of suitable material (2-3 mm of lead) should be incorporated into the enclosure if it is possible for the primary beam to strike the wall of the enclosure in the absence of an accessory.
7. Each port or aperture of the X-ray tube housing must be provided with an automatic beam shutter so arranged that it can only be opened when the collimating system, or other apparatus providing adequate shielding, is in place. Any unused ports should be blanked off.
8. The electrical mains supply to the equipment must be provided with an emergency isolation switch near the door leading into the laboratory. This should be coloured red indicator and clearly labelled. It should have a warning notice by its side stating that it must be switched off in the event of a fire. If this is not possible it must be brought to the attention of the URPO.

10.3 *Setting Up*

1. If possible to set up samples and alignment using external controls these must always be used.
2. If this is not possible and interlocks must be by-passed to allow access inside the shielded enclosure only the authorised person(s) are allowed to do this. Machine specific work instructions must be prepared to describe how this can be undertaken. These must be approved by the URPO.

3. The key to allow access to the shielded enclosure must be kept secure and when issued must be signed out and then back into the secure position.

10.4 *Monitoring*

Monitoring equipment should be available in every room where X-ray optics work is done, and monitoring should be carried out –

(a) immediately an assembly is ready for use or after any change to an accessory or enclosure;

(b) immediately before commencing operations that require a permit to work system it is vital to establish the position of any high dose rate areas;

(c) periodically around equipment and enclosures to ensure that the shielding remains effective. (This should be done at least once per month when the set is in use.)

Records of monitoring should be kept for the monthly surveys and at other times whenever any radiation is detected which would indicate investigatory or remedial action to be taken. This record must be of a permanent nature suitable for periodic auditing by the URPO.

A base line survey round the shielded enclosure must be carried out. Any permanent rise in count rate above this base line survey at a point should be assumed to indicate that a fault in the shielding may have occurred. This should be brought to the attention of the DRPS and the equipment not used until he/she confirms that work can proceed.

10.5 *Personal Dosimeters*

The doserates round a totally enclosed X-ray crystallographic unit are so low that personal dosimetry is not required for routine work.

If operations are being performed which require access to the open beam, then whole body and finger personal dosimeters should be worn if thought appropriate and issued by URPO.

10.6 *Incidents*

In the event of a suspected incident occurring involving the use of an X-ray unit the DRPS and URPO must be informed immediately.

18 Geological Samples

A geological specimen is only deemed a radioactive material if it exceeds the specific activities stated in the legislation entitled 'Environmental Authorisations (Scotland) Regulations 2018' (URL: http://www.legislation.gov.uk/sdsi/2018/9780111039014/contents).

If the radioactive geological ore contains natural uranium or thorium then it may be exempt from the Environmental Authorisations (Scotland) Regulations 2018 (see URL: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69357/pb13624-rsl- guidance-110914.pdf) which state that such samples must comply with the General Binidng Requirements for working with radioactivity and be less than the limits set out in the legislation :

The management of a thorium alloy.	(a) The radioactive substances common rules; (b) a thorium alloy must only be disposed of by landfill.

7. The management of a uranium or thorium compound.	(a) The radioactive substances common rules; (b) a uranium or thorium compound which is solid waste must only be disposed of in normal refuse; (c) the total quantity of uranium or thorium in a uranium or thorium compound disposed of from a premises in normal refuse must not exceed 0.5 kilogrammes per week; (d) a uranium or thorium compound which is aqueous waste must be disposed of to a relevant sewer; (e) the total quantity of uranium or thorium in a uranium or thorium compound disposed of from a premises to a relevant sewer must not exceed 0.5 kilogrammes per year.

If a radioactive ore which does not include uranium or thorium, it may be classed as NORM (Naturally Occurring Radioactive Material) material and thus exempt from the Environmental Authorisations (Scotland) Regulations 2018:

Concentration of radionuclides: NORM industrial activities

Radionuclide	Solid or relevant liquid concentration in becquerels per gram (Bq/g)	Any other liquid concentration becquerels per litre (Bq/l)	Gaseous concentration in becquerels per cubic metre (Bq/m^3)
U-238sec	1	0.1	0.001
U-238+	5	10	0.01
U-234	5	10	0.01
Th-230	10	10	0.001
Ra-226+	1	1	0.01
Pb-210+	5	0.1	0.01
Po-210	5	0.1	0.01
U-235sec	1	0.1	0.0001
U-235+	5	10	0.01
Pa-231	5	1	0.001
Ac-227+	1	0.1	0.001
Th-232sec	1	0.1	0.001
Radionuclide	Solid or relevant liquid concentration in becquerels per gram (Bq/g)	Any other liquid concentration becquerels per litre (Bq/l)	Gaseous concentration in becquerels per cubic metre (Bq/m^3)
Th-232	5	10	0.001
Ra-228+	1	0.1	0.01

but if the radionuclides are being purified then it maybe necessary to get an appropriate Permit to hold the ore and to dispose of this ore. If you do propose to purified radionuclides from an ore you must check with the Head of EHSS **PRIOR to starting the work**.

