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Health and Safety

Ionising Radiation

Policy & Guidance

SAF-POL-RAD

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The Health and Health & Safety Department will maintain the official version of this document. Before referring to any printed copies, please ensure that they are up-to-date.

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Management of work with ionising radiation at the University of Nottingham

1. Introduction

University policies establish standards and expectations for health and safety across the organisation and set the minimum standards expected.

Each working unit, which may be a Department, Site, Institute or School and will be referred to as a Business Unit in this policy, can produce its own arrangements, in order to locally implement these standards. Any standard(s) imposed at a local level must meet all requirements set out in this policy. Where there is a discrepancy, the University policy takes precedence.

2. Policy Statement

For work with ionising radiation, the University will implement arrangements to minimise the risks generated by its work activities. Radiation protection duties are imposed upon the University by:

- The Ionising Radiations Regulations 2017 (IRR17)
- The Environmental Permitting (England and Wales) Regulations 2016 [as amended 2018] (EPR16) and Environmental Permits issued in accordance with those regulations.
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG09) and related legislation.
- Commission Regulation (Euratom) No 302/2005 of 8th February 2005 on the application of Euratom safeguards (Euratom)
- Radiation (Emergency Preparedness and Public Information) Regulations) 2019 (REPPIR19)
- The Ionising Radiation (Medical Exposures) Regulations 2017 (IRMER17)

The objectives of the University's radiation protection arrangements are that:

a. All work with ionising radiation can be justified by the fact that the scientific benefits of carrying out the work offset any significant risks associated with it.
b. The significant risks of exposure to ionising radiation arising as a result of the University's routine work activities and reasonably foreseeable incidents are suitably assessed and then controlled by appropriate radiation protection arrangements; ensuring that resulting radiation exposures are restricted so far as reasonably practicable and at all times below any legal exposure limits.

c. The quantities of radioactive material in use and the quantity of radioactive waste generated as a consequence of that use are minimised by the adoption of Best Available Techniques (BAT) and that the chosen waste disposal option constitutes the best environmental option.
d. All relevant legislative requirements are met and can be demonstrated where appropriate by the provision of necessary records.

This Policy documents the University's organisational structure and responsibilities to achieve the required standards of radiation protection and radioactive waste management. Ultimate responsibility for compliance with health and safety and environmental statutes remains with the University.

This document is prepared by the Health & Safety Department in consultation with the appointed Radiation Protection Adviser (RPA) and Radioactive Waste Adviser (RWA) and others throughout the University. It will be subject to a formal review at intervals not exceeding three years and otherwise as necessary in the event of changes in legislative requirements or University Policy.

3. Associated Documents

A number of pro forma documents are referenced throughout this management system which will assist in compliance with the relevant legislation and University policy. These pro forma are all given the prefix 'IR' and are listed below.

IR001: RPS appointment letter

IR002: SRPS appointment letter

IR003: New project proposal / Justification of work

IR004: Authorisation of work

IR005: Authorisation to obtain new or replacement closed sources or radiation generating equipment

IR006: Moving a source of ionising radiation within the University

IR007: Radiation worker registration

IR008: Decommissioning

IR009: Radiation risk assessment (blank)

IR010: Radiation risk assessment (unsealed sources)

IR011: Radiation risk assessment (sealed sources)

IR012: Radiation risk assessment (x-ray generators)

IR013: X-ray monthly safety check sheet

IR014: Guidance local rules template

IR015: Radiation worker training syllabus and record

IR016: Laboratory awareness training record

IR017: Co-operation between employers agreement

IR018: Classified persons appointment letter

IR019: Formal investigation report

IR020: Declaration of pregnancy

IR021: Routine contamination monitoring

IR022: Contingency plan investigation

IR023: Leak test certificate

IR024: Open source dispensing record sheet

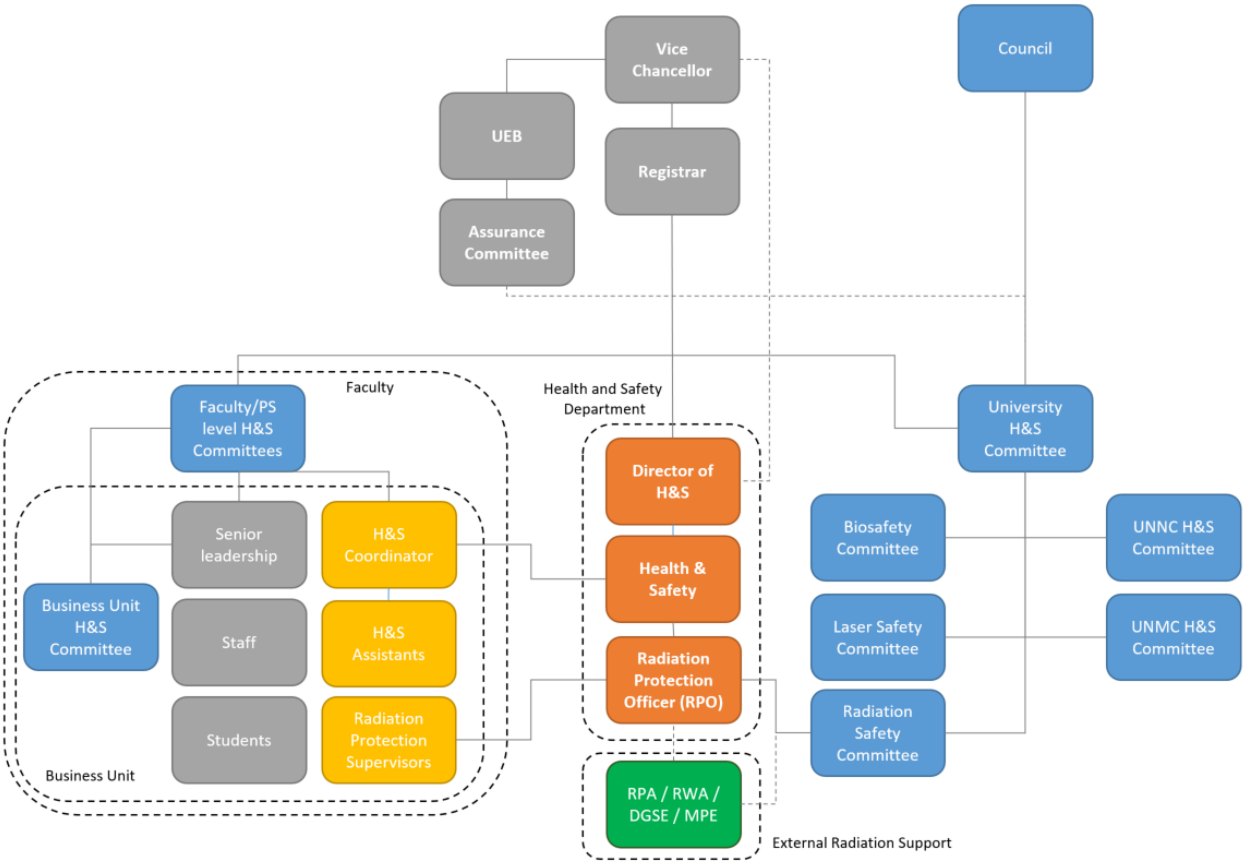
IR025: Waste disposal record sheet

IR026: IR(ME)R Appointment Letter

IR027: Sealed source accountancy record

IR028: Equipment Handover Form

4. University Management Structure



5. Key roles and responsibilities

In order to satisfactorily implement the management system, individuals and bodies are assigned particular responsibilities and duties as outlined below, with responsibility for complying with University policies and with relevant legislation.

5.1. Vice Chancellor

The Vice Chancellor holds overall accountability for compliance with legislation and ensuring the required resources are available to implement and maintain the University radiation protection management system.

5.2. Director of Health and Safety

The Director of the Health and Safety is responsible for carried out by the Health & Safety Department. Specifically, for work with ionising radiation, the Director will:

5.2.1 Promote the adoption of appropriate a University-wide radiation protection management system for work with ionising radiation.

5.2.2 Oversee the preparation, maintenance and distribution of University-wide radiation protection documentation.

5.2.3 Oversee the work of the Radiation Protection Officer (RPO).

5.2.4 Act as the University's principal point of contact with Regulators (although the Director may be represented by the RPO) and arrange for statutory reporting of incidents or accidents.

5.2.5 Manage the Health & Safety Department's budget, including a component for radiation protection expenditure.

5.3. Radiation Protection Officer

The Radiation Protection Officer (RPO) is appointed by the University to advise the heads of departments, committees and senior management on radiation protection and compliance with relevant health and safety and environmental legislation concerning the University's work with ionising radiation. The RPO reports to the Director of Health and Safety and is supported by the University's external Radiation Protection Adviser (RPA) and Radioactive Waste Adviser (RWA), Radiation Protection Supervisors (RPS), radiation workers, contractors etc. The role of the RPO includes:

5.3.1 Maintaining University-wide radiation protection documents and preparation of new or revised documents. Provision of draft safety documentation for adoption by departments.

5.3.2 To provide advice and assistance to departments on day-to-day ionising radiation safety issues and to advise on the keeping and use of radioactive material and the accumulation and disposal of radioactive waste in order to secure compliance with Permits issued under EPR16.

5.3.3 To make arrangements for the keeping of central records of the work with ionising radiation carried out by departments and those who carry out that work.

5.3.4 To provide or direct radiation protection training for radiation workers and for those who supervise them.

5.3.5 To undertake a planned programme of departmental inspections and audits, producing reports and following up on corrective actions.

5.3.6 To carry out investigations of accidents and incidents involving ionising radiation; including the investigation of any notified incident where contingency plans have been implemented to prevent or mitigate significant exposures.

5.3.7 To liaise with relevant external agencies including the Health and Safety Executive (HSE), the Environment Agency (EA), the Office for Nuclear Regulation (ONR), Care Quality Commission (CQC), Nottinghamshire Fire & Rescue Service, and Nottinghamshire Police. This will include making applications for new or revised Permits and making statutory notifications.

5.3.8 To make arrangements for leak tests of sealed radiation sources in the University.

5.3.9 To make arrangements for the testing of radiation monitoring instruments.

5.3.10 Supervising the University's provisions for personal dosimetry. This will include monitoring the arrangements for issue and return of dosemeters; monitoring received doses; and investigation of unusual dosimetry results.

5.3.11 To liaise with the University Occupational Health Service, the Director of Estates and other officers of the University, where appropriate.

5.3.12 To liaise with NHS Trust, where appropriate.

5.3.13 Supervising arrangements for the collection of radioactive waste from departments, its accumulation and ultimate transfer for disposal to contractors; and the keeping of requisite records.

5.3.14 To act as Radiation Protection Supervisor for the University Health & Safety Department.

5.3.15 To carry out such additional radiation protection duties as may be specified, from time to time, by the Director of Health and Safety.

5.3.16 To liaise with the externally appointed RPA, RWA and MPE.

5.4. Head of Department

The Head of Department is responsible for securing compliance within relevant legislation and University Policy within their own department and, where relevant, in relation to work with ionising radiation carried out by departmental staff at other premises. The Head of Department must:

5.4.1 Ensure the provision of adequate facilities and control measures to achieve a safe place of work where risk of exposure to ionising radiation is restricted so far as is reasonably practicable.

5.4.2 Ensure that effective arrangements are in place to manage ionising radiation safety and to control the acquisition and use of radioactive material and the accumulation and disposal of radioactive waste.

5.4.3 Ensure that all individuals with roles or responsibilities for putting the arrangements described above into effect have been made aware of their duties and fully understand them and that those duties are appropriately documented. Arrangements should be in place for routinely reviewing that duties have been satisfactorily performed.

5.4.4 Ensure that those with roles or responsibilities for putting the arrangements described above into effect are provided with adequate training in support of their role and are granted sufficient time and resources to do so effectively.

5.4.5 Appoint sufficient numbers of suitable Radiation Protection Supervisors (RPS) with the duties specified in Section 5.5 and to appoint one of these RPSs as the Senior / Departmental Radiation Protection Supervisor (SRPS) with the additional duties specified in Section 5.6 [see Form IR001, (RPS appointment letter)]

5.4.6 Ensure that all persons working with radiation, supervising that work or otherwise affected by the work with radiation are provided with adequate information, instruction and training in the risks they face within the department and the necessary precautions required to restrict exposures so far as reasonably practicable. This should include attendance at specific University training events and additional department specific training in support of their role.

5.4.7 Where duties necessary for compliance with radiation safety policy and legislative requirements have been delegated to individuals, ensure that individuals have been made aware of those duties and fully understand them.

5.4.8 Ensure that all persons based in the department who are required to work with ionising radiation are registered as radiation workers with the Health & Safety Department in advance of commencing the work.

5.4.9 Ensure that risk assessments are prepared for all work with ionising radiation and that local rules are adopted which document the administrative procedures in place to control any significant risks which cannot be removed by engineering controls.

5.4.10 Formally approve departmental management documents and subordinate radiation protection procedures, including local rules for work with ionising radiation.

5.4.11 Where work with ionising radiation is sufficiently extensive or complex, provide a forum for discussion of radiation matters within the department, attended by RPSs and users alike, effectively coordinating departmental efforts in radiation protection.

5.4.12 Ensure that there is a mechanism in place for internal reporting and investigation of radiation incidents and accidents, and that significant incidents, as specified in Appendix 1, are reported to the University RPO without delay.

5.4.13 In consultation with Departmental and Area/Divisional Safety Officers, ensure that there is a programme of internal inspection and audit of departmental radiation protection arrangements and facilities, and that there are mechanisms for reporting and following up deficiencies and agreed corrective actions.

5.4.14 Consult with the RPO on all matters specified in Appendix 1 of this document and on any other radiation safety matters as required to achieve compliance.

5.5. Radiation Protection Supervisor

To assist them to comply with their radiation safety responsibilities, the Head of Department must appoint sufficient Radiation Protection Supervisors (RPS) with the responsibility of supervising work with ionising radiation to ensure that it is carried out in accordance with the requirements of the departmental local rules. The appointment must be made in writing and notified to the Health & Safety Department. Where multiple RPSs are appointed within a department, the Head of Department should appoint one to act as the Senior Radiation Protection Supervisor (SRPS). In smaller departments with only one appointed RPS, this individual will take on the role as SRPS (see Section 5.6) [see Form IR001, (RPS appointment letter)].

The appointed RPS should be directly associated with the work with ionising radiation such that they are familiar with and able to exercise close supervision of the work, although they do not need to be present at all times whilst the work is underway. The RPS should command sufficient authority and respect from the people within the specific work areas for which they are appointed to enable them to act in a supervisory capacity. The RPS will report on radiation safety matters to the SRPS or directly to the Head of Department as necessary. Should the RPS have concerns over observed standards of radiation protection or radioactive source/waste management, they have the authority of the Head of Department to place restrictions on or prohibit any further work with ionising radiation until these concerns have been satisfactorily resolved. In such cases, the advice of the RPO should be sought.

The number of RPSs appointed will depend on the extent of work undertaken in the department, its range and complexity and on the distribution of work across the department. Sufficient RPSs should be appointed to cover absence, including deputising for the SRPS. The RPSs should be given sufficient time and resources to undertake their supervisory duties. The Head of Department should seek the advice of the RPO on the appropriate number of RPSs.

Prior to undertaking their duties, or as soon as possible thereafter, the appointed RPS will attend a suitable RPS training session provided by one of the University's approved suppliers and any additional specialist training for which they are nominated to ensure they are competent to supervise the work carried out in the department. RPSs are additionally required to attend any further training or periodic update sessions every three years or when there are significant changes to the work or legislation.

Specifically, in fulfilling their supervisory role, where relevant the RPS should:

5.5.1 Maintain close contact with the radiation workers within the area for which they have supervisory responsibility, providing regular visits to the area whilst work is underway.

5.5.2 Confirm in advance of their commencing work with ionising radiation that any new worker has registered with the Health & Safety Department as a radiation worker; has attended a Health & Safety Department radiation safety session or is scheduled to attend the next one; has received information, instruction and training in departmental radiation safety procedures (including the local rules); and has received any additional department-specific training in support of their role, for example training in safe performance of the experiment or protocol.

5.5.3 Provide practical guidance and assistance to users on the actions required to achieve compliance with the local rules and associated radiation safety procedures.

5.5.4 Supervise or assist, where competent to do so, in the implementation of contingency plans designed to restrict exposures in the event of a radiation incident or accident; seeking the advice of the SRPS and RPO as necessary and notifying all significant incidents (as specified in Appendix 1) to the SRPS and/or RPO without delay.

5.5.5 Oversee the ordering of radioactive materials as documented within departmental Standard Operating Procedures (SOPs), ensuring that the departmental or group limits for keeping and use of radioactive material and accumulation and disposal of waste arising from its use can be met and therefore that limit conditions contained in University Environmental Permits will be satisfied.

5.5.6 Supervise the systems in place for performing routine dose rate and contamination measurements, ensuring that suitable records are kept and that appropriate action is taken in the event that levels of contamination or dose rates are found to be higher than expected.

5.5.7 Supervise the procedures for accounting for all open and closed sources from their receipt onto the premises until their ultimate transfer from site or disposal as radioactive waste; ensuring that suitable records are kept of acquisition of radioactivity, quantities held and wastes accumulated and disposed of.

5.5.8 Supervise the procedures for accumulation and disposal of radioactive wastes in accordance with departmental procedures (SOPs and local rules).

5.5.9 Supervise the procedures for periodic testing of any installed engineering controls, safety features and warning devices and to ensure that suitable records are maintained and that necessary remedial action is taken to address deficiencies.

5.5.10 Notify the SRPS and Head of Department of any matters that, in their opinion, necessitate a revision of departmental safety procedures or documentation.

5.5.11 Attend the departmental Radiation Safety Committee and, where relevant, the departmental Safety Advisory Committee and any other meetings convened to address radiation safety matters.

5.5.12 Consult with the RPO on all matters specified in Appendix 1 of this document and on any other radiation safety matters as required.

Any additional duties specified by the Head of Department should be documented on appointment and must not prevent the RPS from carrying out their primary function: to supervise work subject to local rules. Further guidance to departments on the appointment of RPSs is available in the Approved Code of Practice for IRR17.

5.6. Senior Radiation Protection Supervisor

The Head of Department must appoint a Senior Radiation Protection Supervisor (SRPS) responsible for the day to day coordination of radiation protection arrangements within the department, having the Head of Department's authority to take action and to direct others to secure compliance with legislative requirements. In departments with only one appointed Radiation Protection Supervisor, this individual will be appointed as the SRPS. The SRPS will report directly to the Head of Department on radiation protection matters.

