



UNIVERSITY OF EDINBURGH GENERIC RISK ASSESSMENT - RADIATION

RP/RA11 – USE OF CYCLOTRON

Foreword

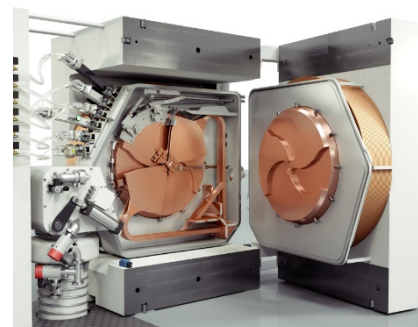
This is a generic risk assessment for use by persons involved in or effected by the application of radiation outlined in the Scope section below. It must be read together with the relevant completed and countersigned Proposed Scheme of Work form. Together they make up the risk assessment of each application 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 are 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 applies to the routine operation of the GE Healthcare PETtrace 8 cyclotron used for the production of radioisotopes. It does not apply to the servicing of the cyclotron. The hazards arising from working with / being exposed to the radioactive products of the cyclotron are covered in separate risk assessments, except for the hazard arising from them before their removal from the cyclotron vicinity.



Hazards

- Irradiation of part or whole of the body by external neutron, beta, positron, or gamma radiation during normal use.
- Contamination and ingestion of radioactive material in case of accident.
- Ingestion of radioactive gas during normal use.

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 radiation levels arising from the cyclotron can be very high and are complex. There can be gamma dose rates up to Sv/h and neutron dose rates of tens of Sv/h. Whole body irradiation at these levels could give rise to a LD₅₀ (60-days) in about 30 minutes of exposure.

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Reasonably foreseeable accidents:

Type of Incident	Possible Effects
A person being in the vicinity of the cyclotron during routine operation	Exposure to scattered radiation
A person being in the vicinity of the cyclotron when a failure in the cyclotron or associated protective measures causes a beam to be generated.	Exposure to scattered radiation
Damage is sustained to any enclosure or shielding as the result of an impact	Exposure to scattered radiation.
Leakage of radioactive material due to a failure of the cyclotron-product containment system.	Internal or skin contamination

Justification and Optimisation

It is assumed that the cyclotron is needed to fulfil the desired work. When initially acquiring the cyclotron a justification must be made for the desired choice of model, and the output.

Control Measures

Technical

- The cyclotron must only be operated in a purpose-built enclosure. The enclosure should reduce the external radiation levels to a time-averaged dose rate of 3 $\mu\text{Sv/h}$ or an instantaneous dose rate of 7.5 $\mu\text{Sv/h}$, as advised by the University Radiation Protection Adviser.
- Access to the enclosure whilst the cyclotron is operating should be prevented by a door or similar that if opened stops the cyclotron generating radiation, and if open prevents the cyclotron generating radiation. If the door is opened whilst the cyclotron is generating radiation, it should not be possible to restart the cyclotron without manual intervention.
- The door(s) to the enclosure must be operable from inside, including in case of power failure.
- The enclosure must be fitted with suitable general extract ventilation to remove any significant accumulations of radioactive gases.
- Suitable instrumentation must be installed to sample the air in the enclosure for radioactivity. The instrument must be capable of sounding an alarm if the concentration of gaseous radioactivity is above a preset activity concentration level, and display the level both locally and at a central control point.
- A suitable fixed gamma radiation monitor must be located in the enclosure, providing an indication in the enclosure and at a central control point. This monitor should have the capability for setting an alarm level, and the alarm should be able to sound in both the enclosure and at a central control point.
- There must be a switch within the room near the exit point which has to be manually activated before the cyclotron can begin generating radiation. This must be interconnected with the door interlock, so that the door has to be closed within a short period of time after operation of the exit switch to allow the cyclotron to operate.
- There must be one or more emergency switches within the enclosure and at the control panel that if operated immediately stop the cyclotron generating radiation. Once operated, they should lock in the operated position and require manual intervention to unlock. They should be clearly labelled.
- There must be one or more warning lights located in a clear position inside and outside the enclosure, and at the control panel that automatically indicate when:
 - the cyclotron is about to operate; and

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- the cyclotron is operating.

The format of the warning lights must be such as to clearly indicate their meaning, and are distinguishable. The warning lights should either be wired so that failure of a light prevents the cyclotron producing radiation, or be duplicated so that the cyclotron can continue to be safely operated.

- The entrance to the enclosure must be fitted with a sign to indicate that it is a radiation Controlled Area when the cyclotron is operating. This could be incorporated with the warning lights.
- The cyclotron should only be operable by using a key switch or password.
- Within the limits imposed by other requirements, the internal surfaces of the enclosure must be designed and installed to minimise the risk of radioactive contamination and permit easy decontamination.
- There must be a hand basin outside the enclosure for personal washing, supplied with hot and cold running water, disposable towels, soap and a nail brush.
- There must be suitable storage facilities within the vicinity for the used cyclotron foils.
- There should one or more appropriate contamination monitors available in case of suspected loss of irradiated product. There must also be access to an appropriate means of measuring dose rates.

Procedural

- The procedures for safe operation of the cyclotron must be written down in Local Rules.
- No person must be allowed in the cyclotron enclosure while it is operating.
- A check must be made that nobody remains in the enclosure before exposure. The last person out must operate the exit switch.
- Routine operation of the cyclotron must be in line with the prepared SOPs and the manufacturer's instructions.
- Operation must only be by persons trained in the correct use of the equipment.
- The exposure control key / password must be kept secure and separate from the cyclotron when it is not being used, and only issued to those authorised to operate the cyclotron.
- All those involved with the operation of the cyclotron must wear a whole-body radiation dosimeter.
- Entry into the cyclotron enclosure after its operation should not be made until the radiation level in the enclosure is such that persons will not receive a cumulative daily dose of more than 24 microSieverts.
- The foils and any associated components must only be handled by trained staff using tongs or similar tools, unless the residual activity has decayed to trivial levels.
- The cyclotron and ancillary facilities must be inspected and maintained so far as is necessary to ensure their continuing safe use and in line with the manufacturer's recommendations. Handover arrangements in between operating and service staff should be described in the Local Rules.
- The operation of warning lights, delay switch, interlocks and emergency switches should be checked weekly and the test recorded.
- Plans must be drawn up and included in the Local Rules for procedures in case of the accidents listed above.

Behavioural

- All users must be authorised using the University's radiation authorisation arrangements, which includes the radiation protection training arrangements.
- A Radiation Protection Supervisor must be appointed to provide suitable supervision of the use of the cyclotron. 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.

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- 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 the work with the cyclotron.

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, the investigation dose level is $\frac{6}{\text{no. of dosemeter wearing periods/y}}$ mSv per dosemeter.

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	○	○	⊙

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