18.1 Decay of Radioactive Ores

The decay of radioactive ores which contain uranium and thorium can produce significant quantities of radon. As a consequence, these ores must be stored in a well ventilated area with limited access. All those wishing to access this area must wear a dosimeter badge at all times.

Regular measurements of the levels of Radon should be undertaken. Radon measurement badges can be obtained through Environmental, Health and Safety Services. If the levels of Radon exceed 300 Bq/m^2, there is then a requirement to put in place measures to reduce this activity.

Due to the potentially high activities of radiation, only those with specialised training may access these ores.

18.2 Risk Assessment for Working With Radioactive Ores

An appropriate risk assessment must be undertaken when working with such ores. This will assess the radioactive hazard as well as potential chemical hazards associated with these agents. Appropriate control measures should then be put in place to protect workers. The prioritisation of the control measures will be:

- Eliminate
- Substitute
- Engineering controls including shielding
- Procedures (eg working at a distance from the source – Dose is proportional to the invers square of the distance from the source)
- Wearing personal protective equipment (this will include the use of gloves and appropriate masks eg PP3 particulate masks to avoid inhaling dust from such ores)

This risk assessment must be shown and signed by all workers to show that they agree to comply with the control measures identified. The supervisor will be the owner of the risk assessment and will be responsible for ensuring the control measures are being applied.

18.3 Dose Limitations

The dose limitations for geological ores are the same as for work with unsealed sources (see section 5). The dose for ores can be worked out very approximately using the following equations

For β Radiation of 0.5MeV and 3 MeV

$$\text{Dose Rate (mGrays per Hour) in air at 10 cm from source} = 800 \times \text{Activity (GBq)}$$

For γ Radiation in the range of 0.1 MeV and 3 MeV

$$\text{Dose Rate (}\mu\text{Grays per Hour) in air at 1m from } \gamma \text{ Source} = 140 \times \text{Activity (GBq)}$$

As an example, for depleted Uranium:

The following table provides an indication of external exposure rates in μSv/h from depleted uranium (Radiation Protection Dosimetry, Delacroix et al 2002 –

Weight of Compound (g)	*External Body Dose (from an open source @30cm)* (μSv/h)	*Hands (contact with stock bottle)* (μSv/h)
1	0.00034	0.026
10	0.0034	0.26
100	0.034	2.6

Shielding must be appropriate (see section 7) thus for gamma radiation heavy metals or dense material like concrete will be needed but shielding for beta radiation will be perspex.

18.4 Purification of Fissile Radionulcides

No work purifying fissile radionulcides from geological ores can start without the approval of the University Radiation Protection Adviser and the Head of EHSS. Thus any experiments which might enrich U-235 will have to be notified to the appropriate authorities. Such purification will require accurate record keeping and will require security plans and approvals before the work can begin.

Fissile material is defined as:

MATERIAL	CATEGORIES	
	I/II	III
1. Plutonium (other than plutonium with an isotopic concentration exceeding 80% in plutonium-238) which is not irradiated	More than 500 grammes	500 grammes or less, but more than 15 grammes
2. Uranium-233 which is not irradiated	More than 500 grammes	500 grammes or less, but more than 15 grammes
3. Previously separated neptunium-237 which is not irradiated	More than 1 kilogramme	1 kilogramme or less, but more than 15 grammes
4. Previously separated americium-241, previously separated americium-242m or previously separated americium-243, which are not irradiated	More than 1 kilogramme	1 kilogramme or less, but more than 15 grammes
5. Uranium-235 in enriched uranium containing 20% or more of uranium-235, which is not irradiated	More than 1 kilogramme	1 kilogramme or less, but more than 15 grammes