The appointment must be made in writing and copied to the Health & Safety Department [see Form IR002, (SRPS appointment letter)].

Whilst the role of the appointed RPS satisfies a legally defined function to supervise that work is carried out in accordance with the local rules, the role of the SRPS is much broader; fulfilling additional administrative duties on behalf of the Head of Department. For example, in addition to fulfilling the supervisory RPS duties, where relevant the SRPS should:

5.6.1 Act as the principal point of contact between the department and the Health & Safety Department and to consult the RPO on all matters specified in Appendix 1 of this document and on any other radiation safety matters as required.

5.6.2 Take necessary action to implement the advice of the RPO including that contained within University policy and guidance documents to achieve a high standard of radiation safety within the department.

5.6.3 Supervise the departmental arrangements for keeping and use of radioactive materials and accumulation and disposal of radioactive waste to secure compliance with Permits under EPR16.

5.6.4 Coordinate the appointed RPSs.

5.6.5 Coordinate arrangements for compliance with University policy on new or refurbished radiation facilities and on cessation of work and laboratory clearance requirements.

5.6.6 Disseminate relevant information to radiation workers such as revised safety documents or matters identified during safety audits or visits/inspections carried by the Health & Safety Department, HSE or the EA.

5.6.7 Submit monthly returns to the Health & Safety Department of purchases, stocks and disposals of radioactivity and any additional periodic or ad-hoc returns relating to the department's work with ionising radiation or inventory of radioactive materials.

5.6.8 Register every person who intends to work with ionising radiation with the Health & Safety Department as a radiation worker in advance of the work.

5.6.9 Coordinate the on-the-job training required by newly appointed radiation workers and authorising, where applicable, suitably experienced individuals to train or mentor them.

5.6.10 Organise access into radiation work areas by cleaners, maintenance engineers, visitors etc. including the requisite exchange of relevant health and safety information and provision of any necessary instruction and training.

5.6.11 Coordinate the issue of radiation dosemeters to relevant staff and return at the end of the wear period to the Health & Safety Department.

5.6.12 Coordinate the submission to the Health & Safety Department of the department's radiation monitoring equipment for annual testing.

5.6.13 Make, or assist in, formal workplace inspections and audits to assess radiation protection standards; making recommendations on remedial action required to improve standards and comply with University policy.

5.6.14 Investigate and report to the RPO incidents and accidents (including near misses) involving ionising radiation.

5.6.15 Consult the RPO as soon as possible after a member of staff working with ionising radiation or who is directly affected by that work declares that they are pregnant or, if they work with open (unsealed) sources, breastfeeding.

5.6.16 In the event that a worker in a radiation area has declared themselves as pregnant, assist the individual's line manager or academic supervisor to undertake an assessment of possible radiation exposures and notify the RPO of the outcome of that review.

It should be noted that although the SRPS may provide advice and guidance to the Head of Department and to others, the role is formally not an advisory one. Formal radiation protection advice under the IRR17 can only be provided by the appointed Radiation Protection Adviser (RPA; see Section 5.9). Similarly, advice on use of BAT in the management of radioactive waste disposals must be provided by the appointed Radioactive Waste Adviser (RWA; see Section 5.10).

5.7. Radiation Safety Committee

Where work with ionising radiation is sufficiently extensive or complex, the Head of Department must convene a departmental Radiation Safety Committee (DRSC) to provide a forum for discussion of radiation matters within the department, effectively coordinating departmental efforts in radiation protection to achieve consistent arrangements across the department. The Committee should be chaired by the SRPS and be attended by RPSs, the Departmental Safety Officer and representative users. The RPO will be invited to attend as necessary. Meetings will be held at least twice per year and additionally as necessary to address specific matters. Minutes will be presented to the Departmental Safety Advisory Committee and the Head of Department. The SRPS will take action to resolve any urgent matters identified by the Committee.

The University must also convene a University-wide Ionising Radiation Safety Committee (IRSC) to provide a forum for discussion of significant radiation matters, effectively coordinating efforts in radiation protection to achieve consistent arrangements across the University. The Committee should be chaired by a senior member of the University management team and be attended by the RPO, SRPSs and Departmental Safety Officer where relevant. Meetings will be held at least twice per year and additionally as necessary to address specific matters. Minutes will be presented to the

University's Safety Advisory Committee and the Director of Health and Safety. The RPO and SRPSs will take actions to resolve any urgent matters identified by the Committee.

5.8. Line manager / academic supervisor

Line managers and academic supervisors must:

5.8.1 Ensure that any staff they are responsible for understand their responsibilities under this policy statement and the departmental radiation safety arrangements.

5.8.2 Ensure that only competent staff who have received appropriate training carry out work with ionising radiation and that any such work can be justified in terms of the scientific benefits balanced against the associated radiation risks.

Specifically, they should:

5.8.3 Nominate individuals intending to carry out justified work with ionising radiation for registration as a radiation worker, and ensure that arrangements are made for staff to receive necessary training.

5.8.4 Consult the RPO and SRPS as soon as possible after a member of staff working with ionising radiation or directly affected by such work declares that they are pregnant or, for work with open sources, that they are breastfeeding.

5.8.5 Ensure that an assessment is carried out of the possible exposures to ionising radiation by a worker in a radiation area who has declared herself to be pregnant and that the RPO is notified of the outcome of that assessment.

5.8.6 Inform the RPO and SRPS urgently in the event of any accident, incident or near miss involving any member of their group or any facility for which they are responsible.

5.9. Radiation Protection Adviser

Where appropriate, appointed RPAs are required to give advice on the observance of IRR17 including:

5.9.1 The requirement Notification, Registration or Consent to carry out work with ionising radiation.

5.9.2 Radiation risk assessments.

5.9.3 Restriction of exposure, including applying the required hierarchy of control measures.

5.9.4 Personal protective equipment (PPE) including respiratory protective equipment.

5.9.5 Maintenance of control measurements and PPE.

5.9.6 Dose limitation for employees and other persons.

5.9.7 Contingency plans.

5.9.8 Information, instruction and training of employees and other persons.

5.9.9 Co-operation between employers.

5.9.10 Designation and management of controlled and supervised areas, including signage and monitoring arrangements.

5.9.11 Selection and use of radiation monitoring equipment.

5.9.12 Provision of local rules and written systems of work.
5.9.13 Designation and monitoring of employees and other persons.
5.9.14 The designation and management of outside workers.
5.9.15 The conduct of any investigations required by IRR17.
5.9.16 Arrangements for the control of radioactive substances, including waste, with regard for any specific requirements under The Environmental Permitting (England and Wales) Regulations 2016 [as amended 2018] and in consultation with any appointed Radioactive Waste Adviser.
5.9.17 Misuse of interference with any source of ionising radiation.
5.9.18 Duties of employees.
5.9.19 Liaison with MPE.

The University has a duty to specifically consult its appointed RPA(s) regarding the following:

5.9.20 The implementation of requirements for controlled and supervised areas.
5.9.21 The prior examination of plans for installations and the acceptance into service of new or modified sources of ionising radiation in relation to any engineering controls, design features, safety features and warning devices provided to restrict exposure to ionising radiation.
5.9.22 The regular calibration of equipment provided for monitoring levels of ionising radiation and the regular checking that such equipment is serviceable and correctly used
5.9.23 The periodic examination and testing of engineering controls, design features, safety features and warning devices and regular checking of systems of work provided to restrict exposure to ionising radiation

The University will provide adequate information and facilities to the appointed RPAs to allow them to provide appropriate and timely advice.

5.10. Radioactive Waste Adviser

Where appropriate, appointed RWAs will be required to provide advice on the requirements of EPR16 with respect to the conditions contained within Environmental Permits issued to the University for the accumulation and disposal of radioactive waste and on good working practices.

In addition, the RWA will be required to provide advice on other key national legislation and regulations, BAT, and environmental monitoring where relevant to the keeping and use of radioactive materials and accumulation and disposal of radioactive waste.

The University will provide adequate information and facilities to any appointed RWAs to allow them to provide appropriate and timely advice.

5.11. Dangerous Goods Safety Adviser (Class 7 dangerous goods)

Where appropriate, appointed DGSA(s) will provide advice on the requirements of CDG09 with respect to the transport of radioactive material (Class 7 dangerous goods). This description of the role does not include advice on the transport of other classes of dangerous goods.

In line with the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), the appointment will include:

5.11.1 Monitoring compliance with CDG09 and associated legislation.
5.11.2 Advising on the carriage of radioactive material.

Where relevant, the DGSA's duties will also include providing advice on the following:

5.11.3 The procedures governing the identification of dangerous goods being transported.
5.11.4 Any special requirements in connection with the dangerous goods being transported.
5.11.5 The procedures for checking the equipment used in connection with the carriage, loading or unloading of dangerous goods.
5.11.6 The proper training of the University employees and the maintenance of records of such training.
5.11.7 The implementation of emergency procedures in the event of any accident or incident that may affect safety during the carriage, loading or unloading of dangerous goods.
5.11.8 Investigating and, where appropriate, preparing reports on serious accidents, incidents or serious infringements recorded during the carriage, loading or unloading of dangerous goods.
5.11.9 The implementation of appropriate measures to avoid the recurrence of accidents, incidents or serious infringements.
5.11.10 The account taken of the legal prescriptions and special requirements associated with the carriage of dangerous goods in the choice and use of sub-contractors or third parties.
5.11.11 Verification that employees involved in the carriage, loading or unloading of dangerous goods have detailed operational procedures and instructions.
5.11.12 The introduction of measures to increase awareness of the risks inherent in the carriage, loading and unloading of dangerous goods.
5.11.13 The implementation of procedures to ensure the presence on board the means of transport of the documents and safety equipment which must accompany transport and the compliance of such documents and equipment with the regulations.
5.11.14 The implementation of procedures to ensure compliance with the requirements governing loading and unloading.
5.11.15 The existence of any required security plan.

The University will provide adequate information and facilities to any appointed DGSAs to allow them to provide appropriate and timely advice.

5.12. Medical Physics Expert

Where appropriate, appointed MPEs are required to give advice on the observance of IRMER17, as it applies to the University, on the following:

5.12.1 Employer Duties.
5.12.2 Identification and appointment of Duty Holders.
5.12.3 Information, instruction and training of Practitioners and other persons.
5.12.4 Selection of equipment used to perform radiation protection measurements.
5.12.5 The acceptance testing of medical radiological equipment.
5.12.6 Radiation protection of the patient.
5.12.7 Production and review of procedural documents.
5.12.8 The conduct of any investigations required by IRMER17.
5.12.9 Dose constraints for Carers and Comforters.
5.12.10 Optimisation of exposures.

The University has a duty to specifically consult its MPE regarding the following:

5.12.11 General compliance with IRMER17.
5.12.12 The preparation of technical specifications for equipment and installation design.
5.12.13 The surveillance of medical radiological installations.
5.12.14 The analysis of events involving or potentially involving accidental or unintended exposures.
5.12.15 Acceptance testing of equipment.
5.12.16 The selection of equipment required to perform radiation protection measurements.
5.12.17 The training of practitioners and other staff in relevant aspects of radiation protection.

The University will provide adequate information and facilities to any appointed MPEs to allow them to provide appropriate and timely advice.

5.13. Employees

All employees of the University have a duty to comply with radiation safety arrangements in place within their department and to take reasonable care of themselves and others who may be affected by their actions. All persons must:

5.13.1 Recognise where they are likely to encounter sources of ionising radiation during their work.
5.13.2 Be familiar with the basic safety precautions relating to ionising radiation.
5.13.3 Recognise that they should not continue in any situation if they feel that they are exposed to a risk to their health and safety that is not being appropriately controlled.
5.13.4 Complete any training for which they have been nominated.
5.13.5 Comply with any local rules, written arrangements or operating procedures relating to work with ionising radiation.
5.13.6 Report any accidents or incidents, including near-misses to their line managers or academic supervisor, and the SRPS.
5.13.7 Be aware of the importance of notifying their line manager or academic supervisor as soon as possible if they are pregnant or breastfeeding.

6. Control of work with ionising radiation

The risks associated with work with ionising radiations and the requirement compliance requires that the University applies suitable and sufficient control over any such work. The following sections document how those controls will be implemented across the University.

6.1. Justification of work with ionising radiation

All work practices involving ionising radiation undertaken at the University are considered to be justified in accordance with the Justification of Practices Involving Ionising Radiation Regulations 2004 without the need for any subsequent consideration of the costs and benefits to society. However, within those categories, it is still necessary to justify any individual piece of work utilising radioactive materials or radiation generators in terms of the scientific benefits balanced against the risks of exposure and generation of radioactive waste. Departments are required to consider the justification of work with ionising radiation on a case-by-case basis.

The following table contains an abridged list of existing classes or types of practice that are currently, and may in the future be, of relevance to the University. Proposed work that is not covered by one of these descriptions may not be carried out without the written authority of the RPO.

Purpose	Classes or types of practice
Production of radioisotopes	Manufacture of radioisotopes using nuclear reactors & accelerators.
Production of radioactive products	Manufacture of radioactive sources, substances & radiopharmaceuticals.
Non-destructive testing	Use of radioactive sources, substances & radiation generators for radiography.
Detection & analysis	Use of sealed sources & x-ray generators for analysis. Use of beta sources for gas chromatography detectors.
Equipment producing ionising radiation incidentally	Use of electron beam welders, electron microscopes, radar, thermionic valves, cathode ray tubes, ion implantation machines & high voltage switchgear.
Radioactive tracers	Use of radioactive tracers for medical or biological techniques.
Medical & biomedical research	Use of ionising radiation in radiography, fluoroscopy, interventional radiography, computed tomography, in-vivo nuclear medicine, in-vitro nuclear medicine, teletherapy, brachytherapy & neutron activation analysis.
Diagnosis & therapy - Veterinary	Use of ionising radiation in radiography, fluoroscopy, computed tomography, in-vivo nuclear medicine, in-vitro nuclear medicine, teletherapy & brachytherapy.
Teaching, including further & higher education & training	Use of radioactive sources, substances & radiation generators
Ionising radiation metrology	Use of calibration sources in the testing of equipment

Purpose	Classes or types of practice
Transport of radioactive material	Transport of radioactive material by road in accordance with ADR

For these existing generic classes or types of practice, the practice includes activities associated with the main purpose of the class or type of practice. This includes, where appropriate, research and development, manufacture, repair, maintenance, supply, assembly, handling, holding, testing (operation and quality assurance), storage, transport (including export and import), decommissioning and waste management, including disposal.

Specifically excluded from the above table are those justified practices involved in medical diagnosis and treatment.

6.2. Authorisation of work with ionising radiation

Authorisation of work helps to ensure that necessary standards will be satisfied and allows the specification of any conditions under which work must be undertaken. Certain legislative requirements must be fulfilled in advance of work commencing, such as notification of work to the HSE; applying for and complying with relevant Notifications, Registrations and Consents; or obtaining EPR16 Permits from the Environment Agency. Consequently, departments should consult the RPO as early as possible when any new work with ionising radiation is being planned in order that these requirements can be fulfilled in sufficient time to avoid delay.

The University Health & Safety Department operates a system of prior authorisation (permission) to undertake work with ionising radiation [see Form IR004 (Authorisation of work)]. Written authorisation must be obtained from the RPO before commencing work. Work with ionising radiation falls into the following broad categories and departments must seek authorisation for each relevant category:

6.2.1 Work with open/unsealed radioactive materials.
6.2.2 Work with closed/sealed sources.
6.2.3 Work with radiation generators.

Before authorisation is granted, departments must implement appropriate measures to comply with the requirements of University policy and the associated requirements of IRR17 and EPR16. In particular, where relevant, departments must be able to demonstrate to the RPO that:

6.2.4 Work with radioactive materials can be carried out in accordance with a relevant University Permit or an exemption condition under EPR16.
6.2.5 The selection of any equipment used for work with ionising radiation will include radiation safety considerations, and its initial installation will be subject to a critical examination sufficient to demonstrate the capability of the equipment to restrict exposures so far as reasonably practicable.
6.2.6 Safe working practices can be adopted, based on a suitable and sufficient radiation risk assessment, to ensure that the exposures of all persons can be restricted as low as reasonably practicable (IRR17 ALARP principle).

The authorisation from the Health & Safety Department will specify any limitations or specific conditions over and above the requirement to satisfy relevant University policies and legislative requirements.

Where authority relates to work with radioactive materials carried out in accordance with an EPR Permit or exemption conditions, the Health & Safety Department will allocate limits on the quantities of radioactivity that can be held within particular departments or accumulated and disposed of as waste. Whilst ensuring compliance with permit conditions, these limits also enable the management of work below any activity thresholds for premises contained within the REPPIR19.

Any proposal to undertake work beyond the scope of the issued Health & Safety Department authorisation forms must be agreed in advance with the RPO and a revised document issued to grant any additional permissions. This includes any proposal to obtain new or replacement closed sources or radiation generating equipment [see Form IR005 (Authorisation to obtain new or replacement closed sources or radiation generating equipment)] or to move any radioactive sources or radiation generating equipment to another department premises or institution [see Form IR006 (Moving a source of ionising radiation within the University)].

6.3. Applications and prior notifications to Enforcing Authorities

Having been notified of the intention to undertake work with ionising radiation or to make significant changes to existing work, the RPO will coordinate all necessary submissions to the relevant enforcing authorities. Specifically, where necessary and in advance of the work commencing, the RPO will notify the HSE or apply for the necessary Notifications, Registrations and Consents to work with ionising radiation, and will make applications to the EA for permits to keep, use, accumulate and dispose of radioactivity on and from University premises. Where necessary applications for environmental permits will include an assessment of the environmental impact of the University's proposed discharges.

6.4. Authorisation of individuals

The University Health & Safety Department administers a system of prior registration of radiation workers [see Form IR007 (Radiation worker registration)]. With the exception of a limited number of work practices specified below, anyone intending to work with ionising radiation on the University premises or on the premises of another employer must complete a registration form and submit it to the Health & Safety Department before work begins. This includes workers visiting the University from other institutions. The registration system enables the Health & Safety Department to maintain a record of those individuals at work with ionising radiation and the specifics of that work, including their dosimetry arrangements. Where relevant, the registration system ensures that any necessary security requirements have been completed before access to sensitive sources, locations or information is granted.

An individual's registration as a radiation worker requires the endorsement of their line manager or academic supervisor, that the proposed work with radiation is justified and supported by their department. The form requires the countersignature of SRPS in the department where the work will

take place and therefore individuals must complete a registration form for each department in which they intend to work with ionising radiation.

