UNIVERSITY OF EDINBURGH
GENERIC RISK ASSESSMENT - RADIATION

RP/RA1 - WORK WITH SELF-CONTAINED GAMMA IRRADIATORS

Foreword

This is a generic risk assessment for use by persons involved in or effected by the application of radiation outlined in the Scope section below. It must be read together with the relevant completed and countersigned Proposed Scheme of Work form PSoW/US6. Together they make up the risk assessment of each application for each person working with radiation in the University. The specific control measures for each application are recorded in the relevant Local Rules.

Where risks are recognised with an application that are not included in this assessment the University Radiation Protection Adviser must be informed.

Note that this assessment refers only to the risk arising from radiation. There might be other risks arising from this work and these must be properly assessed using the University's risk assessment approach. Guidance can be obtained from the Health and Safety Department.

Scope

This risk assessment concerns work with apparatus containing gamma irradiating sources used for the purpose of research, sterilisation or intended changes in the physical, biological or chemical properties of material. It refers only to self-contained irradiators where the material under examination or treatment is inserted into an enclosed irradiation chamber.

Hazards

- Irradiation of part or whole of the body to external gamma radiation during normal use.
- Irradiation of part or whole of the body to very high levels of external radiation in case of an accident;
- Contamination of the skin by small amounts of radioactive material due to leakage in normal use, leading to irradiation and possible uptake into the body.
- Contamination of the skin and uptake into the body of large amounts of radioactive material in case of an accident.

Persons likely to be exposed to the hazard: University staff, research staff, students, other workers and members of the public. Pregnant women and persons less than 18 years old would be at particular risk.

Risk before the implementation of control measures:

Category of Person	High	Medium	Low
University staff, research staff, students and other workers	◉	○	○
Members of the public	◉	○	○
Persons particularly at risk: pregnant women and young persons	◉	○	○

The dose rates close to an unshielded source of the type and activity used in gamma irradiators is very high. The activity used in irradiators varies, but a typical irradiator might contain around 120 TBq of caesium-137. The theoretical dose rate at 1 metre distance from such a source would be about 10 Gyh^{-1}. This would give rise to a LD_{50} (60-days) in less than 30 minutes of exposure.

Reasonably foreseeable accidents:

Type of Incident	Possible Effects
Mechanical or electrical failure	Exposure to the main beam; exposure to other high levels of radiation whilst resolving the immediate problems of the failure
Control failure	Exposure to the main beam; exposure to other high levels of radiation whilst resolving the immediate problems of the failure
Serious impact	Increase in external radiation levels; mechanical or electrical failure – see above
Flooding	Mechanical or electrical failure – see above
Fire	Increase in external radiation levels; loss of radioactive material to the atmosphere

Justification and Optimisation

It is assumed that the irradiator is needed to fulfil the desired work. When initially acquiring an irradiator a justification must be made for the desired choice of isotope and the activity of the source(s) should be minimised.

Control Measures

Technical

- The irradiator source(s) must be sealed, and considered as non-dispersible for the purposes of the Radiation (Emergency Preparedness and Public Information) Regulations. To this end, if the activities of any of the sources exceed the relevant values listed below, measures must be taken to ensure that the sources are either classified under International Standard ISO 2919 or issued with a Special Form Certificate, either of which must confirm that the source encapsulation can adequately withstand temperatures of at least 800℃ and external pressures of 7 MPa.
    - Cs-137 10 GBq
    - Co-60 60 GBq
- Each source must be disposed of before the end of the manufacturer's recommended working life, except when the Special Form Certificate is renewed beyond the end of the source's working life, in which case it must be disposed of before the end of the expiry date of that certificate or any subsequent renewal.
- It must not be possible to readily remove the source(s) from the irradiator.
- The sources(s) should be shielded during all normal use and routine maintenance operations to reduce accessible dose rates to not more than 7.5 μSvh^{-1}. Where this is not reasonably practicable and higher accessible dose rates are justifiable, procedural controls must be put into place. Normally-accessible dose rates high enough to require classification of workers are not justifiable.
- The source chambers or chamber doors must be interlocked with the sources so that it is not possible to gain access to the chambers whilst the sources are exposed. Interlocking mechanisms must be to a high integrity, and not solely controlled by programmable electronic systems.
- There must be mechanisms to indicate clearly when sources or chambers are in the exposed position.
- Irradiators must be marked in accordance with the Health and Safety (Safety Signs and Signals) Regulations to indicate clearly the presence of radioactive material.
- It must be possible, in case of equipment failure, to return sources to their shielded positions without access to significantly increased dose rates.
- In the case of chambers large enough for persons to enter, the following controls must be in place:
    - a clear warning signal inside the chamber to indicate that an exposure is about to take place;