MATERIAL	CATEGORIES	
	I/II	III
6. Uranium-235 in enriched uranium containing 10% or more, but less than 20%, of uranium-235, which is not irradiated	10 kilogrammes or more	Less than 10 kilogrammes, but more than 1 kilogramme
7. Uranium-235 in enriched uranium containing less than 10% but more than 0.711% of uranium-235, which is not irradiated		10 kilogrammes or more

8. Irradiated reactor fuel being used, stored or transported within the United Kingdom		Any quantity
9. Irradiated reactor fuel being transported outside the United Kingdom, other than such fuel which, prior to being irradiated, was uranium enriched so as to contain 10% or more, but less than 20%, of uranium-235	Any quantity	
10. Irradiated reactor fuel being transported outside the United Kingdom which, prior to being irradiated, was uranium enriched so as to contain 10% or more, but less than 20%, of uranium-235		Any quantity
11. Other irradiated nuclear material		Any

"enriched uranium" means uranium enriched so as to contain more than0.711% of uranium-235;

"irradiated" and "previously separated" have the meanings given in regulation 3(2) of the Nuclear Industries Security Regulations 2003

Inventories of NORM must be maintained to satisfy 'Euratom' Regulation 302/2005 regulated in the UK by the 'safeguards' division of the Office for Nuclear Regulation (ONR).

If there is a plan to work with such agents, there must be appropriate levels of security which must be discussed with the University Security manager before any work can start.

Appendix 1

Duties of a University Radiation Protection Adviser (URPA)

The scope of advice which the URPA may be called upon to give includes the following:

- Providing the Principal's Office with advice on radiation protection;
- Providing advice and guidance to the University Radiation Protection Service
- Undertake inspections of radiation protection procedures in relevant Schools/Units;
- Identification of 'Controlled' and 'Supervised' areas;
- Designation of any person as a 'Classified person';
- Control of access to 'Controlled Areas';
- Investigation of excessive doses of radiation;
- Contingency and emergency arrangements;
- Hazard survey reports;
- Selection criteria for Departmental Radiation Protection Supervisors and the technical aspects of their work;
- Guidance on the production of 'Local Rules';
- Prior examination of plans for new equipment, installations and processes or modifications which may have a radiation safety implication;
- Prior examination and review of operational procedures, or modifications, having a safety implication;
- Acceptance of new installations, processes and equipment, or modifications, having a radiation safety implication;
- Provide guidance on the provision and maintenance of safety features;
- Provide guidance on the provision, testing and maintenance of Personal Protective Equipment (PPE) and Respiratory Protective Equipment (RPE);
- Establishing monitoring procedures;
- Interpretation and significance of radiation exposures;
- Ratification of new projects;
- Investigation of notifiable incidents;
- Methods of complying with the requirements of the relevant statutory provisions and codes;
- Process applications for and amendments to the necessary Permit for the storage, use and disposal of radioactive materials;
- Such other aspects of radiation safety as the University Court considers necessary or as the URPO advises to be so.

Appendix 2

Duties of the University Radiation Protection Service.

The duties of this service include the following:

- Provide competent advice to Schools/Units on radiation protection
- To ensure continuing compliance with the governing legislation and Codes of Practice and with new directives or instructions issued by the Health and Safety Executive or any other relevant Agency;
- To provide the radiological protection advisory service to all employees of the University working with ionising radiation;
- To produce University Site Specific Local Rules, Work Instructions for Working with Radiation and relevant risk assessment templates for work with ionising radiation;
- To manage the Radiation Management programme RadProt.
- To manage Radioactive materials and X-ray ‘User’ registrations using the RadProt system;
- To ensure that all projects involving radioactivity or X-ray equipment have appropriate risk assessments, can be justified and are appropriately approved
- To provide, as required by the regulations, a structure for the implementation of contingency arrangements in the event of an accident;
- To provide personal dosimeters and arrange for their processing and record keeping to be carried out by an Approved Laboratory;
- To arrange for medical examinations for Classified Workers to be carried out by an Appointed Doctor and ensure proper records re maintained.
- To ensure that all sealed source wipe tests, instrument calibrations and radprot records are up to date and correct, as required by the legislation.
- To provide training in radiological safety through Radiation Protection Courses and providing e-learning training courses for all staff and students
- To arrange for the removal of radioactive waste from Schools/Units and its transport to the appropriate authorised store;
- To ensure that all contamination monitors and dose rate meters are properly calibrated and maintained in good working order;
- To undertake periodic inspections of all areas using radioactive materials and X-ray equipment
- To investigate all significant radiation incidents at the University, and prepare reports on such incidents to the URPA and Principal’s Office.
-

Appendix 3

The Duties of a Departmental Radiation Protection Supervisors (DRPS).