Registration is not required in for the use of ionising radiation by students as part of the teaching curriculum under the direct supervision of an RPS.

Persons under the age of 18 will not be registered or permitted to work with ionising radiation unless:

6.4.1 The work is essential for their training.
6.4.2 They will be under the direct supervision of an RPS.
6.4.3 A radiation risk assessment has been carried out in consultation with the RPO, which concludes that effective doses could not exceed 0.5 millisieverts per year (pro rata) under any reasonably foreseeable circumstances.

Persons under the age of 16 will not be engaged in work with ionising radiation under any circumstances.

Where necessary, departments should implement any additional authorisation or limitations on the work an individual can undertake with ionising radiation within the department.

6.5. Optimisation of work with ionising radiation

The University is committed to minimising so far as is reasonably practicable the impact of its work with radioactive materials on the environment and any individuals exposed as a result. This commitment to environmental optimisation is consistent with the conditions of those University Permits authorising the accumulation and disposal of radioactivity, that BATs are adopted to limit the impact of radioactive discharges. To satisfy these conditions, the University is required to have appropriate management systems and relevant controls in place. These should not be disproportionate to the risk and should not conflict with the requirement that occupational exposures are as low as reasonably practicable (ALARP). The University's BAT arrangements for each of its Permitted sites are documented separately.

Departments working with open sources of radioactivity are expected to document practical BAT procedures within local rules and other departmental operating procedures as appropriate. The approach to optimising the radiological impact of work with radioactivity must prioritise minimising the generation of radioactive waste, followed by minimising the effect of any waste unavoidably generated. Procedures should ensure that facilities are properly designed, used and maintained; that appropriate records are kept; and that all persons engaged in the work, its supervision, or the provision of advice and services aimed at achieving BAT are suitably competent. To that end, the concept of BAT and requirements of EPR are included in all compulsory University training sessions for open source users and their RPSs. Training of workers is discussed in greater detail in Section 7.5 of this document. Furthermore, the University has appointed a RWA to provide advice on compliance with EPR permit conditions, including the use of BAT and the requirement for periodic reviews of BAT.

It is implicit to the BAT requirement that the number of locations in which radioactive materials can be held and radioactive waste can be accumulated or disposed of should be minimised and that

appropriate records are kept of those areas. Departments are expected to keep records of the rooms in which work with radioactivity is carried out, including the type of work and details of specific isotopes. The accuracy of this information is essential to the effective control of radioactive proliferation, and an associated record will ultimately be required confirming that any such area has been cleared of all radioactive materials and is free of radioactive contamination on cessation of the work (see Section 6.6).

All proposals for the use of radioactive substances must be carefully considered as part of the risk assessment. Use of radioactivity must only be authorised where it can be demonstrated as justified, and where non-radioactive techniques do not exist or are insufficiently sensitive, restrictively expensive, or unsuitable for other legitimate reasons. In considering the justification of a particular project, the extremely low environmental impact of the University's work should be borne in mind such that any costs incurred to reduce discharges should not be disproportionate.

The radiation risk assessment process should also consider, where practicable, selection of the least radiotoxic substance compatible with the work and the minimum starting activity necessary to achieve the desired scientific outcome with the minimum effect on the environment.

All new or refurbished laboratory facilities and storage areas for the use, accumulation and disposal of radioactivity must be designed and constructed to minimise the generation of radioactive waste, in accordance with the Environment Agency's 'Radioactive Substances Act Guidance (RASAG) Chapter 4 - Generic Issues (Guidance on standards for radiochemical laboratories in non-nuclear premises)' and in consultation with the RPO. Departments should routinely review the standards of existing facilities in meeting current EA expectations. All facilities will be routinely reviewed during periodic RPO audits and remedial advice given as necessary. Departments must ensure that facilities and equipment are maintained.

6.6. Cessation of work with sources of ionising radiation

Before any premises or radioactive work areas are vacated, Heads of Departments must ensure that suitable arrangements are put in place, in good time and with sufficient resources, to ensure that all areas under their control are free of radiological hazards and fit for others to work in. Prior to surrender of EPR permits on cessation of work with radioactivity, the EA will expect confirmation that this has been done [see Form IR008 (Decommissioning)].

Whilst work may not have ceased indefinitely, any laboratory where work with radioactivity is to be suspended should be subjected to the same standard of clearance required [see Form IR008 (Decommissioning)]; specifically ensuring that the area is free of radioactive contamination and that any retained stocks are securely stored and that appropriate records are kept.

7. Protection against ionising radiation

The Ionising Radiations Regulations 2017 (IRR17) came into force on 1 January 2018. They are enforced by the HSE and have been produced in order to ensure that employers engaged in work with ionising radiation (in this case the University) keep ionising radiation exposures of staff ALARP and below relevant dose limits.

7.1. Radiation risk assessments

The University operates a risk-based approach to radiation protection and all measures implemented within departments must be supported by a suitable and sufficient risk assessment. The University, before commencing a new activity involving work with ionising radiation in respect of which no radiation risk assessment has been made by the University already, must make a suitable and sufficient assessment of the risk to any employee and other person. The purpose of undertaking a radiation risk assessment is to identify the measures needed before work starts to restrict radiation exposures and to address all relevant regulatory requirements. The expected format and content is specified within paragraphs 70 and 71 of the Approved Code of Practice for IRR17.

Generic radiation risk assessments for common work activities involving work with ionising radiation are contained in Appendix 2. The generic assessments identify the actions required before work starts to establish management arrangements to restrict radiation exposures so far as reasonably practicable and to address all relevant regulatory requirements, including compliance with legal exposure limits. Therefore, before commencing work with ionising radiation, departments must review the University's generic assessments that are available. In consultation with the RPO, Heads of Department must ensure that all matters identified during this review have been addressed before work is allowed to commence.

The generic radiation risk assessment should also be used as guidance to producing a task-specific radiation risk assessment. A task-specific radiation risk assessment must be completed in each case. IRR17 compliant radiation risk assessment templates are available, which contain further guidance on the process [see Form IR009 (blank]), Form IR010 (unsealed sources), Form IR011 (sealed sources) and Form IR012 (x-ray generators)]. The task-specific radiation risk assessment will consider risks of exposure in greater detail than with the generic assessments. The assessment should assess the exposure risks faced by workers and any other affected persons as a result of routine work and reasonably foreseeable incidents with respect to the work.

This task-specific assessment will inform decisions on practical exposure restriction measures including the procedure, technique, equipment choice, protective equipment and training needs. Such measures could only be considered generically in a University-wide assessment. 'Task-specific' means that the assessment will be relevant to, for example: a particular experimental protocol, device capable of producing x-rays or maintenance procedure.

In the specific case of work involving radioactive materials, the task-specific radiation risk assessment must include the justification to use radioactivity.

An open source assessment must also include a waste stream estimate to determine in advance of work commencing the quantity of radioactive waste that will be generated for disposal via each permitted disposal route (aqueous, solid, organic liquid and gaseous). This advance assessment should guarantee that departmental radioactive waste limits cannot be exceeded under any reasonably foreseeable circumstances. The assessment record should clearly state the estimated percentage of the starting activity of an assay that will pass to each disposal route. Any calculations, measurements and experimental trial runs undertaken in support of the waste stream estimate should be retained for future reference. No protocol must be allowed that would generate radioactive waste for which the department has not been granted authorisation for disposal by the Health & Safety Department.

The process of risk assessment and the specification of protection measures and precautions must also take into account the potential for different types of accident or incident. The consequences of these should be addressed in terms of potential exposure of workers and other persons, and other issues such as radioactive contamination, unauthorised discharges and other possible regulatory breaches. Where such consequences are identified, effective contingency plans must be prepared to deal with them.

Task-specific risk assessments must be reviewed at routine intervals not exceeding 2 years and when there are any significant changes to work practices or legislation. During any routine review, particular attention should be paid to the justification to continue keeping radioactive sources that are infrequently used. Where stocks of radioactive material greater than three years old are to remain onsite, a justification including the testing of the viability of the stock, should be produced by the Principle Investigator and included in the task-specific radiation risk assessment.

Departmental risk assessments should enable departments to identify the actions required to address the requirements of the following sections.

7.2. General principles for restriction of exposure

The fundamental principle of radiation protection is that radiation exposures must be as low as reasonably practicable (ALARP) and departments must take all necessary steps to ensure this requirement is satisfied by complying fully with the requirements of this policy document.

It is the University policy that all radiation hazards should be appropriately identified using radiation warning signs that comply with the Health and Safety (Safety Signs and Signals) Regulations 1996. Once a person has been alerted to the presence of a hazard, practical restriction of exposure is achieved by adoption of basic radiation safety principles: minimising the duration of an exposure; maximising the distance from the source; and the use of appropriate shielding. Health and safety legislation require the adoption of the following hierarchy of control measures to achieve ALARP. Protection is usually most effectively provided by a combination of some or all of the different control methods specified below:

Primarily, wherever practicable, restriction of exposure should be achieved by use of engineering controls and design features (e.g. shielding and containment) and supplemented where appropriate by safety features (e.g. interlocks, warning devices). Where possible all installed devices should be fail-safe.

7.2.1 Engineering controls and design features are those intrinsic safety measures essential to the safe operation of the facility, i.e. work cannot be performed without the control measure in place. Examples where exposure restriction is achieved by engineering control include:

- Constructional shielding around radiation generator installations (e.g. x-ray rooms and accelerator bunkers) and high activity gamma sources (e.g. irradiators) to restrict accessible dose rates outside the facility during use such that access restriction is not necessary.
- Lead shielded hot cells with remote handling tools providing total enclosure of work with high activity gamma emitting isotopes.
- Laboratory design features that take into account the risk of contamination; prevent its spread; and ensure ease of cleaning and decontamination.
- Abatement of short-lived radioactive waste gases by trapping on filters in the exhaust.
- A mechanical interlock device that prevents a source drive mechanism operating when an access door is open.
- Dose rate operated interlock devices preventing access to a radiation enclosure until levels of radiation and contamination have decayed to a safe level.

Examples of additional safety features include:

- A safety interlock device installed on the entrance door to a radiation enclosure that terminates the exposure or closes a beam shutter if an attempt is made to open the door.
- An emergency stop device to immediately terminate a radiation exposure in the event of an incident.
- A key operated control panel or locking-off arrangements to prevent unauthorised or accidental initiation of a radiation exposure.

Examples of warning devices include:

- Exposure indicators (power on; exposure imminent; x-rays on) and audible pre-exposure sirens installed on radiation generating equipment.
- Warning lights providing a visible warning of a reduced level of protection, e.g. if a safety feature is disabled to perform a particular task, such as beam alignment.
- Area monitoring devices providing an audible alarm in the event of a sudden increase in radiation dose rate.

7.2.2 When all possible engineered means have been exhausted, procedural controls in the form of systems of work should be implemented to address any residual exposure risks that remain. These systems of work should be recorded within departmental local rules. Any control measure that relies on an individual making a choice whether or not it should be used is a procedural control, irrespective of whether the protection measure is itself a physical control. If the choice is made not to adopt the control measure, no protection is afforded to the individual. Examples of procedural controls include:

- The requirement within the local rules to use any laboratory safety measures during work with open sources, i.e. source containers, drip trays, bench shields, pipette shields, shielded waste containers etc.
- The specification of additional safety measures during non-routine work that presents greater exposure risks, e.g. x-ray beam alignment with engineered safety features disabled; performance of high activity or high activity concentration iodinations. Such examples would require an additional permit-to-work.
- Documented safe handling procedures for radioactive sources, including the specification of handling tools or local shielding.
- Written arrangements for essential entry into controlled areas during work with ionising radiation to achieve ALARP.
- The specification of monitoring programmes in radiation rooms including specific decontamination procedures.
- The instruction to anaesthetise a veterinary radiography subject to obviate the need for manual restraint.

7.2.3 Lastly, where further restriction can be achieved by its use, personal protective equipment (PPE) should be employed. Where reliance is placed on the use of PPE, its use must be clearly stipulated within the local rules. All PPE must be checked and maintained or replaced as necessary at appropriate intervals. Examples of personal protective equipment include:

- The wearing of laboratory coats, disposable gloves, and protective eyewear in an open source laboratory.
- The wearing of lead aprons during medical and veterinary radiography exposures where it is not possible for staff to leave the room.

7.3. Maintenance and testing of equipment, safety features and warning devices

All departments must have appropriate maintenance and testing schedules in place for any equipment, engineering controls, design features, safety features and warning devices installed for radiation protection purposes. This regime should be implemented for radiation generator installations (x-ray sets and accelerators) and sealed source equipment. The schedule should include safety interlock devices, warning lights and sirens, shutter mechanisms, emergency stop devices, etc. This should be carried out on a monthly based and recorded [see Form IR013 (x-ray monthly safety check sheet)].

Similarly, maintenance and testing schedules should be in place for any equipment essential to the optimisation of work with radioactive materials and compliance with permit conditions; for example, laboratory analytical equipment used for the determination of radioactivity in experimental samples or waste streams; dose calibrators; QA Programmes; macerators, fume cupboards etc.

Routine checks must be made and records kept of the continued operation of any such equipment and appropriate action taken to repair or replace any device that is found not to function as required. Maintenance and testing should be carried out by a competent person, with reference to any relevant manufacturer's instructions. Records must be retained that are sufficient to demonstrate that any such equipment or device has been maintained in an efficient state, in efficient working order and in good repair, and that it has continued to pass routine performance tests.

The format of any test should be documented including the pass/fail criteria. Tests must be made by a competent person using a method that does not expose that person to any significant risks. For example, it is not acceptable under any circumstances to remain within a radiation enclosure at any stage of the exposure sequence to confirm the function of internally situated safety features or warning devices. The advice of the RPO should be sought on a safe method of testing installed control measures.

7.4. Local rules and standard operating procedures

It is University policy that local rules are put in place for all controlled and supervised areas. Every department must implement appropriate written systems of work for all work with ionising radiation to ensure that work is carried out safely and in accordance with the requirements of health and safety and environmental permitting legislation. The RPO should be consulted on the provision of the following:

7.5.1 Local rules containing the key working instructions designed to restrict exposure in the area to which they refer, detailing:

- The work with ionising radiation to which the local rules refer and the areas in which that work may be carried out, including whether those areas are designated as controlled or supervised areas or are not designated (registered areas).
- The practical actions to be taken by registered radiation workers and other persons to restrict exposures so far as reasonably practicable. For work inside controlled areas, local rules should document any special procedures to restrict significant exposures and include access arrangements for non-classified persons to ensure that annual exposures could not exceed 6 millisieverts effective dose, 150 millisieverts extremity dose or 15 millisieverts eye dose.
- For higher risk operations, the arrangements for providing individual authorisation of the work (permit-to-work) and ensuring the satisfactory restoration of normal protection measures on completion of the works, including all engineered safety features and warning devices.
- The contact details of persons with radiation safety responsibilities, including the radiation protection supervisors and RPO.
- Contingency plans to be followed in the event of an incident or accident involving a radioactive source or radiation generator, including any reporting arrangements and the need for a formal record or analysis of events.
- A statement of the University's formal dose investigation level specified in Section 7.12.

Local rules should be specific to a particular work area or laboratory and should address the relevant requirements when working with specific hazards. It is therefore likely to be appropriate in most cases to have separate local rules for open sources, closed sources and radiation generators. Departments must ensure that the local rules are accessible in those areas to which they relate.

[See Form IR014 (guidance local rules template)]

7.5.2 Procedures for controlling work with radioactive materials; detailing:

- The departmental management arrangements for ensuring the adoption of best available techniques (BAT) to optimise the quantity of radioactive substances in use and the quantity of waste being generated as a result. The selection of the most appropriate disposal route for the types of waste generated during experiments should be addressed.
- Controls on acquisition of radioactive materials that guarantee no radioactive material can be brought onto the premises that could place the department in breach of any permit condition or relevant EPR exemption condition or for which the department has not received specific authorisation from the Health & Safety Department. These controls should document the approval process and require verification of the existence of experimental protocols, risk assessments, and (where relevant) waste stream analyses prior to making arrangements to take radioactive material onto the premises.
- The arrangements for taking safe and secure delivery of radioactive materials.
- Precautions to be taken when working with radioactive materials to guarantee their continued security, accountancy, safe handling, maintenance etc.
- Practical arrangements for the accumulation and disposal of radioactive waste on and from the premises, guaranteeing compliance with permit conditions and departmental waste accumulation and disposal limits.
- Whilst local rules (see above) are provided to satisfy a health and safety requirement, it would be appropriate to include practical procedures crucial to ensuring compliance with EPR for ease of reference to radiation workers. Departments may therefore wish to consider this when addressing the above points.

7.5. Information, instruction and training

Personnel must not undertake work where there is a risk of exposure to ionising radiation until they have been provided with adequate information, instruction and training, and are therefore competent to do so in accordance with University and legislative requirements. The level of instruction and training considered necessary for the work with ionising radiation is contained in the training matrix below. Line managers and academic supervisors should ensure that arrangements are made for staff to receive the appropriate training.

Departments are responsible for supplementing that training, having identified the specific needs of individuals commensurate with their departmental role.

The contents of that training should be identified as part of the risk assessment process. However, a suggested syllabus for a department's task-specific training is available [see Form IR015 (Radiation worker training syllabus and record)].

In addition to those persons working directly with ionising radiation, departments should consider the information, instruction and training needs of others associated with or affected by the work, however peripherally. For example, workers who share a laboratory with open source users or who may be required to access an open source laboratory should receive some instruction on the risks in the area and any actions they are required to take to minimize their exposure, particularly in the event of an incident. Others for whom instruction should be provided will include *Goods-In* staff required to take delivery of radioactive packages; laboratory cleaners; building maintenance workers, etc. A suggested format for recording the laboratory awareness training of non-radiation workers available [see Form IR016 (Laboratory awareness training record)].

The core of knowledge covers those topics considered to be the minimum knowledge required for any radiation worker, including information on the risks associated with the work with radiation; the precautions to take; and the importance of complying with procedures. As a result, the University has fulfilled its duty to inform every radiation worker that radiation is hazardous and of the procedures/arrangements put in place to address the significant risks. Additional training sessions are available to cover the required safety arrangements for work with open sources, closed sources and radiation generators. Individuals should attend those sessions which are relevant to their work. Syllabuses for the Health & Safety Department's core of knowledge and topic specific training modules are detailed in Appendices 3 and 4.

Additional training must be provided to workers with extra responsibilities; for example Radiation Protection Supervisors or drivers moving radioactive materials between departments. This is provided by one of the University's approved radiation safety training providers.