    - a clear warning signal inside the chamber to indicate that exposure is taking place;
    - a means for a person to leave the chamber; and
    - for a person within the chamber, a means to prevent the source(s) being exposed.
- The irradiator must be located within a secure building, and access must be restricted by technical means to those having good reason.
- If exposure rates in excess of 7.5 μSvh^{-1} are normally accessible around the irradiator, it must be located within a separate room or a segregated and demarcated area. Exposure rates outside the room must not exceed 7.5 μSvh^{-1}. The room/area must be marked at the boundary to warn of the presence of both ionising radiation and a controlled area.
- The exposure control must be operated by a removable key.
- A gamma alarm monitor must be fixed near to the irradiator to monitor that radiation levels do not change. It must be set to sound an audible alarm if radiation dose rates exceed 20 μSvh^{-1} at its location.

Procedural

- Installation and assembly, routine maintenance and repair, dismantling and removal of the irradiator must be in accordance with safe systems of work. Where necessary, they must include a specific method statement. Advice should be sought from the University RPA.
- All routine work with the irradiator must be in line with prepared Local Rules and the manufacturer's instructions.
- The exposure control key must be kept secure and separate from the irradiator when the irradiator is not being used.
- All users must be authorised by the University RPA.
- Persons under the age of 18 years must not be allowed to operate the irradiator.
- Where a controlled area exists around the irradiator, the following restrictions must be imposed:
    - undergraduates may only use the irradiator under the direct supervision of an authorised worker.
    - entry to the controlled area must be in accordance with a written arrangement, which must be appended to the Local Rules. All visitors must be accompanied.
    - persons must not be allowed to enter the area once it is known that they are pregnant, except with the agreement of the University RPA and in compliance with any special control measures.
- Where a controlled area does not exist around the irradiator, personal dose monitoring is not required. Where a controlled area does exist, dose assessment might be necessary and advice must be sought from the University RPA.
- The irradiator and ancillary facilities must be inspected and maintained so far as is necessary to ensure their continuing safe use.
- The source(s) must be routinely tested for leakage every six months, and immediately after any incident which might have damaged them.
- The presence of the source(s) must be checked by a suitable safe means every month.
- A survey of the radiation levels around the irradiator and where applicable the controlled area must be carried out annually, and after any incident that could have given rise to damage.
- Plans must be drawn up and included in the Local Rules for procedures in case of the accidents listed above.

Behavioural

- All persons who use the irradiator must be trained in its correct and safe operation.
- Where a controlled area exists around the irradiator, all female workers operating the irradiator must be instructed in the need to inform their line manager as soon as they are aware that they are pregnant.

- A Radiation Protection Supervisor must be appointed to provide suitable supervision of the use of the irradiator. He/she must be trained in the measures required to ensure compliance with the controls outlined in this risk assessment and with the Local Rules.
- All relevant workers must be trained in the action to be taken in order to implement the contingency plans made.

Dose constraint

No special dose constraint is required for work with gamma irradiators.

Dose Investigation level

In view of the fact that the majority of the risks can be controlled by technical means, and classified workers should not be required, an investigation dose level of 6 mSv per annum is set.

Risk after the implementation of control measures:

Category of Person	High	Medium	Low
University staff, research staff, students and other workers	○	○	◉
Members of the public	○	○	◉
Persons particularly at risk: pregnant women and young persons	○	○	◉