The terms of reference for a DRPS are as follows:

- To provide advice on radiation protection matters to the Head of the School/Unit and all relevant personnel within the School/Unit;
- To liaise with Principal Investigators, Researchers and students within the School/Unit to ensure the School/Unit complies with governing legislation and Local Rules;
- To liaise with the URPA as required;
- To recommend the designation of radiation workers;
- To manage Users and Radiation risk assessments for their School/Unit on the University's Computerised radiation management Programme RadProt.
- Using the RadProt system, to monitor and where necessary manage the storage, use and disposal of radioactive materials in their School/Unit
- Be responsible for approving all purchases of radioactive materials for the School/Unit. Such orders must be recorded on the RadProt system.
- When radioactive sources arrive, it is the duty of the DRPS to check that the source is correct (correct volume, activity, radionuclide ordered) and also to ensure that it has not leaked and contaminated any of the packaging. When the source has been checked, the DRPS should add it to the RadProt system as an active source which can be used by other workers.
- To maintain the records of sealed sources. These records must show the nature and activity of the material, the date of receipt, the place of storage and the method and route of disposal;
- To supply the URPA, whenever requested, with a summary of the current School/Unit holdings of radioactive substances;
- To ensure the annual leakage testing of sealed sources is carried out and to keep a copy of such tests and to supply a copy of such tests to the URPA;
- To arrange for appropriate contamination monitoring to be carried out at regular intervals in designated radiation areas within the School/Unit and to keep records of their results;
- Where necessary, to ensure that relevant workers monitor their thyroids and keep records of such monitoring;
- To arrange for the distribution of personal dosimeters which are issued by the University Radiation Protection Service;
- To draw up and issue 'Systems of Work' to unclassified radiation workers after consultation with the University radiation Protection Service;
- To ensure that the requisite Permit, warning signs and notices are posted;
- In the event of an accident which involves radiation exposure, radioactive contamination or significant release or loss of radioactive materials, the DRPS should take immediate measures as he/she deems necessary and to inform the Head of the School/Unit and the URPS as a matter of urgency.

Appendix 4

Terms of Reference for the Radiation Hazards Management group

The terms of reference for this sub-committee are:

- To monitor and provide policy guidance on the health and safety aspects of the use of ionising and other electromagnetic radiations and radioactive substances within the University;
- To ensure that safe working practices are followed;
- To establish and review a policy for the provision of information, instruction and training in the field of radiation protection;
- To report regularly and submit recommendations to the Principal's Office;
- To draft 'Local Rules' and guidance for the approval of the Principal's Office as and when necessary or desirable;
- To ensure that notifications are submitted to the Health and Safety Executive or the Scottish Environment Protection Agency in compliance with legal requirements;
- Review inspections of workplaces which use radioactivity, other electromagnetic radiations (eg Lasers), Ionising radiations and area where there is a significant magnetic field.
- To consult Scottish Environment Protection Agency (SEPA), Health and Safety Executive and any other enforcement agency as and when necessary or desirable.

Appendix 5

Membership of the Radiation Hazards Management Group

Members

Head of EHSS

URPO

University Radiation Protection Adviser

University Laser Safety Adviser

DRPS - Centre for Biomolecular Sciences

DRPS - Bute Medical Building, School of Biology (Convenor)

DRPS - Gatty Marine Laboratory, School of Biology

DRPS - Sir Harold Mitchell Building, School of Biology

DRPS - School of Chemistry

DRPS - X-ray Equipment in Chemistry and BMS /BSRC Complex

DRPS - School of Geography and Geosciences

DRPS - School of Physics and Astronomy

DRPS - School of Psychology

Convenor - Prof Karen Spencer

Secretary – URPO

Clerk - Mrs Emma Harbour

Appendix 6

University of St. Andrews

Appointment of Departmental Radiation Protection Supervisor

I wish to nominate ....

as the Departmental Radiation Protection Supervisor for the

School/Unit ....

Signed .... (Head of the School)

Date ....

I agree to act as DRPS in accordance with the duties outlined in the University of St. Andrews Local Rules and Guidance for Work with Ionising Radiation

Name ....

Signed ....

I ratify this nomination

Name of URPO ....

Signed (URPO) ....

Date ....