Training must be provided in advance of the work commencing and departments must maintain records of the training received by all radiation workers. Refresher training should be provided at appropriate intervals according to need, typically every three years but not exceeding five years. For example, some additional instruction or refresher training will usually be required when a person's duties change or when working procedures are revised. Departments are responsible for the

provision of this training and for the maintenance of appropriate records.

The table below summarises the University's role specific training requirements:

Role	Health & Safety Department training[#]						Departmental training
	Core of Knowledge	Open source module	Closed source module	Radiation generators	Driver module	RPS training	
Radiation worker	✓	✓*	✓*	✓*			✓
Radiation Protection Officer	✓	✓	✓	✓		✓	
RPS / SRPS	✓	✓*	✓*	✓*	✓ *	✓	✓
Drivers of radioactive materials	✓	✓*	✓*		✓		✓
Goods-in staff	✓						✓
Co-workers in radiation rooms							✓
Occasional entrants into radiation rooms, e.g. cleaners							✓
Visitors to the University (not radiation workers)							✓
University visitors to other institutions	✓						

[#] Provided by formal training session or computer-based learning modules

* As appropriate to the work being undertaken or supervised.

7.6. Co-operation between employers

If two or more employers engaged in work with ionising radiation share the same workplace or their work with ionising radiation affects one another, whether on a temporary or permanent basis, they have a legal duty under IRR17 to co-operate with each other.

It is University policy that, where radiation workers will be working elsewhere, or if external workers are being hosted, a 'co-operation of employers agreement' [see Form IR017 (Co-operation between employers agreement)] will be required to ensure that responsibilities for control arrangements such as risk assessment, training, supervision and dosimetry are agreed with the other employer. See also Section 7.33 (Work with other institutions).

7.7. Designation of controlled, supervised and 'registered' areas

Radiation working areas across the University are designated according to the risk of exposure people face when entering them as either controlled, supervised or the University termed 'registered' areas. The safety precautions required in the areas differ. Departments are responsible for the correct designation of areas and must seek the advice of the RPO before doing so. Having designated the area, departments must ensure that appropriate precautions are implemented for work carried out in there. Areas should be designated as follows:

7.7.1 **Controlled areas** are designated when it is necessary for persons to follow special procedures designed to restrict significant exposures in the area, taking into account foreseeable accidents and incidents including the failure of protection measures. Controlled areas must be designated in departments where:

- The accessible external dose rate in the area exceeds 7.5 microsieverts per hour when averaged over the working day.
- A person's hands can enter an area where the dose rate exceeds 75 microsieverts per hour when averaged over an 8-hour period.
- There is a risk of spreading radioactive contamination outside the working area which could lead to significant exposures.
- Access restriction to the area by people unconnected with the work is required on dose restriction grounds. Whilst it is undoubtedly best practice to restrict access to a radiation work area to non-radiation workers, a controlled area need only be designated if this restriction of access is due to foreseeable exposures.
- Effective doses received by persons working in the area could exceed 6 millisieverts in a calendar year; or equivalent doses could exceed 15 millisieverts per year to the lens of the eye or 150 millisieverts per year to the skin or the extremities.
- The dose rate (averaged over a minute) exceeds 7.5 microsieverts per hour and employees untrained in radiation protection are likely to enter that area, unless the only work with ionising radiation involves radioactive substances dispersed in a human body and none of the other above conditions applies.
- The instantaneous dose rate exceeds 100 microsieverts per hour even if the dose rate, when averaged over a working day, is less than 7.5 microsieverts per hour

Having designated a controlled area the Head of Department must exercise appropriate control over the work practices in that area sufficient to achieve appropriate dose restriction, i.e. implement a range of practical precautions including access restriction; display of warning signs; demarcation; radiation and contamination monitoring and the adoption of written procedures in the form of local rules appropriate to the risks of exposure. The advice of the RPO must be sought.

Examples where designation of a controlled area would be appropriate include:

- Radiation stores used for the storage of closed sources or the accumulation of waste arising from work with gamma emitting isotopes, such that the dose rate exceeds 7.5 microsieverts per hour.
- Open source laboratories holding large stocks for use during highly complex protocols or where there are high dose rates (particularly to the extremities) or a

risk of atmospheric release such that particular aspects of the work require the adoption of specific dose restriction measures.
- The interior of an x-ray enclosure large enough for a person to gain access.

7.7.2 **Supervised areas** are designated where the risks of exposure are lower but nonetheless it is appropriate to keep the working conditions in the area under review with a view to designating a controlled area should a change in circumstances require it. Supervised areas should be designated where:

- Effective doses could exceed 1 millisievert in a calendar year; or equivalent doses could exceed 5 millisieverts per year to the lens of the eye or 50 millisieverts per year to the skin or the extremities.

Examples where designation of a supervised area would be appropriate include:

- A teaching laboratory where closed sources are temporarily removed from storage for use in an experiment during which they are subject to continuous supervision, radiation monitoring, local access restriction and source movement records to control exposures.
- A general laboratory used by radiation workers and non-registered workers that contains a dedicated open source workstation used occasionally for simple radiochemical assays. Significant exposures (e.g. those in excess of 1 millisievert per year) may not be reasonably foreseeable during routine work. However, in the event of an accident or incident it may be necessary to implement immediate measures to restrict exposures or to prevent the spread of contamination outside the immediate working area, i.e. it may be necessary to temporarily designate a controlled area and restrict access to the laboratory by the non-registered workers during the remedial work.
- An area used for keeping and use of radioactive sources with an ambient dose rate of more than 2.5 microsieverts per hour.

7.7.3 **Registered areas:** Areas where radiation risks are low but where practical precautions are still required to comply with legislative requirements.

Whilst most controlled and supervised areas are permanently designated, in specific circumstances it may be appropriate to temporarily designate a controlled area; for example, during equipment maintenance procedures requiring installed protection measures to be disabled or defeated. This is permitted provided that the advice of the RPO has been sought and appropriate precautions for controlled areas are implemented. Similarly, temporary de-designation of a controlled area may be appropriate to allow access to the area by, for example, cleaners. However, before an area is de-designated the department are responsible for ensuring that the reasons for its initial designation no longer apply, e.g. sources/stocks are returned to storage and contamination and/or dose rate monitoring (as appropriate) have been carried out to confirm that the area is safe to enter.

More detailed advice on the requirements for designation of controlled areas and the necessary precautions that should be in place is available the Approved Code of Practice for IRR17. Consideration of the requirement for area designation in specific applications is contained in the relevant radiation risk assessments.

7.8. Entry into designated areas

Only individually authorised staff working in accordance with the written arrangements contained within the departmental local rules are permitted to enter controlled areas. To satisfy legislative requirements, the written arrangements must be sufficient that a non-classified radiation worker could not under any reasonably foreseeable circumstances receive an annual effective dose in excess 6 millisieverts; or an annual equivalent dose greater than 15 millisieverts to the lens of the eye or 150 millisieverts to the skin or the extremities.

However, the University's written arrangements should ensure that no registered worker could exceed the relevant University's investigation level (see Section 7.12).

Any person required to enter a controlled or supervised area must receive adequate information, instruction or training on the exposure restriction measures to be adopted inside the area and any specific actions to be taken in the event of an incident or accident. Further details on radiation protection training are contained in Section 7.5.

7.9. Designation of classified persons

The Ionising Radiations Regulations 2017 require the University to designate as a classified person anyone who might receive an effective dose greater than 6 millisieverts, or an equivalent dose greater than 15 millisieverts to the lens of the eye or 150 millisieverts to the skin or extremities, during routine work or reasonably foreseeable incidents. The work with ionising radiation carried out by the University should not ordinarily warrant designation of classified persons but specific cases may arise from time to time and these should be referred to the RPO.

Effective (i.e. whole body) doses are not expected to exceed 6 millisieverts during routine work but occasionally practices might be performed where exposures of this magnitude are possible, including as the result of an accident or incident. Furthermore, work involving the manipulation of higher activity open sources may present risks of exposure high enough to warrant classification of workers on the basis that 150 millisieverts extremity doses are reasonably foreseeable. Doses to the lens of the eye should not approach the relevant 15 millisievert classification threshold if work with penetrating radiations is performed behind appropriate shielded screens and all work with open radioactive sources is performed whilst wearing suitable protective laboratory eyewear to prevent contamination of the eye. However, if a radiation risk assessment does conclude that the dose thresholds for classification could be exceeded, before resorting to the classification of an individual every attempt must be made to reduce potential exposures by the implementation of further protection measures; for example, using shielded pipettes/syringes and automatic dispensers, etc.

Any individuals who are designated as classified persons must have their appointment confirmed in writing [see Form IR018 (Classified persons appointment letter)] by the Head of Department. They

must be informed why they are being classified and receive appropriate information regarding the risks of exposure during their work and any additional training required in support of their role. Classified persons will be subject to a program of occupational medical surveillance coordinated through the University Occupational Health Service and will be provided with suitable dosimetry and dose record keeping by an Approved Dosimetry Service (where approval is granted by HSE); arrangements for which will be made by the RPO.

7.10. Dose limitation

The University must ensure that its employees and other persons are not exposed to ionising radiation to an extent that any dose limit specified in IRR17 is exceeded in any calendar year. The dose limits for different classes of person on detailed below. The limits only relate to exposures received by individuals within that class. The exposure of employees while they are at work is considered separately from any exposure they might receive when not at work with ionising radiation. Therefore, the limits for adult employees will only apply to occupational exposures. Exposures received by an individual while not at work will be subject to the separate limits applying to any other person.

7.10.1. Employees and trainees of 18 years of age or above:

- The limit on effective dose is 20 mSv in any calendar year.
- The limit on equivalent dose for the lens of the eye is 20 mSv in a calendar year; or in accordance with conditions approved HSE from time to time, 100 mSv in any period of five consecutive calendar years subject to a maximum equivalent dose of 50 mSv in any single calendar year.
- The limit on equivalent dose for the skin is 500 mSv in a calendar year as applied to the dose averaged over any area of 1 cm2 regardless of the area exposed.
- The limit on equivalent dose for the extremities is 500 mSv in a calendar year.

7.10.2. Trainees aged under 18 years:

- The limit on effective dose is 6 mSv in any calendar year.
- The limit on equivalent dose for the lens of the eye is 15 mSv in a calendar year.
- The limit on equivalent dose for the skin is 150 mSv in a calendar year as applied to the dose averaged over any area of 1 cm2 regardless of the area exposed.
- The limit on equivalent dose for the extremities is 150 mSv in a calendar year.

7.10.3. Other persons:

- The limit on effective dose for any person other than an employee or trainee referred to above including any person below the age of 16, is 1 mSv in any calendar year. This does not apply in relation to any person (not being a carer and comforter) who may be exposed to ionising radiation resulting from the medical exposure of another and in such a case the limit on effective dose for any such person is 5 mSv in any period of 5 consecutive calendar years.

- The limit on equivalent dose for the lens of the eye is 15 mSv in any calendar year.
- The limit on equivalent dose for the skin is 50 mSv in any calendar year averaged over any 1 cm2 area regardless of the area exposed.
- The limit on equivalent dose for the extremities is 50 mSv in a calendar year.

If it is suspected that an overexposure (dose limit exceeded) has occurred the RPO should be informed immediately.

7.11. Dose assessment and recording

The University will undertake appropriate assessment of the radiation exposures received by those at work with ionising radiation and ensure that records are maintained of those exposures. Where a need for dose assessment has been identified by a risk assessment it will be achieved by provision of suitable personal dosemeters or other means where dosemeters are not appropriate.

Whole body dosimetry must be provided for:

7.11.1 Individuals who work with closed sources or radiation generators where accessible instantaneous whole body dose rates exceed 7.5 microsieverts per hour.

7.11.2 Individuals who work with photon emitting isotopes, including positron emitters, in unsealed forms where accessible instantaneous whole body dose rates exceed 7.5 microsieverts per hour.

7.11.3 Individuals who routinely access controlled areas whilst work with radiation is underway. This dosimetry will be used to demonstrate the effectiveness of written arrangements in restricting worker exposures in the area to less than 3/10 of the relevant dose limit.

7.11.4 Individuals who have been classified on the basis of potential external body exposures.

Where significant exposures can be received in short periods of time, routine passive dosimetry will be supplemented with direct reading and alarming electronic personal dosemeters (EPDs) on the advice of the RPO. Where electronic personal dosemeters are identified as a control measure as part of the radiation risk assessment, the department must set appropriate trigger levels, i.e. the level of cumulative exposure that would warrant a particular course of action, such as cessation of work. Departments must maintain a cumulative log of an individual's EPD records.

Extremity dosimetry should be provided for:

7.11.5 Individuals who routinely dispense using unshielded pipettes from 9.25 MBq (common activity of 'off-the-shelf' phosphorous-32 stock) stocks of high energy beta or positron emitters or manipulate single aliquots of that order.

7.11.6 Individuals who routinely manipulate 50 MBq quantities of photon emitting isotopes (e.g. iodine-131) [other than positron emitters] in single aliquots.

7.11.7 New workers using open sources of high energy beta or photon emitting isotopes, at least initially, to confirm good isotope handling technique.

7.11.8 Individuals who have been classified on the basis of potential extremity exposures.

Eye dosimetry should be provided for:

7.11.9 Individuals who routinely manipulate high activities of highly energetic sources outside shielded enclosures, where a radiation risk assessment estimates that annual exposures greater than 1 millisievert are possible. However, in the first instance, avoidance of exposure should be attempted where practicable using suitable shielded viewing screens. A 10 mm thick Perspex screen will completely absorb the beta/positron emissions from most radioactive sources. The thickness of lead acrylic or lead glass required for effective photon shielding will depend on the energy of emissions e.g. lower energy iodine-125 photons compared to 511 keV PET emissions. Where a risk assessment identifies the potential for significant eye doses, the advice of the RPO should be sought on their mitigation.

Dosimetry will not routinely be provided in the following circumstances:

7.11.10 Individuals working with weak beta emitters (e.g. carbon-14, phosphorus-33, suphur-35) will be discouraged from wearing personal dosimetry. Dosimetry will not be provided for work with tritium.

7.11.11 Individuals who work with equipment (including radiation generators) permanently installed within a suitably shielded and interlocked facility such that instantaneous dose rates during normal operation outside the facility do not exceed 1 microsieverts per hour.

In certain circumstances additional or alternative methods of dose assessment will be appropriate and should be provided, particularly where assessment of intakes is required; for example thyroid monitoring or urine sampling. The choice and implementation should be agreed in consultation with the RPO. Similarly, where no suitable dosemeter exists for the work being performed, the RPO should be consulted on an appropriate means of indirectly assessing exposures.

Arrangements for provision of suitable dosemeters and their subsequent assessment will be made by the Health & Safety Department although departments are responsible for ensuring that issued dosemeters are worn, cared for and then returned for assessment. The RPO will review all received doses and notify departments of significant exposures.

If dosimetry is provided it must be returned within the required timeframe and with the associated return forms. Non-compliance with this requirement could result in radiation work being suspended or stopped by the RPO / RPA.

Dose records for classified person should be kept until the person to whom the record relates has or would have attained the age of 75 years but in any event for at least 30 years from when the record was made. All other dose records should be kept for at least 2 years. All dose records should be checked by the RPO and then disseminated to the relevant RPSs who must make these records available to the persons to whom the records relate.

7.12. Dose investigation levels

To assist in the management of radiation exposures, the University has set a dose investigation level of 1 millisievert effective dose for anyone working with radiation within a calendar year (0.25 millisievert per quarter). It is not considered necessary for anyone to approach this dose as a result of the University's work activities. The purpose of the investigation level is to enable the University to monitor whether radiation exposures are being restricted to a level which is as low as reasonably

practicable (ALARP). If a radiation worker's cumulative exposures exceed the investigation level during a calendar year or if they are likely to, the RPO and departmental representatives (including the worker and SRPS) will undertake an investigation to determine whether exposures are in fact ALARP or whether further dose restriction measures are required. A formal investigation report [see Form IR019 (Formal investigation report)] will be prepared in these circumstances.

The University's investigation level is set at a level which should not be exceeded during well managed operations. It is not appropriate to set a lower level for the whole University, but departments may decide as a result of a risk assessment to set lower *trigger levels* applicable to their own circumstances. However, in doing so, consideration must be given to how those exposures will be monitored, particularly in the absence of dosimetry.

There is no formal legislative requirement to set an investigation level for extremities or the lens of the eye. However, it is appropriate to do so to aid demonstration that exposures are similarly ALARP. The University has set a dose investigation level of 50 millisieverts for extremities within a calendar year for all workers. Similarly, a dose investigation level of 1 millisieverts is appropriate for the lens of the eye. Higher dose investigation levels may be appropriate in specific circumstances and these will be set on the advice of the RPO.

7.13. Dose constraints

Where necessary in the planning of new facilities for work with ionising radiation, the University will specify a design constraint of 1 millisievert on the annual effective dose of any radiation worker and 0.3 millisieverts on the annual effective dose of any other person. This means that the design must ensure that projected exposures of any person during future use of the facility should not exceed these figures.

A foetal dose constraint of 1 millisievert is set as a prospective control for the remaining term of pregnancy following declaration. Departments are required to implement all necessary measures to ensure that the foetal exposures could not exceed 1 millisievert as a result of routine work and reasonably foreseeable incidents. See also Section 7.14.

7.14. Protection of female workers

Departments must make female workers aware of both the potential risk to the foetus caused by exposure of the mother to ionising radiation during pregnancy and subsequently, specifically where unsealed radioactive materials are used, the risk to the nursing infant. Then, once an individual has declared her pregnancy [see Form IR020 (Declaration of pregnancy)], the department must take appropriate steps to restrict the worker's exposure to penetrating radiations or significant sources of contamination.

Departments must take all reasonably practicable steps to restrict exposures of female workers during pregnancy in order to ensure that the exposure of the foetus does not exceed 1 millisievert during the remaining term. However, doing so relies on being informed of the pregnancy or breastfeeding. It is therefore important that female workers are encouraged to notify the department as soon as possible if they become pregnant or are breastfeeding. Once the department

has been notified, suitable controls must be implemented to restrict the equivalent dose to the foetus to less than 1 millisievert during the remaining term of the pregnancy or, in the case of a nursing infant, to remove the potential for significant bodily contamination of the mother.

In most cases, the risks arising from the University's work with ionising radiation are sufficiently low, and this is supported by the University's selected investigation level of 1 millisievert (annual effective dose). Where penetrating external radiations are the relevant hazard, a 1 millisievert dose to the surface of the abdomen is estimated to correspond to a foetal dose of 0.5 millisieverts. Therefore, if the University's investigation level is not exceeded, the foetal dose will not exceed 1 millisievert. However, where intakes are possible and since certain isotopes are preferentially taken up by the tissues of the placenta and foetus, a maternal committed effective dose of 1 millisievert could result in a significantly higher foetal dose. Where intakes are reasonably foreseeable, the advice of the RPO should be obtained.

When notified, the SRPS and the individual's line manager/academic supervisor should undertake a review of the individual's work and potential exposures identified by the supporting risk assessment to determine whether any additional controls are required. Where the work involves open sources, the RPO should be consulted on the review. The RPO should be notified in writing of the outcome of reviews including any protection measures implemented as a result. The worker may approach the Health & Safety Department or the University's Occupational Physician for advice on the risks of exposure or to express any concerns regarding the requirement to notify their department of the pregnancy.

7.15. Monitoring of ionising radiation

Where departments undertake work with open radioactive sources or undertake work with closed sources in controlled or supervised areas, the levels of radiation and/or contamination in and around those areas must be routinely monitored. The monitoring interval should not exceed one month but should be more frequent in most cases. The purpose of this monitoring is to confirm the correct designation of areas and the effectiveness of controls (for example, the controls to prevent the spread of contamination outside an area). The monitoring also serves to identify exposure trends, i.e. whether radiation or contamination levels are rising, which may indicate a deterioration of standards which would warrant investigation.

Levels of x-ray leakage around installed radiation generators (x-ray sets and accelerators) should be routinely monitored at routine intervals [see Form IR013 (x-ray monthly safety check sheet)] using a suitable x-ray detector and checked against baseline values previously determined in consultation with the RPO. These checks should be supplemented at least annually by the performance of quantitative measurements using a suitable dose rate instrument.

In addition to the periodic monitoring described above, radiation workers should ensure that radiation and contamination monitoring is integrated into their standard laboratory procedures. Where appropriate, dose rate or contamination monitoring must be performed as appropriate throughout their work. This monitoring serves to confirm that the procedures are successfully restricting exposures and that they are working in a safe environment.

In the specific case of work with open sources, contamination monitoring should be performed before, during and after experiments involving unsealed radioactive materials and the results

recorded. At the very least, a record [see Form IR021 (Routine contamination monitoring)] should be made to confirm that all work areas used on that occasion are free from radioactive contamination at the end of the session, such that the next person working in the area can be reassured that they will not be exposed to radioactivity generated during someone else's work. Staff must perform personal contamination monitoring before leaving a designated area. In addition, at weekly intervals whilst the work is underway, checks for radioactive contamination should be performed and recorded around every area within the laboratory where contamination is reasonably foreseeable. The purpose of this weekly monitoring is to confirm that the routine monitoring is effective.

Any identified contamination should be promptly dealt with. Significant contamination, such as spread of contamination outside the working area, or personal contamination, should be reported to the RPO. Records should be kept of the actions taken to deal with identified contamination.

Quantitative monitoring records should be kept, detailing the instrument used and the dose rate or contamination levels measured, together with any remedial actions taken. Use of unqualified expressions such as "OK" or simple use of ticks are open to interpretation and should therefore be avoided. Monitoring records should be available for inspection for a period of at least two years after measurements were made. The RPO should be consulted for advice on the practical requirements for radiation monitoring.

The training received by radiation workers within the department must include the selection of the appropriate monitoring method; its limitations; correct monitoring technique; interpretation of results and record keeping. Individuals should also be conversant with the actions to be taken in the event that levels of contamination or dose rates are found to be higher than expected (see Section 7.16).

Departments must provide and maintain sufficient equipment suitable for monitoring purposes and should present the equipment for statutory testing when requested by the Health & Safety Department. All radiation monitors used in controlled and supervised areas must be tested annually by or under the supervision of a qualified person. Instruments which have not been tested within the past year must not be used for monitoring.

7.16. Incident and accident procedures

As part of the radiation risk assessment process, departments must identify and prepare for all reasonably foreseeable incidents that would require immediate actions to restrict exposures or to ensure continued compliance with legal requirements. Those actions should be recorded within the contingency plans in the department's local rules.

Generic contingency plans for reasonably foreseeable incidents identified by the RPO are included within the generic guidance risk assessments (see Appendix 2) although these may not be exhaustive. Departments should review the relevance of those guidance contingency plans to specifically identified incidents and revise and adopt them accordingly. All persons who would to any extent be involved or affected by the implementation of a contingency plan must be provided with adequate information, instruction and training, to ensure that the plan is effectively implemented and exposures suitably restricted when the time comes. Furthermore, departments are required to review and rehearse the arrangements in their contingency plans at appropriate intervals.

Any materials, equipment or documentation required when implementing contingency plans should be readily available to all persons required to put the plan into effect. The purpose of this investigation is to record and analyse events leading to the incident with a view to preventing a recurrence and revising procedures as necessary.

In the event that any part of the contingency plan is put into effect to prevent or mitigate significant exposures, an investigation should be carried out and recorded [see Form IR022 (Contingency plan investigation)] by the department in consultation with the RPO.

On a larger scale, the Radiation (Emergency Preparedness and Public Information) Regulations 2019 place duties on organisations with large inventories of dispersible radioactive materials on the same premises. The regulations address the consequences of an initiating event (e.g. a fire) involving sufficient quantities of radioactive material to lead to significant exposures off site.

By the specification of departmental limits, the University Health & Safety Department effectively limits the quantity of radioactive material that can be held on specific premises such that a "radiation emergency" as defined in REPPIR is not considered to be reasonably foreseeable.

7.17. Notification of incidents and accidents

Individuals should report to their line manager any occurrence which leads to the implementation of a contingency plan contained within the local rules or other safety instructions, or leads them to believe they could have received a radiation exposure significantly greater than expected for the work being undertaken (with reference to projected exposures estimated in the radiation risk assessment). Individuals should also report any deterioration or failure of any installed protection measure that could make such exposures possible. Thorough notes should be made as soon as possible of the circumstances of the incident, including source details, operating parameters, proximity and duration of exposure, and all persons present. A report should be prepared identifying any actions to prevent recurrence. The University Incident Reporting system must be used to report and record all radiation incidents.

Where an exposure is considered likely to exceed the relevant University investigation level, or more generally where a failure of protection measures may have resulted in any increased exposure, the RPO must be notified to investigate the circumstances of the exposure. Failures of protection measures could include failure of a shutter, source mechanism, interlock, emergency stop device, or damage to shielding. The RPO must also be notified in the event of any incident specified in Appendix 1. The RPO will advise on follow-up actions.

7.18. Selection, installation and modification of equipment for use at work with ionising radiation

The selection process for any equipment incorporating a radioactive source or radiation generator must consider the capability of its design and construction to restrict exposures so far as reasonably practicable by the appropriate application of the hierarchy of control measures (see Section 6.2). The RPO's advice should be obtained.

The installation or modification of equipment for use at work with ionising radiation, where that modification could have an effect on the extent of radiation exposures, must be subject to a critical examination to confirm that:

7.18.1 The equipment's safety features, and warning devices are operating correctly; and

7.18.2 The equipment remains capable of restricting exposures as far as is reasonably practicable. Radiation dose rates around the equipment must not exceed 2.5 microsieverts per hour (ideally less than 1 microsieverts per hour) if non-registered workers can gain access to it.

The RPO must be consulted on the need for and the content of any critical examination. The critical examination report must include an assessment of all installed safety features and, where relevant, comprehensive radiation dose rate or contamination measurements.

Any new equipment must be supplied with adequate information about its safe use and any maintenance and testing requirements necessary such that it remains capable of restricting exposures. Any equipment procured for use on patients or volunteers must involve consultation with a MPE as part of the procurement process and before the item is purchased.

7.19. Control of acquisition, receipt and disposal of radioactive substances

Departments must maintain strict control over the acquisition, use and disposal of radioactive materials. This applies equally to source purchases or sources obtained or taken on loan from other departments or institutions. No radioactive material may be brought onto the premises for the first time unless it has been confirmed in consultation with the RPO that:

7.19.1 The source may be held on the premises in accordance with the provisions of the EPR16, being the minimum quantity and most appropriate type of radioactive source required for the work, and are either:

- Covered by an environmental permit to keep and use radioactive material on University premises.
- Subject to conditional exemption provisions within EPR relating to use of the material. Copies of relevant exemptions are available on the Environment Agency web site.
- Completely out-of-scope of EPR. For example: geological specimens; natural samarium isotopes (when not used for their radioactive properties) and potassium-40.

7.19.2 Any radioactive waste arising out of the use of the source, including the waste source itself, can be accumulated and disposed of in accordance with an EPR permit or exemption condition, and that there is an appropriate financial mechanism in place to meet the projected disposal costs.

7.19.3 Arrangements have been made for the continued security of the radioactive material and waste, including any more stringent requirements of counter-terrorist guidelines implemented through EPR. Where the radioactive materials are considered to constitute a significant security risk, this includes arrangements for the security of any information pertaining to the radioactive material.

7.19.4 Other regulatory requirements (e.g. notification to HSE) and the requirements University policy can be met.

7.19.5 Adequate storage facilities are available (e.g. shielding)

For unsealed radioactive materials used routinely by departments the above checks need only be made on the first occasion a source of that type is obtained. On subsequent occasions the department should ensure that orders can only be placed that relate to approved protocols, carried out by registered radiation workers, and that could not result in breach of any EPR permit or exemption condition. At the very least, requests for radioactivity should be made by registered radiation workers and countersigned by an authorised RPS once they are satisfied that the source and any waste generated can be accommodated within permit limits or any lower departmental stock or waste limits imposed by the Health & Safety Department and monitored via IsoStock.

In accordance with the principles of ALARP and BAT, users should only request the type and size of source that is genuinely needed for their programme of work. When approving purchases of radioactive materials, consideration should always be given to whether the material or source is available, suitable and accessible elsewhere in the department or University. Standard operating procedures for acquiring open sources should be documented for reference by radiation workers in addition to any normal procurement procedures.

Request will be processed via the University IsoStock system only. If alternative requests are required, then the RPO should be contacted.

On rare occasions, it may be acceptable to set up a standing order with suppliers for frequent deliveries of the same product; for example, if daily deliveries are required. Standing orders must be arranged in consultation with the SRPS, ensuring that stock and waste levels never exceed departmental or permit limits and that subsequent deliveries can be cancelled by telephone at short notice if stock levels are sufficient. Contingency arrangements should be in place to ensure adequate controls remain in place in the event of absences of key staff.

No closed radioactive sources may be obtained, either permanently or temporarily on loan, without the prior written approval of the RPO. This includes individual closed sources and sources installed within pieces of equipment, such as sample counters.

Whilst radioactive geological specimens (e.g. radioactive rocks and minerals) are completely out-of-scope of environmental permitting legislation, they are nonetheless subject to other legislative controls and written approval must be obtained from the RPO before any radioactive geological specimens are brought onto the premises.

The system for dealing with receipt of radioactive materials onto the premises should be clearly documented and adequate information and instruction given to all persons involved in the process of receiving a source. Departmental arrangements must ensure that:

7.19.6 Delivery is made only to approved locations where authorised and trained persons can take receipt of the package. Training should include the means of identifying radioactive deliveries, particularly when most packages bear no external labels to alert the recipient to the radioactive contents.

7.19.7 Receipt of the package is confirmed by signature.

7.19.8 The package is collected and signed for immediately by an authorised user or RPS for return to the laboratory. If this is not possible, provision must be made for temporary, safe and

secure storage in the receiving area. An up-to-date list of persons authorised by the research groups to collect packages must be provided to the receiving staff.

7.19.9 Any handover of responsibility for the inbound package within the department from the point of receipt to ultimate storage within the laboratory should be confirmed by signature and records kept, at least until the source has been entered into the laboratory's source accounting system.

7.19.10 The SRPS must be notified of the arrival of radioactive materials onto the premises. The SRPS must inform the RPO of the arrival of any closed sources onto the premises.

7.20. Keeping of radioactive materials

All radioactive materials must be held in accordance with the conditions of the relevant permit or EPR exemption conditions. Every radioactive source must be assigned a unique identifier and placed under the control of a named RPS within the department. Appropriate source records must be kept from the point of receipt to ultimate disposal of the source.

When they are not in experimental use or being moved, all radioactive materials must be stored within a suitable container within a suitable and secure store. To be considered suitable, arrangements must comply with health and safety legislation, EPR Permit conditions and current Police counter-terrorism requirements.

Any store for radioactive materials must satisfy the following criteria:

7.20.1 Where relevant, the store should be physically secured to the premises to prevent its removal.

7.20.2 It must be locked to prevent access to its contents by anyone other than an authorised and registered radiation worker. The key or code must be unique and under controlled issue to persons authorised to withdraw radioactive sources from that particular store. In the specific case of laboratory storage of open sources within locked fridges/freezers, if a dedicated store cannot be provided then a separate locked container or compartment must be provided within the appliance to which only authorised persons have access. If storage appliances are left unlocked during work because of frequent access, they should at the very least be locked at the end of the working session (lunchtime/evening).

7.20.3 Where reasonably practicable, the store should be dedicated to the storage of radioactive materials and any other materials and equipment directly associated with their use, such as shielding materials and handling tools. No flammable, explosive or corrosive materials must be kept inside.

7.20.4 The store should incorporate sufficient shielding such that radiation levels around the outside do not exceed 2.5 microsieverts per hour (preferably less than 1 microsieverts per hour), particularly where stocks of gamma emitting isotopes are held.

7.20.5 Stores for closed sources should provide fire resistance. Where it is reasonably practicable to do so, a store guaranteed to provide at least 1 hour protection of its contents should be provided. Open sources requiring cold storage should be stored in spark-proofed appliances.

7.20.6 A radiation warning sign with legend "Radioactive materials" or equivalent should be displayed on the outside of the store, along with details of the permitted contents. The RPO

should be consulted if the requirement to display a radiation warning sign might conflict with the security requirement for discrete storage of radioactive materials.

7.20.7 The store should provide the appropriate environmental conditions for any source contained therein and, where relevant, it should provide weather protection and ventilation to prevent the build-up of radioactive gases (e.g. radon from the storage of radioactive minerals).

Source containment should provide appropriate shielding to restrict radiation exposures on handling so far as is reasonably practicable and must be capable of preventing release of radioactive material in any reasonably foreseeable event.

Containers and housings used to hold closed sources must as a minimum be labelled with a radiation warning sign and the legend “radioactive”. However, where practicable, the isotope, activity and serial number should be included to facilitate prompt identification. Any source that could present a significant hazard if lost should be robustly labelled by an engraved metal plate or equivalent. Departments are encouraged to maintain photographic records of closed sources and their immediate containment for ease of identification in the event of loss or theft.

The security of radioactive materials permanently installed within equipment should be considered as part of the risk assessment process. Such sources must not be readily accessible or removable. The equipment itself must either be rendered immobile by its physical size or attachment to the premises, or maintained within a secure environment, i.e. the security provided at the entrance to the laboratory must be sufficient to prevent unauthorised access to or removal of the entire piece of equipment. Note: Access by other than registered radiation workers to any equipment having an accessible external dose rate in excess of 2.5 microsieverts per hour must be appropriately restricted.

Unsealed radioactive materials should be stored and moved upright within double containment.

7.21. Radon in the workplace

The University is required to test for radon where the premises are in a ‘radon affected area’ and / or there are occupied workspaces underground e.g. basements (occupied > 50 hours per year). Radon affected areas can be viewed on the UK Radon Map (https://www.ukradon.org/information/ukmaps)

Radioactive geological specimens also present an inhalation hazard due to the potential for radon and thoron gas generation. Radon and thoron gas concentration monitoring in the rooms used for storage must also be carried out.

Head’s of Departments are responsible for carrying out radon measurements in consultation with the RPO. Where radon levels are above the UK’s action level of 300 Bq/m^2 are measured, radon mitigation action must be taken (advice may be sort from the RPO).

7.22. Leak testing of closed radioactive sources

A leak test of all University closed sources must be carried out at least once every two years to confirm that the source or its encapsulation has not deteriorated or been damaged leading to a potential release of radioactive material. Leak tests must be carried out more frequently where a risk assessment identifies that the age of the source or the conditions in which it is used or stored are likely to lead to deterioration of its integrity. See Appendix 5 for the University's leak test method.

Leak tests will be performed or organised by the Health & Safety Department and a report issued on completion of the test [see Form IR023 (Leak test certificate)]. Departments must retain records of leak tests until the subsequent test is performed, or for at least two years from the date of disposal of the source.

Advice will be provided by the RPO of the potential consequences and remedial actions in the event that any closed source fails the leakage test. Any source found to be leaking will be considered for urgent disposal.

In certain cases where leak tests are not appropriate, the Health & Safety Department will make alternative arrangements to assess the continued integrity of closed sources.

7.23. Source accountancy

Every department must keep records of the quantity and location of all radioactive substances and update those records at appropriate intervals. These records must be sufficient to ensure that the whereabouts of all radioactive sources is known and that losses can be quickly identified. Every radioactive source (whether they are open or closed sources and whether they are artificially or naturally radioactive) must have an associated record including:

7.23.1 Isotope
7.23.2 Activity (or atomic mass for U/Th work carried out under exemption conditions)
7.23.3 Unique identifier
7.23.4 Location on the premises
7.23.5 Date of receipt
7.23.6 Date of disposal (where relevant)
7.23.7 Source user / owner

In addition to that record, a physical check must be made and recorded at routine intervals (at least monthly) to confirm that all sources are still present and that suitable records are available for each.

For open sources, a record must be kept for every stock of radioactive material. Users must make records of any activity dispensed from stocks for use in laboratory procedures and ultimately disposed of in accordance with permit conditions. The University uses IsoStock for source accountancy (see Appendix 6). So far as reasonably practicable, users must be capable of accounting for every stock source, daughter, probe, or radioactive material in the process of an experiment. In particular, radioactive samples retained for subsequent use or review must be accounted for with cross reference to the originating stock vessel. Where radioactive material consists of a single

isotope within a large number of small vessels within the same secondary container, such as microtubes used in biomedical research, it is acceptable to assign a unique identifier to the batch, together with the total activity and the number of individual vessels. Further guidance on open source accounting contained in Appendix 6.

The open source dispensing record sheet [see Form IR024 (Open source dispensing record sheet)] will usually serve as a combined source record and routine location check. This is because the sheet records the entire life of the source from acquisition to disposal. However, where open sources are infrequently used, a regular stock check is still necessary to confirm that the source is still present. Furthermore, departments are required to report their stock levels to the Health & Safety Department each month and in order to make these returns (this can be done through via IsoStock's reporting options), groups should make physical inventory checks of their storage locations. It is not acceptable to simply perform a material balance calculation (i.e. in minus out) because such a calculation does not address the potential for loss.