Appendix 7

Duties of a Radiation Worker

The duties of a radiation worker are as follows:

- To ensure their own safety and the safety of others by their actions or omissions when working with ionising radiations;
- To work with due diligence when handling radioactive materials;
- To undertake the University Radiation Protection Course and pass the test on the e-learning Moodle University radiation Protection Course.
- To become registered as a University of St. Andrews radiation worker;
- To be working on a radiation project that has been approved by the URPA;
- To be familiar with the University Site Specific Local Rules, Work Instructions for working with Radiation and relevant risk assessments for work with ionising radiation;
- To be aware of the main chemical and physical properties of any radioactive substance being used;
- To be familiar with the physical properties and biological effects of the radiations generated or emitted;
- To take all necessary precautions to reduce to a minimum work-associated hazards e.g. radiation, fire etc.;
- To make full and proper use of any personal Protective Equipment (PPE) provided;
- To report without delay to the DRPS any known defect in the PPE provided;
- To have available adequate monitoring equipment which they know how to use and can correctly interpret the readings of such equipment;
- To carry out such radiation, contamination and thyroid monitoring as is recommended in the Local Rules and Guidance;
- To submit orders for radioactive materials only to the DRPS for their approval prior to ordering materials;
- To inform the DRPS in advance whenever radioactive substances from a source other than a commercial supplier are to be brought into the School/Unit;
- To wear personal dosimeters in the position stipulated by the University Radiation Protection Service;
- To record the nature and activity of all the radionuclide disposals in the form of (i) Solid and Liquid waste deposited in a designated container (ii) Aqueous Liquid waste discharged via designated sink via the University's Radiation Hazard Management programme RadProt.
- To obtain approval from the URPA, via the DRPS, before transporting any radioactive substances out with the School/Unit;

- To notify the and DRPS before carrying out equipment modifications which may have a radiation safety implication.
- Notify the DRPS as a matter of urgency if there has been any incident involving radioactive materials

Appendix 8

New Worker Registration should be done via the online apply button on RadProt

https://portal.st-andrews.ac.uk/radprot/

Appendix 9

RADIATION CONTROLLED AREA AND EQUIPMENT HANDOVER FORM

Part 1: School/unit – Handover of Controlled Area and Equipment to Company Representative			
SITE:		CONTROLLED AREA / ROOM:	
COMPANY CARRYING OUT WORK:			
REASON FOR HANDOVER:			
IDENTIFY KNOWN HAZARDS WITH CONTROLLED ARE OR EQUIPMENT:			
As an authorised representative of the School/Unit I hereby hand over the controlled area and equipment as above. Information has been exchanged to enable appropriate risk assessment to be made.		Company: As an authorised, and suitably trained, representative of the company, I accept responsibility for the controlled area and equipment. I will work in compliance with my employer's procedures and Local Rules.	
School/Unit Representative:	Signature:	Company Representative:	Signature:
Date:	Time:	Date:	Time:

Part 2: COMPANY REPRESENTATIVE – Handover of Controlled Area and Equipment to School/Unit Please tick all applicable categories of work carried out. See visit / service report for full details.	
Category of Work	Details
☐ Routine Service	
☐ Fault Diagnosis / Repair	
☐ Installation of Part(s)	
☐ Upgrade / Modification	☐ Hardware / ☐ Software
☐ Incident Response	
☐ RPA Inspection	
☐ Exposure Protocol Changes	
☐ Other	
Could this work have implications for radiation safety of image quality?	☐ NO / ☐ YES

If "Yes", tick one or more boxes below that apply. Please refer to the visit / service report for full details.		
☐ Shielding	☐ Interlocks / Exposure termination	☐ Safety features / warning devices
☐ Beam quality / filtration / grid	☐ Collimation / alignment / field sizes	☐ Detector dose / input dose
☐ 1. Equipment is OPERATIONAL following work as indicated above and detailed on the visit / service report.		
☐ 2. Equipment is PARTIALLY OPERATIONAL, but limitations may exist, please refer to visit / service report.		
☐ 3. Equipment is NOT OPERATIONAL and MUST NOT BE USED.		

Part 3: School/Unit – Returning Equipment to Use I confirm that I have been authorised as a competent practice representative ☐
I confirm that the above Company has provided information and that I have reviewed the associated service report (if applicable) and appropriate checks have been carried out in accordance with my employer's procedures ☐
☐ 1. I am satisfied that the equipment is in a satisfactory condition for use.

<table>
<tr><td colspan="4">☐ 2. I am NOT satisfied that the equipment is satisfactory for use.
Reason:
Actions taken:</td></tr>
<tr><td>School/Unit Representative:</td><td>Signature:</td><td>Company Representative:</td><td>Signature:</td></tr>
<tr><td>Date:</td><td>Time:</td><td>Date:</td><td>Time:</td></tr>
</table>

Appendix 10

Contamination Monitoring of Work Surfaces

Work Area / Room Number ....

Date	Name of Worker	Radio-Nuclide	Type of Monitor and serial number	Counts per Second (CPS) (Or Counts per minute for Tritium)		Action if contaminated.
				Before Work	After Work	

Notes: (i). Using an appropriate monitor, check the work surface(s) for any radioactive contamination before and after use.

(ii). Where the count per second detected is above 3 times background, this surface should be regarded as contaminated

Appendix 11

The Maximum Permitted Activity of Unsealed Radionuclides

which may be Stored/Used at One Time.

NOTE: *All radioactivity must be stored in a locked cabinet or room.*

The activity of a radionuclide given under **STORAGE** is the cumulative total and must never be exceeded. The maximum activity of a radionuclide stored in an individual vial must never exceed the activity for that nuclide given under **USAGE.**

Where more than one radionuclide is involved, the **Quantity Ratio** must be used. This ratio is derived from the equation

$$\Sigma \frac{Q_p}{Q_{lim}}$$

Q_p = Quantity of radionuclide present

Q_{lim} = Quantity of the radionuclide specified in this table

NOTE: The quantity ratio must **NOT** exceed 1

STORAGE		USAGE	
Radionuclide	**Supervised Area (MBq)**	**Supervised Area (MBq)**	**Teaching Laboratory (MBq)**
3H	1000	**100**	**20**
14C	**500**	**50**	**10**
22Na	**50**	**5**	**1**
24Na	**50**	**5**	**1**
32P	**50**	**5**	**1**
35S	**500**	**50**	**10**
36Cl	**50**	**5**	**1**
45Ca	**50**	**5**	**1**
51Cr	**500**	**50**	**10**
59Fe	**50**	**5**	**1**
86Rb	**50**	**5**	**1**
125I	**10**	**5**	**0.1**

Appendix 12

University of St Andrews

Dose rates from Spillages of Specific Radionuclides

Tritium

Beta Max	Beta Range	Half Life
0.00568 MeV Mean energy	6 mm in air	12.32 years
0.01859 MeV Max energy		

In Use

- The dose rate from a Tritium Source is effectively zero
- Similarly the skin dose rate from contamination is effectively zero
-

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
1.85 x 10^{-11} $Sv.Bq^{-1}$ – tritiated water	1.8 x 10^{-11} $Sv.Bq^{-1}$ tritiated water	0.00 mSv/h $kBq.cm^{-2}$
4.1 x 10^{-11} $Sv.Bq^{-1}$ – organically bound#	4.2 x 10^{-11} $Sv.Bq^{-1}$ organically bound	
1.85 x 10^{-15} $Sv.Bq^{-1}$ – tritium gas		

It is recommended that an RBE of 2 is applied where significant quantities are used.

Classification.

The maximum quantity of Tritium in a laboratory is 100 MBq for it to be classified as a supervised radiation area. For amounts above this a specific risk assessment must be undertaken to decide on area classification.

Ingested dose from 10 MBq of Tritium is 4.2 10^{-2} mSv

Carbon 14

Beta	Beta Range	Half Life
0.04945MeV Mean energy	24 cm in air	5730 years
0.15648MeV Max energy		

In Use

The external dose rate from operations with Carbon 14 can be considered to be effectively zero

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
5.8×10^{-10} Sv.Bq^{-1} vapour	5.8×10^{-10} Sv.Bq^{-1}	3.24E-1 mSv.h^{-1} kBqcm^{-2}
6.5×10^{-12} Sv.Bq^{-1} dioxide		
8.0×10^{-13} Sv.Bq^{-1} monoxide		

Classification

Based on the worst effective dose coefficients the total quantity of carbon-14 allowed in a supervised laboratory in the University is 50 MBq.

The ingested dose from 2.5 MBq of Carbon 14 is 1.5 mSv

The skin dose with a contamination level of 2.5 MBq/cm^2 over 5 minutes would be 68 mSv.