For closed sources, departments should perform physical checks of source locations and make an entry in a source record logbook that the source is still present. The frequency of checks should be determined taking account of the likely movement of the source. For static sources securely attached to machines, the Health and Safety Executive specify a monthly check. For portable sources, checks are expected on each working day. Portable sources which spend most of their time within a secure store can be subject to a monthly check, on the condition that this is supplemented by a movement log (see below) and key control under the supervision of an RPS.

For sources that are routinely moved (e.g. from a store to equipment and then back to store), an entry must be made in the source record logbook of each movement. The source must be signed out and the destination noted, together with the name of the person responsible for its safekeeping whilst out of the store. Then, on return to store, the source must be signed back in again. The transfer of any radioactive material to another location (i.e. to another group, or building, or institute), whether it is temporary or permanent, must be appropriately recorded in the relevant source record, including the date, destination, and signature of the recipient [see Form IR006 (Moving a source of ionising radiation within the University)].

Confirmation of the presence of a source should not place the checker at risk of significant exposure. It is not expected; indeed it is forbidden to dismantle equipment containing radioactive sources. For sources contained within equipment, the means of confirming the presence of the source can be by detection of external radiation through the body of the equipment or, in certain cases where equipment operation relies on the presence of the source, by confirmation that the equipment is still working.

During any routine source inventory check, any sources that have become surplus to the department's future research needs should be identified and arrangements made for their disposal in accordance with the relevant source disposal conditions within this policy.

7.24. Accumulation and disposal of radioactive waste

Safe disposal of radioactive waste in accordance with statutory provisions is an essential part of ionising radiation safety. Departments must ensure that all activities capable of generating radioactive waste are identified; that the different categories of wastes are identified and appropriate procedures implemented to deal with and ultimately dispose of waste. Every department must comply with limits and conditions imposed by EPR permits or exemption conditions, or by any more restrictive conditions specified by the Health & Safety Department. All users must therefore be made conversant with the limits and conditions, as a failure to comply may result in enforcement action. Where necessary, specific instructions should be provided to radiation workers on how waste should be accumulated and disposed of from the department.

Suitable records must be kept of all radioactive waste disposals, in a form approved by the RPO. Waste disposal records should be held by the department for a period of at least five years from the date of disposal or transfer of waste from the premises (IsoStock carries out this function).

The University's permits to dispose of radioactive waste require that the University adopts BAT to control its work with radioactivity and to minimise the impact of its waste disposals on the environment. Every department engaged in work capable of generating radioactive waste must prepare procedures sufficient to comply with the BAT provisions in the permit.

These should be incorporated into the departmental local rules and any additional work instructions considered necessary to achieve compliance. Further to this, departments must ensure that areas used for the accumulation and disposal of radioactive waste are fit for purpose, adhering fully to the specification detailed in the Environment Agency's 'Radioactive Substances Act Guidance (RASAG) Chapter 4 - Generic Issues (Guidance on standards for radiochemical laboratories in non-nuclear premises)'. Departments should routinely review the standards of existing facilities and ensure they are maintained in good working order.

Departments must implement arrangements to ensure that the combined waste generated by each of its open source laboratories does not exceed any waste limit contained in the EPR permit, relevant exemption condition, or specific limits assigned to the department by the Health & Safety Department. These arrangements are likely to require the division of waste limits between individual user groups, laboratories or waste disposal points as appropriate.

The RPO must be consulted prior to undertaking any procedure that might generate problem waste, including waste with other hazardous properties. No procedure may be carried out unless a permitted disposal route is available, and the department has been authorised by the Health & Safety Department to use it. Specifically, arrangements must be made with the Health & Safety Department regarding the disposal of putrescible radioactive waste via the University's solid waste stream. Waste carriers must be provided with the required documented information to enable them to produce their own transport Radiation Risk Assessments and Contingency plans.

Disposal of any closed source, irrespective of its activity, must be referred to the RPO who will coordinate arrangements for disposal. Requirements for the disposal of open sources are more complicated and is discussed further in the following sections.

7.25. Disposal of aqueous radioactive waste

Aqueous waste is defined as radioactive waste in the form of a continuous aqueous phase together with any entrained solids, gases and non-aqueous liquids, although departments must minimise so far as reasonably practicable the quantity of entrained non-aqueous material in the aqueous phase.

Aqueous radioactive waste must be disposed of to the foul drain via the normal laboratory drainage system immediately on production, or in the case of waste collected during an experiment (e.g. cell harvester flask) as soon as possible on completion of the experiment. All disposals of aqueous radioactive waste must be flushed through with large volumes of water at the time of disposal and the sink immediately monitored to confirm that it is free from residual contamination.

Departments must designate suitable sinks within each open source laboratory for radioactive waste disposals. Disposal sinks must be clearly identified and labelled using a radiation warning sign with explanatory legend to identify their permitted use (see Appendix 7). In addition, the entire drain run from the disposal sink to the point at which it joins the main sewer or becomes inaccessible should be labelled with suitable radiation warning signs (see Appendix 7).

To ensure compliance with departmental aqueous waste disposal limits, the department should allocate a monthly waste disposal limit for each permitted isotope to each sink designated for the disposal of radioactive waste. These monthly limits should be displayed for reference next to the sink together with a waste disposal record sheet [see Form IR025 (Waste disposal record sheet)].

An entry must be made on the sink record sheet every time a disposal is made, detailing the date, isotope, activity (or in the case of exempt uranium and thorium disposals, the atomic mass in grams), user's initials and a reference to the originating stock. This enables a cumulative monthly record to be kept of the quantity of radioactive material discharged. The group RPS should review the disposal records to ensure that sink limits are not being exceeded. No new experiment must be started if the waste it would generate would lead to the sink limit being exceeded. Departments must keep disposal records sufficient for the purposes of demonstrating compliance with waste limits for a period of at least 5 years from the date of disposal of radioactive materials (IsoStock carries out this function).

In certain circumstances, very small (i.e. µl) volumes of aqueous waste in sealed vessels may be considered as solid waste for disposal purposes if the risk assessment identifies that risks posed by discharging the contents as aqueous waste outweigh the benefits of doing so. In practice, this must involve a consideration of the potential for contamination and worker dose outcome from the task, plus confirmation that the waste can be accommodated within a department's existing solid waste limits. An example where this approach would be advantageous would be multiple Eppendorf pipette ends containing microlitre quantities of high energy beta emitters. The accumulated extremity dose from uncapping and discharging to drain in such circumstances and the potential for contamination could be significant. Where such vessels are disposed as solid waste, a quantity of absorbing material should be placed in the bottom of the solid waste bin.

7.26. Accumulation and disposal of solid and organic liquid radioactive waste under EPR permit conditions

Solid and organic liquid waste disposed of in accordance with EPR permit conditions must be consigned from the premises for disposal at an authorised facility. Permit conditions limit the quantity (volume and activity) of individual isotopes that can be disposed of and the maximum time waste can be held on site prior to its disposal. Departments must make appropriate arrangements to comply with permit conditions including the waste limits, or the more restrictive departmental limits assigned by the Health & Safety Department. Departments must keep disposal records sufficient for the purposes of demonstrating compliance with waste limits for a period of at least 5 years from the date of disposal of radioactive materials (IsoStock carries out this function).

Prior to removal from the premises for disposal, waste may be accumulated on site for a limited period of time in accordance with EPR Permit conditions. This enables the University to consolidate sufficient waste for disposal and to allow shorter lived isotopes to decay, thereby limiting the quantity of radioactive waste ultimately released into the environment. The department is responsible for ensuring that waste is not held on the premises for longer than the accumulation time limit.

Waste generated at the bench may be stored temporarily within suitable bench-top waste containers that provide the necessary containment and any requisite radiation shielding. Further waste accumulation must utilise the radioactive waste store.

Where practicable, all waste items should be monitored prior to disposal to ensure that radioactive waste containers are not filled with inactive materials. For example, laboratory gloves need not be automatically discarded into the radioactive waste bin.

Suitable arrangements should be made for the on-site accumulation of radioactive waste prior to its collection for disposal; ensuring sufficient space, security and restriction of exposure. Specifically, permit conditions require departments to restrict unauthorised access to accumulating radioactive wastes. In practise, this means that non-registered workers must be prevented from accessing any radioactive waste containers (beta boxes and waste containers). This requirement is straightforward in access-controlled open source laboratories and in these circumstances accumulating waste containers can remain within the open laboratory. However, within mixed occupancy or unrestricted laboratories, arrangements must prevent unauthorised access to waste containers. The following measures should therefore be implemented in those circumstances:

7.26.1 Radioactive waste containers for the accumulation of waste should be locked away where possible (e.g. in an under-counter cupboard). If waste is continually added to the waste containers during the experiment, it is acceptable for the bin to be left out of the cupboard whilst it can be continuously supervised by a radiation worker. However, at the very least, waste containers should be locked away at the end of the experiment or at the end of the working session (lunchtime/evening).

7.26.2 Bench-top waste containers should not be left full on the bench at the end of the session. Waste should be transferred into the waste containers and locked away.

Departments are responsible for the appropriate selection and use of waste containers and for the maintenance of suitable waste disposal records. Records must be kept of the type and quantity of waste in a waste vessel, including bench top containers filled during an experiment. When waste is

transferred into a waste container, an entry must be made on the associated solid or organic liquid waste record sheet detailing the date, isotope, activity and type of waste. The container should be "closed" and the inner sack sealed before any of the container limits (activity or volume) are exceeded, and a waste container record card completed summarising the contents at the time of closure.

Where the waste accumulation time prior to closure of the waste container is comparable to or greater than the half-life of the isotopes being held, use of gross activity without considering the effects of decay will significantly overestimate disposal quantities. Where possible in these circumstances, the RPS should provide a more accurate estimation of the activity in the waste container at the time of closure.

Selection of the appropriate waste container must take account of waste containment and restriction of external exposures from beta and photon emissions. For example, waste containing medium-high energy beta emitters should be stored within Perspex bins (beta boxes) that provide shielding of emissions that would otherwise contribute to external radiation levels within the laboratory. Similarly, further shielding may be required around bins containing radioactive waste, to reduce radiation levels within the laboratory to less than 2.5 microsieverts per hour (preferably less than 1 microsieverts per hour).

Careful consideration must be given to the placement of high activity or high dose rate items within waste bins, such as discarded columns or stock vessels. Waste bins with a surface dose rate in excess of 5 microsieverts per hour cannot be transported from the premises in accordance with transport legislation. Any individual waste item likely to generate an external dose rate of that order should be carefully packed within some additional containment which on its own achieves a surface dose rate of less than 5 microsieverts per hour before placing it in the bin. Therefore, the transport limits would be satisfied irrespective of the movement of waste within the bins.

It should be noted that, unless otherwise stating in writing by the Environment Agency, the accumulation period for a particular bin, begins when the first item of radioactive waste is placed in that bin, not from the date it is sealed.

7.27. Accumulation and disposal of solid uranium and thorium wastes under EPR exemption provisions

Small quantities of solid uranium and thorium waste subject to EPR exemption conditions must be disposed of from the premises to a landfill used for normal non-radioactive commercial waste. Quantities consigned to landfill must not exceed weekly maxima specified in the EPR exemption document or any more restrictive limits assigned to the department by the Health & Safety Department. Departments wishing to make use of this disposal route must obtain written authorisation from the RPO to do so. This authorisation will be conditional on the preparation of standard operating procedures documenting how compliance with exemption conditions will be achieved; addressing specifically how waste quantities will be controlled and how the department will guarantee that waste will be transferred directly to an appropriate landfill. Departments must keep waste disposal records sufficient for the purposes of demonstrating compliance with exemption limits for a period of at least 5 years from the date of disposal of radioactive materials.

Prior to consignment from University premises, solid waste may be accumulated for a reasonable period of time to allow consolidation of sufficient waste for efficient disposal. Waste generated at the bench should be stored within small (maximum 10 litre) screw-top disposable plastic pots that must be kept in a secure radiation store until they are ultimately be disposed of from the premises. Waste pots should be labelled with an adhesive radiation warning sign with legend “radioactive” or similar. Since it is a condition of disposal of uranium and thorium under the EPR exemptions that waste should not bear any markings to identify it as being radioactive, no indelible markings should be made on the external surfaces of the waste pot.

Where practicable, all waste items should be monitored prior to disposal to ensure that radioactive waste bins are not filled with inactive materials. For example, laboratory gloves need not be automatically discarded into the radioactive waste bin.

7.28. Disposal of radioactive waste to atmosphere

Any work with ionising radiation that could generate airborne radioactive products under routine circumstances or reasonably foreseeable incidents must be discussed with the RPO and written approval provided before being carried out. Any authorised atmospheric release of radioactive waste must be carried out in accordance with an EPR permit.

Departments must designate suitable fume cupboards or similar extract points within each open source laboratory authorised to discharge radioactive waste to the atmosphere. The final discharge point from each device must be positioned to prevent the re-entry of radioactivity into any building. Fume cupboards must be clearly identified and labelled using a radiation warning sign with explanatory legend to identify their permitted use (see Appendix 7).

In addition, the entire ducting run from the fume cupboard to the stack should be labelled with suitable radiation warning signs (see Appendix 7).

To ensure compliance with departmental gaseous waste disposal limits, the department should allocate a daily waste disposal limit for each permitted isotope. These limits should be displayed for reference on the fume cupboard sash together with a monthly waste disposal record sheet. An entry must be made on the disposal record every time a radioactive discharge is made, detailing the date, isotope, activity and user’s initials. This enables a cumulative monthly record to be kept of the quantity of radioactive material discharged. The group RPS should review the disposal records to ensure that atmospheric discharge limits are not being exceeded. No new experiment must be started if the waste it would generate would lead to the limit being exceeded. Departments must keep disposal records sufficient for the purposes of demonstrating compliance with waste limits for a period of at least 5 years from the date of disposal of radioactive materials.

7.29. Periodic returns

Departments working with open radioactive sources are required to make returns to the Health & Safety Department at the end of each month detailing:

7.29.1 The quantity of radioactive material held in the department at the end of the month.
7.29.2 All radioactive deliveries made to the department during the month.
7.29.3 All aqueous waste disposals made from the premises during the month.
7.29.4 All aerial discharges during the month.

In addition to the requisite departmental records, which must be kept for at least two years, the Health & Safety Department will maintain records of all monthly summaries of departmental waste disposals and will report all radioactive discharges annually to the Environment Agency in accordance with permit conditions.

Departments working with closed sources are required to make annual returns to the Health & Safety Department confirming their full inventory of closed radioactive sources (including radioactive geological specimens).

Work with uranium, thorium and plutonium isotopes is subject to EURATOM nuclear material reporting requirements and departments working with those isotopes are required to make annual returns to the Health & Safety Department of the quantity (atomic mass) of each isotope, further divided into specifically listed categories. The format of these returns will be specified by the Health & Safety Department.

Where relevant a high activity sealed source (HASS) declaration needs to be submitted to the EA every five years (see the 2018 amendment to EPR16).

7.30. Transport and movement of radioactive materials

Arrangements must be made for the safe movement of radioactive materials within departments, between departments and from University premises. Any department wishing to transport radioactive materials by road must apply to the RPO for authorisation to do so.

This authorisation will be conditional on the preparation of written procedures, including a transport quality assurance plan and local rules, and the provision of training to all persons involved in the transport operation. All closed source movements from the premises on public road must be undertaken by the Health & Safety Department, unless individual authorisation has been provided by the RPO.

Radioactive material and radioactive waste must not be moved to another department or premises unless the department has confirmed in consultation with the RPO that the intended movement will not breach any permit condition or other legislative requirement.

With the exception of movement of radioactive materials between University buildings on foot, every shipment of radioactivity from University premises must be by a University-owned motor vehicle or by courier specifically licensed to carry radioactive materials. Transport of radioactive

materials by bicycle or using public transport is not permitted. Postage of radioactive materials is not permitted.

Further guidance on the requirements for transporting radioactive materials by road is contained in Appendix 8.

Movement of radioactive material between University buildings on foot is not subject to the requirements of transport legislation, even if it is necessary to use a public footpath or cross a highway. However, radioactive materials to be moved in this way should be securely packaged to withstand any reasonably foreseeable incident en route without any damage or loss of source containment, potentially resulting in an uncontrolled spread of contamination. At the very least, open sources should be doubly contained and clearly labelled with a radiation warning sign and legend “radioactive materials” or equivalent. Radioactive materials being transferred between buildings in this way should be additionally carried within a suitable box or bag that bears no external radiation warnings.

Departments must comply with the associated requirement for source accountancy and record keeping when transferring radioactive materials between locations.

7.31. Use of ionising radiation for medical exposures

University staff wishing to undertake work with ionising radiation for medical exposures must consult the RPO in advance of any work taking place. The University Health & Safety Department maintains close links with radiation protection colleagues within the NHS Trust and will seek advice on each occasion to ensure that the requirements of the Ionising Radiations (Medical Exposures) Regulations 2017 and, for any proposed administration of radioactivity to a patient or research subject, the ARSAC (the Administration of Radioactive Substances Advisory Committee) Guidelines can be met. In the specific case of University staff on joint University and NHS contracts, it is expected that work involving medical exposure to ionising radiation will be undertaken under the NHS radiation protection management systems.

University staff and students working with ionising radiations within NHS Trust departments are expected to observe the local rules and other safety procedures of the Trust. They should follow the direction of the Trust’s RPSs and may be supervised and given training by these RPSs, in addition to training provided by the University. However, the University maintains primary responsibility for the health and safety of persons under its employ and departments should therefore cooperate fully with the Trust to ensure that arrangements for the work are clearly agreed and documented between both parties to ensure that radiation exposures can be suitably restricted. The RPO must be consulted in advance of any work that could lead to the University’s 1 millisievert investigation level being exceeded under reasonably foreseeable circumstances.

All University staff intending to work with ionising radiation on Trust premises must register with the University Health & Safety Department as explained in the following section.

7.32. Work at other institutions

Departments are responsible for ensuring that appropriate radiation safety arrangements are in place during work with ionising radiation carried out by University personnel at other institutions. This applies to visits to premises on which work with ionising radiation is carried out, or when planning to undertake work with radioactive materials or radiation generators on another premises. Before any member of departmental staff visits another employer's premises for the first time, the RPO should be consulted for advice on the measures expected from that employer. To allow for potential delays in addressing a site's entry requirements for visitors, the RPO should be consulted as soon as possible.