Sodium 22

Gamma Max	Beta	Beta Range	Half Life
1.275 MeV	0.2158 MeV Mean energy	800 cm in air	2.6019 years
0.511 MeV	1.820 Mev Max energy		

In Use

- The skin dose rate 30cm from a point open source of 1 MBq is 100 μSvh^{-1} .
- The skin dose rate 10cm from a 1 MBq distributed unsealed source is approximately 90 μSv/h
- The finger dose rate holding a 5 ml syringe is approximately 5.5 mSv/h per 1 MBq

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
1.3×10^{-9} $Sv.Bq^{-1}$ - 1μm AMAD	3.2×10^{-9} $Sv.Bq^{-1}$	1.68 $mSvh^{-1}$ $kBqcm^{-2}$

Classification

The maximum activity of Sodium 22 that can be held in a laboratory for it to be considered as a Supervised Area is 5 MBq.

The potential dose following the ingestion 0.25 MBq of Sodium 22 is 0.8 mSv.

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 35 mSv

Sodium 24

Gamma	Beta Max	Beta Range	Half Life
2.754 MeV	0.5539 MeV Mean energy	600 cm in air	14.959 hours
1.369 MeV	4.1449 MeV Max energy		

In Use

- The skin dose rate 30cm from a point open source of 1 MBq is 124 μSvh^{-1} .
- The skin dose rate 10cm from a 1 MBq distributed unsealed source is approximately 150 μSv/h
- The finger dose rate holding a 5 ml syringe is approximately 21.7 mSv/h per 1 MBq

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
2.9×10^{-10} $Sv.Bq^{-1}$ - 1µm AMAD	4.3×10^{-10} $Sv.Bq^{-1}$	2.22 $mSv.h^{-1}$ $kBq.cm^{-2}$

Classification

The maximum activity of Sodium 24 that can be held in a laboratory for it to be considered as a Supervised Area is 5 MBq.

The potential dose following the ingestion 0.25 MBq of Sodium 24 is 0.1 mSv.

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 46.5 mSv

Note potential finger dose whilst holding syringe.

Phosphorus 32

Beta Max	Beta Range	Half Life
0.694 MeV Mean energy	720 cm in air	14.263 days
1.711 MeV Max energy		

In Use

Dose rate 30 cm from an unshielded source is 1.18 $mSvh^{-1}$ MBq^{-1}

Finger dose rate from 5 ml plastic syringe is 2.39 $mSvh^{-1}$ MBq^{-1}

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Contamination skin dose coefficient
3.2×10^{-9} $Sv.Bq^{-1}$ - 1µm AMAD, medium clearance time	2.4×10^{-9} $Sv.Bq^{-1}$	1.89 mSv/h per $kBq.cm^{-2}$

Classification

The maximum total quantity of Phosphorus 32 in a laboratory for it to be classed as a Supervised area is 5 MBq.

The ingested effective dose following the ingestion of 0.25MBq, is 0.6 mSv

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 40 mSv

Sulphur 35

Beta	Beta Range	Half Life
0.0487 MeV Mean energy	30 cm in air	87.51 days
0.1671 MeV Max energy		

In Use

The dose rate 30 cm from an unshielded source is effectively zero.

Similarly, the dose rate to the fingers when handling a 5 ml syringe is also almost zero from the bremsstrahlung produce when the Beta particles are stopped.

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
1.3 x 10^{-9} $Sv.Bq^{-1}$ - 1µm AMAD, medium clearance time, inorganic	1.9 x 10^{-10} $Sv.Bq^{-1}$ inorganic	3.54E-1 $mSvh^{-1}$ per $1kBq.cm^{-2}$
1.2 x 10^{-10} $Sv.Bq^{-1}$ - vapour, organic	7.7 x 10^{-10} $Sv.Bq^{-1}$ organic	

Classification

The maximum activity of Sulphur 35 that can be held in a laboratory for it to be considered as a Supervised Area is 50 MBq.

The potential dose following the inhalation of 2.5 MBq of inorganic Sulphur 35 is 3.3 mSv.

The skin dose from 2.5 MBq deposited on 1 cm^2 for 5 minutes is 74 mSv

Chlorine 36

Beta	Gamma	Beta range	Half Life
0.335 MeV Mean energy	0	150 cm in air	3 E+5 years
0.710 MeV Max energy			

In Use

The dose rate (skin) 30cm from a point open source is 100 μSvh^{-1}

The dose rate (skin) 10cm from a 1 MBq distributed unsealed source is approximately 10 μSv/h

Finger dose rate holding a 5 ml syringe with 1 MBq of Chlorine 36 in it 500 μSvh^{-1}

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
6.9 x 10^{-9} $Sv.Bq^{-1}$ - 1μm AMAD medium absorption	9.3 x 10^{-10} $Sv.Bq^{-1}$	1.78 $mSv.h^{-1}$ $kBq.cm^{-2}$

Classification

The maximum activity of Chlorine 36 that can be held in a laboratory for it to be considered as a Supervised Area is 5 MBq.