Where staff intend to undertake work with ionising radiation on another premises, they must first register with the Health & Safety Department, providing details of the specific institution and the work to be carried out.

Departments must liaise with the host institution to confirm the nature of the work to be carried out and the associated radiation risks faced by University of Nottingham staff. Information should be sought on the host's health and safety arrangements for visitors and the actions expected in the event of any reasonably foreseeable incident during the visit. Where the host's arrangements include the provision of dosimetry to visitors (irrespective of any dosimetry provided to the visitor by the University), the department should arrange for dosimetry results to be copied to the University Health & Safety Department. If departmental staff are supplied with dosimetry by the University, both dosemeters should be worn during the visit.

Where the work carried out by University of Nottingham visitors would potentially create exposure risks to the hosts' employees, the department must provide sufficient information to enable the host to review and adapt its health and safety arrangements accordingly.

See also Section 7.6 (Co-operation between employers).

8. Surveillance and reviews

Below are the arrangements by which the University monitors and keeps under review its own performance against its ionising radiation safety objectives whilst at the same time also satisfying the various regulatory requirements, including those for record keeping. This programme forms part of the overall University-wide safety auditing procedures.

8.1. Departmental review and recording

Heads of Department must ensure that there is an adequate programme of ionising radiation safety checks within their department; that the checks are carried out by competent persons; and results are recorded. Where recorded standards are not acceptable, prompt remedial actions must be taken and additional checks made and recorded to confirm that those actions have been successful.

The nature and frequency of routine checks will depend on the applications involved but will typically include:

- Confirmation that all closed radioactive sources are present, with no visible signs of damage, and that they are appropriately labelled and securely stored.
- Routine periodic confirmation of the continued presence of all stocks of open sources, including verification of suitable records and an identification of sources that have become surplus to requirements and that can be disposed of.
- Routine periodic dose rate monitoring records around controlled and supervised areas designated on the basis of external radiation exposures.
- Routine periodic contamination monitoring around open source laboratories.
- Confirmation of continued function of installed engineering controls, safety features and warning devices and of equipment essential to continued compliance with EPR permit conditions.
- Routine inspection of personal protective equipment and replacement of damaged or faulty equipment.
- Review of reported personal dosimetry results (standard and electronic) and follow up actions on unusual doses.

In addition, Heads of Department must ensure that every radiation work area is inspected at least annually. These inspections should normally involve at least one RPS and the Departmental Safety Officer. Departments are also encouraged to ensure, where possible, that the inspection team includes someone who is independent of the area being inspected. A report should be prepared detailing any recommendations on actions necessary to ensure compliance with University Policy, legislative requirements and best practice, including any required modifications or refurbishments to existing facilities to meet current Estates Regulations. A further record should be made confirming the completion of any follow up actions to address substandard findings.

Departments should review their radiation safety arrangements for work with ionising radiations, including risk assessments, local rules and standard operating procedures, at least annually and following any significant changes in work practices.

Information, instruction and training requirements should also be reviewed. A record should be kept of any periodic review of procedural documents and of any revisions made as a result.

The security arrangements for work with radioactive materials should also be routinely reviewed, including a review of staff requiring access to radioactive materials. This is particularly important in the case of work with radioactive materials subject to counter-terrorism security guidelines.

Radiation safety measures will be considered during departmental inspections carried out by Departmental and Area/Divisional Safety Officers and during Health & Safety Department reviews. Matters of concern will be raised with the RPO and notified to the Head of Department for attention where necessary.

Copies of all documents and records essential for the demonstration of compliance with the requirements of this policy or wider legislative requirements should be maintained within the department, readily accessible during departmental reviews or during inspections by the Health & Safety Department or enforcing authorities.

8.2. Health & Safety Department reviews

The RPO will maintain good contacts within departments through the provision of advice and assistance in dealing with routine issues and non-routine enquiries on radiation protection matters, including those matters requiring RPA consultation as detailed in Appendix 1 of this document. The RPO receives formal notifications and reports of any incidents and will investigate any event with potentially significant consequences for compliance with University policy or legislative requirements. The RPO also monitors the results of personal dosemeters; reporting all significant exposures to the department; and following up any unusual doses or doses in excess of the University's formal dose investigation level.

The RPO will undertake a rolling programme of periodic inspections and audits of departments' radiation protection arrangements. Reports will be prepared for the Head of Department and confirmation will be sought that all recommendations necessary to achieve satisfactory radiation safety standards have been addressed by the department within agreed time scales. Where standards are considered to be sufficiently poor that significant radiation exposures or a breach of legislative requirements is reasonably foreseeable, advice will be provided to the Head of Department on immediate cessation of work until all matters of concern are resolved.

Annual summaries of radiation protection interventions within departments are made available to the University Radiation Safety Committee.

In addition to undertaking the above audit and inspection programme, the Health & Safety Department will review the University-wide organisation and arrangements for work with ionising radiation, including associated documentation, at intervals not exceeding three years, by means of a full review of this management system.

8.3. External RPA and RWA reviews

External RPA / RWA will provide advice, guidance, and information as to the ongoing management of ionising radiation work at the University. Document and Management reviews will be included as part of the RPA audit schedule with the University considering and acting upon guidance provided by the RPA / RWA.

8.4. University-wide Ionising Radiation Safety Committee

The University convenes a University-wide Ionising Radiation Safety Committee (IRSC) to provide a forum for discussion of significant radiation matters, effectively coordinating efforts in radiation protection to achieve consistent arrangements across the University. The Committee should be chaired by a senior member of the University management team and be attended by the RPO, RPA, RWA, MPE (when required), SRPSs and Departmental Safety Officer where relevant. Meetings will be held at least twice per year and additionally as necessary to address specific matters. Minutes will be presented to the University's Safety Advisory Committee and the Director of Health and Safety. The RPO and SRPSs will take actions to resolve any urgent matters identified by the Committee. The University Radiation Safety Committee is a sub-committee of the University Safety Committee, and must have a Terms of Reference in place.

9. Appendices

9.1. Appendix 1: matters requiring consultation with or notification to the RPO

The Head of Department is required to consult the RPO as necessary to obtain advice in order to secure compliance with the requirements of University policies and procedures and relevant legislation. Specifically, the RPO must be consulted on, or notified of, the following:

In accordance with the specific requirements of Schedule 4 of IRR17 **the RPO must subsequently consult the University's appointed RPA** (see Section 5.9) on points 1 - 4:

- The requirement to designate controlled or supervised areas and the implementation of appropriate precautions in those areas.
- The prior examination of plans for installations and the acceptance into service of new or modified sources of ionising radiation in relation to any engineering controls, safety features and warning devices provided to restrict exposure to ionising radiation.
- The requirement for, suitability, use and calibration of radiation and contamination monitoring equipment.
- The periodic examination and testing of engineering controls, safety features, warning devices and systems of work provided to restrict exposure to ionising radiation.

In the event of incidents and accidents:

- (Forthwith) Failure to account for the whereabouts of radioactive material, including suspected loss or theft. Subsequent notification to EA, ONR, HSE and Nottinghamshire Police may be required.
- (Forthwith) Suspected escape of, or contamination arising from the accumulation of radioactive waste. Subsequent notification to EA may be required.
- (Forthwith) Suspected radiation exposure of a worker or other person greater than expected. This notification requirement covers exposures arising as the result of an accident or incident, and any exposures that are not considered as low as reasonably practicable (i.e. suspected personal exposure greater than the University investigation level of 1 millisievert effective dose). Subsequent notification to HSE may be required.
- (Forthwith) Breach of radioactive source security, including the presence of intruders. Subsequent notification to EA and Nottinghamshire Police may be required.
- (Forthwith) Failure of engineering controls or safety feature provided to restrict exposure to ionising radiation, including:
    - Failure of an x-ray set to terminate at the end of an exposure.
    - Failure of a radioactive source drive mechanism.
    - Failure of a shutter mechanism
    - Failure of a safety interlock device.
- Subsequent notification to HSE may be required. Notification of the failure of warning devices is not required although departments are expected to take prompt action to replace them.

- The MPE should be consulted when any failures involve exposures to patients / trial participants (so they can advise on whether other regulatory bodies need to be notified including the CQC.
- (Forthwith) Fire affecting a radiation generator or radioactive source or safety features.
- Significant contamination events, including:
  - Large scale contamination of the laboratory.
  - Spread of contamination outside the radiation work area.
  - Personal contamination (excluding contamination of standard laboratory PPE)

In the event of failure to comply (or be able to comply) with University procedures, or of potential breaches of University Permit conditions:

- (Forthwith) Failure to account for the whereabouts of radioactive material, including suspected loss or theft. Subsequent notification to EA, HSE and Nottinghamshire Police may be required.
- (Forthwith) The holding of quantities of radioactive material in excess of departmental or site limits. Subsequent notification to EA may be required.
- (Forthwith) The acquisition, keeping, use, accumulation or disposal of an unauthorised isotope. Subsequent notification to EA and HSE may be required.
- (Forthwith) The accumulation, disposal or discharge of radioactivity in excess of departmental or site limits. Subsequent notification to EA may be required.
- (In advance) A perceived inability to comply with University policy, procedures or established departmental arrangements, including the local rules.
- (Forthwith) Acquisition, use, disposal or discharge of radioactivity by unauthorised persons.
- (Forthwith) Use of a radiation generator by unauthorised persons.

In the event that a worker involved with or affected by work with ionising radiation has declared herself to be pregnant:

- (In advance of work continuing) Notification by a worker who intends to continue working in a laboratory used for open sources that they are pregnant or are breastfeeding.
- Notification of the outcome of a review of the work with ionising radiation to be carried out by a worker in a radiation area who has declared herself pregnant or breastfeeding, including an assessment of potential exposures.
- Necessary controls required to restrict exposures to the foetus or nursing infant following notification of the pregnancy of a radiation worker.

In the event of a proposal to make changes to existing work or premises:

- (In advance) New work or significant changes to existing work, including the proposal to work with new isotopes; to obtain new or replacement closed sources or radiation generating equipment; to undertake work with radiation on different premises; or to make substantial changes to existing laboratories, facilities or premises.
- (In advance) Proposal to transfer radioactive materials to another premises; in particular to a building covered by a different Permit or to another employer's premises.
- (In advance) Cessation of work within a particular laboratory or particular premises.
- (In advance) Proposal to dispose of closed radioactive sources.

- (In advance) A perceived inability to comply with University policy, procedures or established departmental arrangements, including the local rules.
- (In advance) Proposals to change any existing security arrangements for radioactive materials.

9.2. Appendix 2: generic radiation risk assessments

9.2.1 X-ray devices and enclosures
9.2.2 Unsealed sources used in life sciences (beta / gamma emitters)
9.2.3 Unsealed positron emitters
9.2.4 Unsealed alpha emitters
9.2.5 Sealed sources (including HASS)
9.2.6 Radioactive geological specimens
9.2.7 Working in a radon atmosphere
9.2.8 Transport of radioactive materials

9.3. Appendix 3: Core of Knowledge requirements for all University radiation workers

The following list constitutes the minimum knowledge required by all persons working with ionising radiation at the University:

1. The basic principles of radioactivity and ionising radiation and the properties of different radiations (e.g. alpha, beta, gamma, neutrons, x-rays).
2. Activity, radioactive decay and half-life; radiation generator operating parameters.
3. The harmful effects of exposure to ionising radiation.
4. The concepts of exposure and dose of ionising radiation.
5. The concepts of internal and external radiation and significance of radioactive contamination.
6. Sources of ionising radiation: radiation generators, sealed sources, unsealed radioactive substances. Source “design”.
7. Fundamental principles of protection: justification, optimisation, dose limitation.
8. The principle of restricting exposure so far as reasonably practicable (the ALARP principle).
9. The practical application of radiation protection principles: time, distance, shielding, containment and good housekeeping.
10. Hierarchy of protection measures: engineering controls, safety features, warning devices, administrative control and PPE.

Line managers or academic supervisors should discuss individuals’ training needs and make arrangements for their attendance on a Core of Knowledge training course as appropriate. It is accepted that individuals may have received previous training or have previous experience working with ionising radiation and consequently may not require this basic training. Where a decision is made that an individual need not be provided with Core of Knowledge training, a record should be made in departmental training records of the justification behind this decision.

Core of Knowledge training session is covered in computer-based learning modules (Moodle).

9.4. Appendix 4: Health & Safety Department topic specific radiation safety training modules

In addition to the "Core of Knowledge" training prerequisite for all radiation workers, the Health & Safety Department has provided computer-based learning modules (Moodle) for the following categories of work:

9.4.1 Work with open sources
9.4.2 Work with closed sources (including irradiators)
9.4.3 Work with radiation generators (x-rays)

Syllabus for work with open sources:

9.4.4 Overview of principal legislation: the Ionising Radiations Regulations 2017; the Environmental Permitting (England & Wales) Regulations 2016 and Permit conditions
9.4.5 Optimisation (the ALARP principle) and legal dose limits
9.4.6 Minimisation of waste and best available techniques
9.4.7 Hazard and risk assessment: theory and practical guidance
9.4.8 Designation of working areas
9.4.9 Local rules
9.4.10 Standard Operating Procedures for acquisition, use, accumulation and disposal of radioactivity
9.4.11 Practical precautions: workstation and laboratory layout
9.4.12 Open source and waste security and accounting
9.4.13 Radiation and contamination monitoring
9.4.14 Personal monitoring
9.4.15 Emergency procedures
9.4.16 Notifications
9.4.17 Provision of advice

Syllabus for work with closed sources (including irradiators):

9.4.18 Overview of principal legislation: the Ionising Radiations Regulations 2017; the Environmental Permitting (England & Wales) Regulations 2016 and Permit conditions
9.4.19 Optimisation (the ALARP principle) and legal dose limits
9.4.20 Hazard and risk assessment: theory and practical guidance
9.4.21 Designation of working areas
9.4.22 Local rules
9.4.23 Standard Operating procedures for acquisition of radioactivity
9.4.24 Practical precautions including source design
9.4.25 Source security and accounting (including high security)*
9.4.26 Radiation and contamination monitoring
9.4.27 Personal monitoring
9.4.28 Emergency procedures
9.4.29 Notifications
9.4.30 Provision of advice

Syllabus for work with radiation generators (x-rays):

9.4.31 Overview of the Ionising Radiations Regulations 2017
9.4.32 Optimisation (the ALARP principle) and legal dose limits
9.4.33 Hazard and risk assessment: theory and practical guidance
9.4.34 Designation of working areas
9.4.35 Local rules
9.4.36 Practical precautions: hierarchy of controls
9.4.37 Radiation monitoring and routine safety checks
9.4.38 Personal monitoring
9.4.39 Emergency procedures
9.4.40 Notifications
9.4.41 Provision of advice
9.4.42 Work at other institutions

9.5. Appendix 5: method for leak testing of sealed sources

A leak test of all University sealed (closed) sources must be carried out at least once every two years to confirm that the source or its encapsulation has not deteriorated or been damaged leading to a potential release of radioactive material. Leak tests must be carried out more frequently where a risk assessment identifies that the age of the source or the conditions in which it is used or stored are likely to lead to deterioration of its integrity. This includes sources that are beyond the manufacturer's Recommended Working Life (RWL).

Leak tests should have clear pass/fail criteria and, where possible, should be carried out directly on the sealed source capsule. This provides the best possible check for loss of containment. However, where this is not reasonably practicable, for instance when the source is inaccessible or when significant exposures are likely to occur from performing the test in this way, an indirect test should be carried out. This indirect test should be conducted on parts of the source containment or apparatus that can reasonably be expected to have become contaminated by a leak.

The decision to carry out indirect testing needs to be balanced against the radiological implications of failing to detect a loss of containment, which could itself result in significant exposures. Also, particular care is needed in dismantling, or gaining closer than normal access to a source when conducting indirect testing, due to the greater risk of contamination.

The manufacturer or supplier may advise about periodic leak testing and the methods to adopt to give the required assurance that radioactive material is not being dispersed. In the absence of such advice, the test method set out below (which is in line with ISO 9978:1992) is appropriate. Further guidance relating to leak testing of sealed sources can be viewed in the IRR17 ACoP under Regulation 28 (paragraphs 567 – 577).

General leak testing method using Whatman filter paper:

1. Don appropriate PPE (nitrile gloves and laboratory coat)
2. For general leak testing the smear paper should be 55 mm or 60 mm diameter Whatman 54 filter paper or equivalent (these papers do not disintegrate when moistened). Where the leak test wipe is to be counted in a liquid scintillation counter (LSC), a Whatman GF/A (or similar glass fibre filter paper) or cotton bud should be used. Care should be taken if using GF/A filter papers as these are likely to disintegrate if handled roughly (especially when moist).
3. The smear (filter paper or cotton bud) should be moistened before use to maximise the activity removed during the leak test. The smear should normally be moistened with de-ionised water or ethyl alcohol. Care must be taken to ensure no damage is caused to the component containing the source. It may not always be appropriate to use a moistened paper, for example where the source is near sensitive electrical circuits or a lubricated shutter mechanism. In these cases, a dry smear may have to be used.
4. The moistened smear should be handled with tweezers. Longer tongs may be required where the dose rate is significant (e.g. above 75 µSv/h). Always use plastic tweezers; metal tweezers can damage the surface of the source and result in contamination (this is particularly important when leak testing alpha sources).
5. Using one side of the filter paper, smear (wipe) all the accessible surfaces of the sealed source; wherever possible direct access should be made with the source. However, for very high activity sources, the leak test may have to be done indirectly by smearing housing or another component that the source routinely makes direct contact. Sources which could be damaged by direct leak testing such as alpha plaque sources and other open window sources should also be leak tested indirectly, for example by smearing the source container. Equipment should not be dismantled to conduct the leak test without an appropriate risk assessment in place (the risk assessment must address the radiation exposure and the risk of contamination).
6. Ensure that the side of the filter paper that is used to wipe the source is identified clearly using a pen mark or similar (this ensures that the correct side of the filter is presented to the detector within the counting system).
7. If transport or temporary storage of the smear is required, the smear should be placed in a plastic zip seal bag (or where the smear is to be counted in an LSC, a liquid scintillation vial). To reduce the possibility of contaminating the bag, the smear should be folded in half once with the side used for smearing on the inside of the fold. The smear or bag should be appropriately labelled with a unique identifier.

Analysis using the Ludlum Model 3030E alpha / beta draw counter:

1. Don appropriate PPE (nitrile gloves and laboratory coat).
2. Plug scaler counter into mains power and switch unit on at the front.
3. Set the count time switch on the scaler to 5 minutes.
4. Open the drawer and insert a clean filter paper (as a background), close and latch the drawer and press the ‘Count’ button on the front of the unit.
5. Once the count time has elapsed the background result will be displayed in counts per minute (cpm).
6. Record the background result.

7. Insert the appropriate check source for the type of source being tested (Am-241 for alpha, Cl-36 for beta). Set the count time switch for 1 minute and press the 'Count' button on the front of the unit.
8. Record the check source result(s) and compare with previous results to determine whether the system is working normally.
9. Remove the check source and replace with the first sample to be analysed, smeared side facing upwards toward the detector. Make sure that the drawer closes smoothly and that the sample does not move in the sample recess (samples which are creased or folded may catch on inside components and become dislodged within the counting system and therefore may contaminate components and/or not be counted properly).
10. Use the count time switch to set the count time back to 5 minutes and press the 'Count' button to start the count acquisition.
11. Record the sample result.
12. Remove the sample and repeat for each remaining sample. If a sample shows counts significantly greater than the typical background readings, repeat a background reading to ensure that the drawer has not become contaminated.
13. Once all the samples have been analysed do one final background count using the control sample and record.
14. If any smear contains greater than 200 Bq, the certificate (see below) must indicate a test fail. The University's Radiation Protection Officer (RPO) must be informed as soon as possible and appropriate action taken.
15. If activity is detected on the smear above the detection threshold (see below) but below the pass criterion (200 Bq), the results should be discussed with University's RPO as soon as possible.

Analysis using a liquid scintillation counter (LSC)

<u>Weak beta emitters e.g. tritium, carbon-14 and nickel-63 sources should be leak tested using liquid scintillation counting.</u>

1. Don appropriate PPE (nitrile gloves, laboratory coat and eye protection must be worn)
2. Place all the smear samples into individual scintillation vials (if not already) and mark the <u>lid</u> with the smear's unique identifier. There should include at least one background smear (clean filter paper or cotton bud).
3. With the aid of a drip tray add 18-20 ml of scintillation cocktail to each of the samples using a cocktail dispenser.
4. Ensure that each vial is filled to just the start of the neck of the vial and screw the lid on tightly. Note: A reduced volume of scintillation cocktail in a sample can reduce the counting efficiency.
5. Wipe the outside of the vial with a lint free cloth to remove any residue or dust and then shake (or better use a vortex mixer) to agitate and to help with desorption of any radioactivity into the cocktail.
6. Prior to counting the samples, the user should check that the correct assay has being assigned to your chosen protocol flag number for the LSC. The protocol used should be appropriate for the type(s) of source(s) being tested. In many cases a protocol with three basic analysis channels set to 0 - 18.6 keV (tritium channel), 18.6 - 156 keV (carbon-14 channel) and 156 - 2000 keV (wide channel) will be sufficient.

7. Load the sample vials into the sample cassette(s) with the correct protocol flag number, starting with the unquenched standards, in the following order (left first):
    - Background unquenched standard
    - Tritium unquenched standard
    - Carbon-14 unquenched standard
    - Background sample
    - First sample, second sample etc.
8. Insert the correct protocol flag into the first sample cassette ensuring that the flag slide bar is positioned to the left and fully extended.
9. Load each sample cassette into the LSC ensuring that the first cassette is placed closest to the back of the counter.
10. It is important that samples are left in the dark (for at least 1 hour) to ensure that the effect of photoluminescence does not produce an artificially high result. If results indicate a high 'LUMEX' reading, then it could be due to photoluminescence from the excitation of the cocktail or vial by sunlight or UV light. If samples which are left overnight still produce a high LUMEX reading, then this could be due to chemiluminescence occurring. This is a result of a chemical reaction with the cocktail. For further information on other possible causes of unusual results due to static electricity and/or dirty samples please refer to the relevant operating manual.
11. The LSC will first count the unquenched standards and then each of the samples for the specified amount time defined in the assay (10 minutes per sample is recommended).
12. Once all the samples have been counted a copy of the results will be printed automatically and/or an electronic version produced.
13. If any smear contains greater than 200 Bq, the certificate (see below) must indicate a test fail. The University's RPO must be informed as soon as possible and appropriate action taken.
14. If activity is detected on the smear above the detection threshold (see below) but below the pass criterion (200 Bq), the results should be discussed with University's RPO as soon as possible.

Estimating the sample activity on the smear

1. If not already, convert all CPM readings to CPS.
2. Subtract the background CPS from the sample CPS, this gives you the net sample count rate.
3. The alpha or beta activity of a sample may be estimated by dividing the net sample count rate (in CPS) by the appropriate value of counting efficiency* (expressed as a decimal fraction).

*Counting efficiencies can be obtained from the manufacturer of the instrument.

See worked example below.

Calculating the detection threshold of an instrument

1. To calculate an approximation of standard deviation (σ) of a single measurement (based upon a normal distribution) take the square root of the background in CPM (alternatively five separate background counts can be run and σ can be calculated, although this is not necessary for the purposes of a leak test measurement)
2. The detection threshold (95% confidence) = (1.96 x σ) / 60 (CPS above the background).
3. Convert to Bq by dividing by the counting efficiency.

See worked example below.

Recording results

A suitable leak test record includes the:

a) identification of the source or article which is the subject of the test;
b) date of test;
c) reason for test (e.g. pre-use, manufacturer's test, nominal routine, after incident);
d) methods of test, including:
e) when the source or article has not been tested directly;
f) a statement of what part of the device was tested;
g) a statement about whether this is likely to detect any leaking material.
h) a statement of the pass/fail criteria;
i) numerical results of the test;
j) result of the test (pass or fail);
k) any action taken if the source failed the test;
l) name and signature of the person carrying out the test.

Items a) to l) should be recorded on the University's leak test certificate (IR023)

Sample disposal

If results indicate a higher than background reading, then the sample may need to be treated as radioactive and disposed of in accordance with the University's relevant Environmental Permit. Seek advice from the RPO.

Worked example

A caesium-137 (Cs-137) sealed source is leak tested:

- The smear result for beta is 205 CPM
- The background count is 150 CPM
- The manufacturer quoted a beta counting efficiency for Cs-137 of 22 % (4π)

Has the sealed source passed the leak test?

- Smear result in CPS = 205 / 60 = 3.4
- Background in CPS = 150 / 60 = 2.5
- Net counts on the smear = 3.4 – 2.5 = 0.92
- Bq on the smear = 0.92 / 0.22 = **4.2 Bq**
- Leak test passed

Is this above the detection limit?

- Approximation of standard deviation (σ) = √150 = 12.2
- Detection limit = (1.96 x 12.2) / 60 = 0.40 CPS, which equates to **1.8 Bq** (0.40 / 0.22)
- There is activity on the smear above the detection limit

9.6. Appendix 6: IsoStock

Isostock is the software system for accounting for the acquisition, use and disposal of radioactively labelled compounds. The University is required by environmental and health and safety legislation to have systems to account for radioisotopes. Isostock is networked across the University and may be accessed from a designated computer.

No radioactive sources may be acquired (either by official purchase order, gift, sample or by any other route) without the knowledge and approval of the Radiation Protection Supervisor or appointed deputy. Radiochemical acquisitions must be made through Isostock. This requires approval by the RPS before the order can be completed.
The arrival, use and ultimate disposal of each quantity of isotope must be recorded using the Isostock system. The record must be updated at the time that the stock is used or disposed. Stocks and disposals are monitored by the Radiation Protection Supervisor and the Health & Safety Department. The Radiation Protection Supervisor will ensure a monthly stock check against the Isostock record is performed. The H&S Department also carries out checks on radiochemical stocks. The Radiation Protection Supervisor shall establish appropriate local arrangements for ensuring that the necessary Isostock records for stock control and disposal are created and updated. In particular this shall include designating those persons, either individually or as a group, who shall enter data onto Isostock.

Radiochemical requests must be raised on Isostock and must be authorised on the system by the Radiation Protection Supervisor or his/her nominated deputies (the necessary Isostock permissions for this are created by the H&S Department). The order may only be placed with the supplier once it has been authorised (for example by the person responsible for placing orders having received an Isostock order printout signed by the RPS or deputy). Authorisation of isotope requests should confirm that the isotope and quantity are consistent with the approved limits for the project, that the order will not exceed any permitted limits (Isostock will warn if a limit is being approached) and that the person is registered for work against that project. As soon as the isotope arrives at the laboratory it must be "received" onto the Isostock record, which must be updated to record location and "handled by" details. The unique Isostock number must be written on the outer container for the stock (the lid may also be labelled if required but this should not be instead of the container as lids may become swapped).

Only stock storage locations listed on Isostock may be used. Arrangements must be established for checking the accuracy of the stock records. These shall include a monthly, recorded check of the stock in each laboratory against the Isostock record. A printout of the stock by location can be obtained from Isostock and items checked off against this. The record should be kept with the other radiation records for the area. The H&S Department should be contacted in the event of any queries that cannot be resolved locally.

The Radiation Protection Supervisor or nominated deputies shall monitor that radioactive waste is disposed of appropriately and in a timely manner. The "Departmental Waste" screen in Isostock shows solid and organic liquid waste within the laboratories. The "Accumulated Waste" screen shows the waste that has been moved to the waste holding point and awaiting final disposal. This record requires completion to confirm that the final disposal has been made.

9.7. Appendix 7: ionising radiation signage

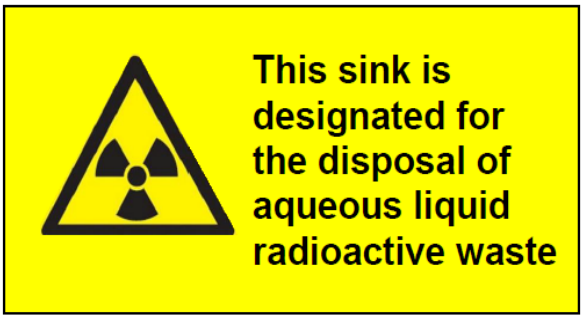
1. Warning signs to be displayed at the entrance to an area designated on the basis of radiation dose rates:

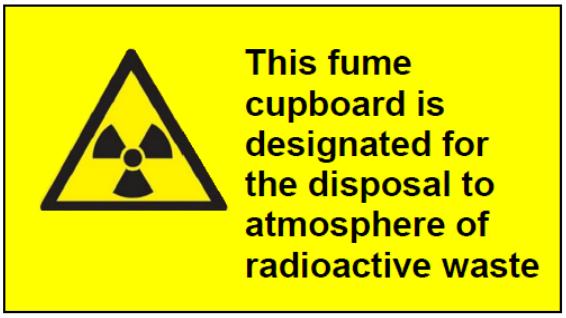
2. Warning signs to be displayed at the entrance to an area designated on the basis of contamination levels:

3. Warning signs to be displayed at the entrance to a registered area:

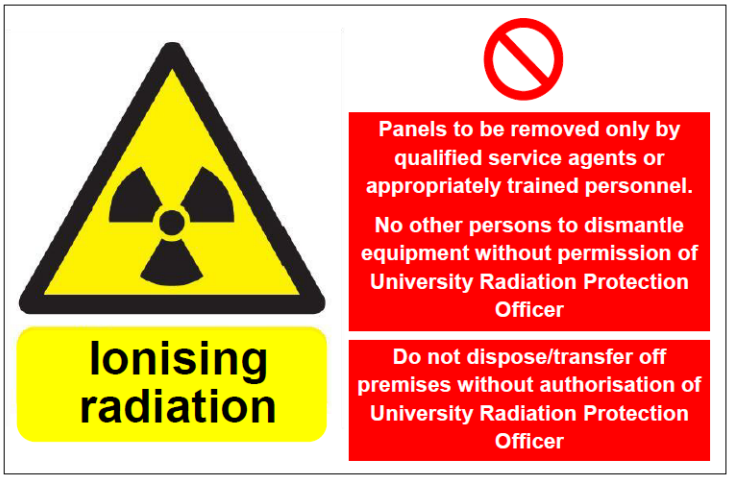
4. Signs for display on radioactive sources and storage location:

5. Signs for display on disposal points:

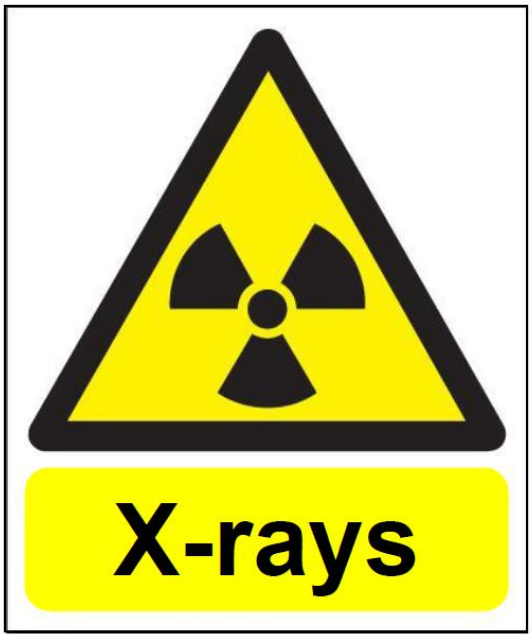




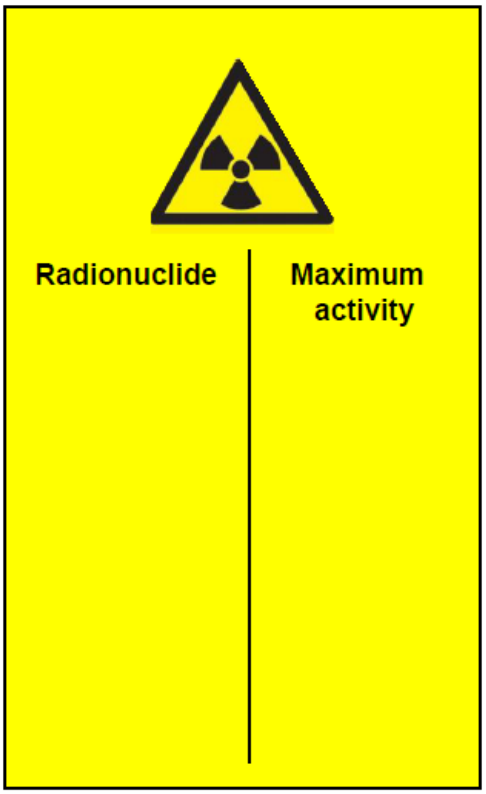
6. Sign for display on access panel of equipment containing a radioactive source e.g. liquid scintillation counter:



7. Sign for display next to x-ray hazards:



8. Signs to display limit conditions:
    a. Stock limits:



b. Sink and fume cupboard discharge limits:

DISPOSAL OF AQUEOUS LIQUID

RADIOACTIVE WASTE TO DRAINS

LIMITS FOR THIS SINK

RADIONUCLIDE	MBq/month

DISPOSAL OF RADIOACTIVE

WASTE TO ATMOSPHERE

LIMITS FOR THIS FUME CUPBOARD

RADIONUCLIDE	MBq/month

9.8. Appendix 8: Transport

It should be noted that the Regulations do not differentiate between radioactive sources and radioactive waste when it comes to excepted package quantities. As long as the waste fulfils the requirements for excepted packages it can be transported as such. The bulk of university transport requirements will be covered by excepted packages.

9.8.1 *Activity Limits for Excepted Packages*

As long as the packaging and documentation requirements are met in full, radioactive material in liquid or solid form with an activity not exceeding that given in Table2 and a surface dose rate not exceeding 5µSv/h, may be transported in an excepted package. When either of these criteria is exceeded then the material must be transported in a Type A package or an industrial package as appropriate.

TABLE 9.8.2 Activity Limits For Excepted Packages (frequently used Nuclides)

Nuclide	Ordinary Solid Form	Liquid Form
H-3	40 GBq	4 GBq
C-14	3 GBq	300 MBq
F-18	0.6 GBq	60 MBq
P-32	0.5 GBq	50 MBq
P-33	1 GBq	100 MBq
S-35	3 GBq	300 MBq
Co-60	400 MBq	40 MBq
Ni-63	30 GBq	3 GBq
Tc-99m	4 GBq	400 MBq
In-111	3 GBq	300 MBq
I-125	3 GBq	300 MBq
Cs-137	600 MBq	60 MBq

NB For special form solid radioactive materials there are higher limits- see Table 2.2.7.2.4.1.2 in the ADR for further details. For instruments containing radioactive materials the individual item limits are ten times the above limits. For gases the limits are the same as for solids, with the exception of tritium where there is a higher limit. A full list of limits for all radionuclides can be extrapolated from Table 2.2.7.2.2.1 of the ADR by using the factors given in Table 2.2.7.2.4.1.2.

9.8.3 General Packaging Requirements

a) When necessary, shielding should be provided to ensure that the dose rate at the surface of the excepted package does not exceed 5µSv/h.
   For instruments or manufactured articles containing an excepted quantity of radioactive material the above dose rate limit does not apply, but the dose rate 10cm from any external point of any unpackaged instrument or article should not exceed 0.1mSv/h
b) Non-fixed contamination of the external surface of the excepted package shall not exceed:-
   a. 4 Bq/cm2 for beta, gamma and low toxicity alpha emitters, e.g. natural uranium and thorium;
   b. 0.4Bq/cm2 for all other alpha emitters.
c) The package shall bear the marking radioactive on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.
d) The package shall be so designed in relation to its mass, volume and shape that it can be easily and safely handled and retain its contents under conditions likely to be encountered in routine

transport, e.g. taking into account acceleration, vibration and braking. The volume of absorbent material should be always at least twice that of a liquid sample. (Absorbent material requirement - good practice, only an ADR requirement for Type A and above.)

e) As far as practicable, the packaging shall be so designed and finished that the external surfaces are free from protruding features and can be easily decontaminated.
f) As far as practicable, the outer layer of the package shall be so designed as to prevent the collection and retention of water.
g) Any features added to the package at the time of transport, which are not part of the package, shall not reduce its safety.
h) The materials of the packaging and any components or structures shall be physically and chemically compatible with each other and with the radioactive contents. If applicable account shall be taken of their behaviour under irradiation.
i) In addition to the radioactive properties, any other dangerous properties of the contents of the package, such as explosive nature, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account in the packing.
j) If the gross weight of the package exceeds 50kg then the maximum weight shall be clearly marked on the package.
k) Departments should document how they meet the requirements of ADR 5.1.5.2.3 for the excepted packages they use as a consignor.

NB Additional labelling requirements might be required by other regulations relevant to Dangerous Goods shipments.