The potential dose following the inhalation 0.25 MBq of Chlorine 36 is 1.7 mSv.

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 64 mSv

Calcium 45

Beta	Gamma	Beta range	Half Life
0.0772 MeV Mean energy	12.5 keV	150 cm in air	162.67 days
0.2568 MeV Max energy			

In Use

The dose rate 30cm from a point open source is negligible.

The dose rate 10cm from a 1 MBq distributed unsealed source is approximately 10 µSv/h

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
2.7×10^{-9} $Sv.Bq^{-1}$ - 1µm AMAD	7.6×10^{-10} $Sv.Bq^{-1}$	8.4E-1 $mSv.h^{-1}$ $kBq.cm^{-2}$

Classification

The maximum activity of Calcium 45 that can be held in a laboratory for it to be considered as a Supervised Area is 5 MBq.

The potential dose following the inhalation 0.25 MBq of Calcium 45 is 0.7 mSv.

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 17.5 mSv

Chromium 51

Gamma	Half Life
0.3151MeV Mean energy	27.7 days
0.320 MeV Max energy	

In Use

- **In Use**
- The dose rate 30cm from a point open source is negligible.
- The dose rate 10cm from a 1 MBq distributed unsealed source is approximately 0.2 µSv/h
- The finger dose rate holding a 5 ml syringe is approximately 90 µSv/h per 1 MBq

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
3.1×10^{-11} $Sv.Bq^{-1}$ 1µm AMAD, medium clearance time	3.8×10^{-11} $Sv.Bq^{-1}$	1.49E-2mSv.h^{-1} kBq.cm^{-2}

Classification

The maximum activity of Chromium 51 that can be held in a laboratory for it to be considered as a Supervised Area is 50 MBq.

The potential dose following the ingestion of 2.5 MBq of Chromium 51 is 9.5 µSv.

The skin dose from 2.5 MBq deposited on 1 cm^2 for 5 minutes is 0.3 mSv

Rubidium 86

Beta	Gamma	Beta range	Half Life
0.830 MeV Mean energy	1.08 MeV (91%) 698 keV (9%)	150 cm in air	18.64 days
1.774 MeV Max energy			

In Use

The skin dose rate 30cm from a point open source of 1 MBq is approximately 110 μSv/h.

The skin dose rate 10cm from a 1 MBq distributed unsealed source is approximately 100 μSv/h

Finger dose rate holding 5ml syringe 24 $mSvh^{-1}$ per MBq

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
9.6×10^{-10} $Sv.Bq^{-1}$ - 1μm AMAD medium uptake	2.8×10^{-9} $Sv.Bq^{-1}$	1.89 $mSv.h^{-1}$ $kBq.cm^{-2}$

Classification

The maximum activity of Rubidium 86 that can be held in a laboratory for it to be considered as a Supervised Area is 5 MBq.

The potential dose following the ingestion 0.25 MBq of Rubidium 86 is 0.7 mSv.

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 39 mSv

Iodine 125

Gamma Max	Half Life
0.035 MeV	59.4 days

In Use

The skin dose rate 30cm from a point source is approximately 0.4 μSvh^{-1}

The dose rate 10 cm from a 1 MBq distributed unsealed source is 1.5 μSvh^{-1}

The finger dose rate holding a 5 ml syringe is 62 μSvh^{-1} per MBq

Effective Dose Coefficients

Inhalation coefficient	Ingestion coefficient	Skin dose coefficient
5.3 x 10^{-9} Sv.Bq^{-1} - 1μm AMAD	1.5 x 10^{-8} Sv.Bq^{-1}	2.1E-2 mSv.h^{-1} kBq.cm^{-2}

Classification

The maximum amount of Iodine 125 that can be held in a laboratory for it to be classed as a Supervised area is 5 MBq

The potential dose following the ingestion of 0.25 MBq of Iodine 125 is 4 μSv

The skin dose from 0.25 MBq deposited on 1 cm^2 for 5 minutes is 0.4 mSv

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Version number	Purpose / changes	Document status	Author of changes, role and school / unit	Date
v1.0	New Document	Approved	Dr Paul Szawlowski	12/07/2021