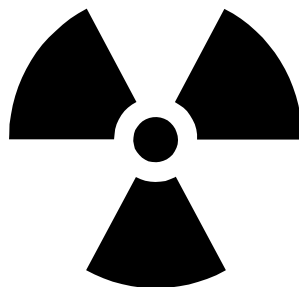
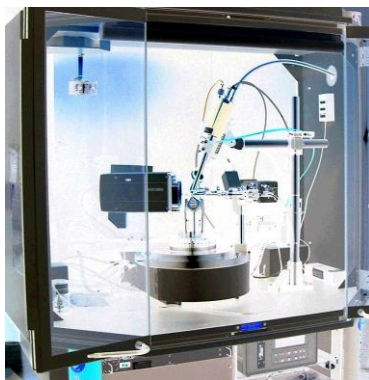
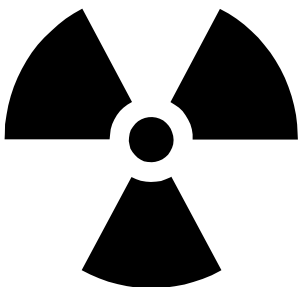
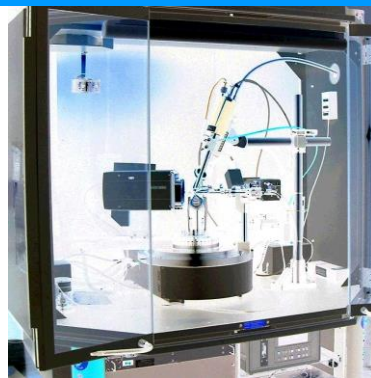
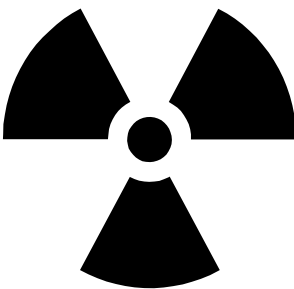
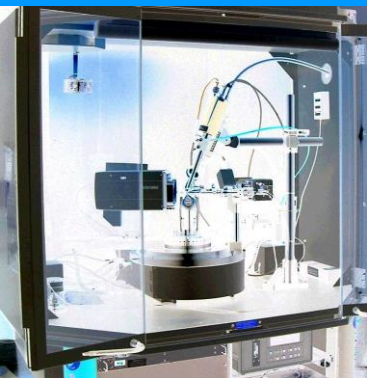


Safety and Radiation Protection Office

Working with X-Ray Equipment

Radiation Safety Rules

May 2016



Radiation Safety Rules – X-Ray Equipment

General Rules for the protection of persons exposed to ionising radiation from sources of x-rays in laboratories at the University of Nottingham. (To be read in conjunction with the Local Rules for any particular area).

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Organisation for Radiation Safety

Director of Health and Safety (Radiation Protection Officer)

The Director of Health and Safety includes the role of University Radiation Protection Officer and acts as the executive officer of the University Safety Committee, putting into effect its decisions relating to the control of radiation hazards. Matters concerning work involving ionising radiation are reported to the University Safety Committee.

Radiation Protection Advisor

Under the Ionising Radiation Regulations 1999 the NUH Medical Physics Department has been appointed as Radiation Protection Adviser, in which capacity they advise the University:

- on matters of limiting radiation dose to personnel,
- as Medical Physics Expert in relation to equipment used for medical exposures,
- in respect of arrangements for securing compliance with the Environmental Permitting Regulations 2010, and licences issued under this, concerning the acquisition, use and disposal of sources.

Radiation Protection Supervisor

The Head of any School working with sources of radiation shall appoint sufficient Radiation Protection Supervisors to develop and monitor local radiation safety arrangements. The Radiation Protection Supervisor shall have appropriate experience and seniority and shall receive appropriate training.

Academic Supervisors

Academic supervisors are responsible for ensuring that those working under their supervision receive the necessary training and instruction to enable them to work safely and in accordance with the Local Rules. There should be sufficient supervision to enable the continuing adherence to correct procedure to be monitored

Medical Adviser

Medical advice concerning exposures to ionising radiation is obtained through the University's appointed Occupational Health provider:

Internal telephone: 14329;

External telephone: 9514329

Principles for the Control of Radiation Exposure

INTRODUCTION

These Local Rules are intended to indicate the general arrangements for work with X-ray sources of ionising radiations that are in force at this University. These arrangements put into practice the requirements of the Ionising Radiations Regulations 1999.

For the purpose of these Local Rules work with ionising radiation includes:

1. Work involving X-ray equipment
2. Work involving electrical equipment emitting ionisation radiation at a potential difference of more than 5,000 volts e.g. cathode ray tubes.

The use of X-ray equipment for the exposure of human subjects is also controlled by the Ionising Radiation (Medical Exposure) Regulations 2000.

The radiation risks must be assessed for any new, modified or relocated equipment so that the radiation protection requirements can be identified and provided before first use. Consequently all X-ray generating equipment must be:

- Pre-notified to and approved by the Safety Office
- Recorded onto site and the location kept up to date,
- Subjected to a Critical Examination to ensure that all safety features and warning indicators are functioning correctly and that dose-rates are within design specifications,
- Access restricted and under the supervision of a designated person,
- Regularly checked for leakage and recorded.

For further information please see: [Management of X-ray Generating Equipment](#)

For each area in which ionising radiation is used (Controlled or Supervised) there are additional Local Area Rules giving details of the area and of the detailed procedures to be used therein.

Together these comprise the "local rules for the purpose of enabling work with ionising radiation to be carried out in compliance with the requirements of the Regulations"

Each member of the University working with sources of ionising radiation is required to have his/her own personal copy of the Local Rules and to certify that it has been read and its contents understood.

In each area there has been appointed a Radiation Protection Supervisor responsible for ensuring that all work in the area is carried out in accordance with the Rules, and all workers must ensure that they are aware of who the RPS is for any area they enter.

No one may enter a designated radiation area (controlled or supervised area) without being aware of the Local Rules for that area. When in the area they must conform to those Rules and with any written system of work in place. This applies both to radiation workers and to all other staff or visitors who may enter the area, including for example cleaners, security staff and contractors.

MEDICAL SUPERVISION OF CLASSIFIED WORKERS

Certain work may require that a person shall be designated as a "Classified Worker" and subject to medical supervision. In this case a satisfactory pre-employment medical examination is required *before* commencing the work. Subsequent examinations are not routinely required but may be carried out if a particular need arises, for example a significant radiation dose received by the worker. The examinations are carried out by the University's

Occupational Health provider with the records maintained under strict medical confidentiality by them.

NEW WORK – PRIOR RISK ASSESSMENT AND APPROVAL

All proposals for new work and/or equipment must be submitted for approval before being put into effect. A special proposal form should be completed and returned to the Safety Office. Approval will only be given when the University Radiation Protection Officer is satisfied that the risks associated with the work have been adequately assessed and the proposed working arrangements and laboratory facilities to control these are satisfactory. In each case there will be one supervisor nominated as taking full responsibility for radiological safety in the proposed work.

For radiation work involving undergraduates, i.e. laboratory practicals or research projects, there are particular requirements on authorising the work and registration of the student. These are summarised in the table in the appendix. The undergraduates must receive written information setting out the hazards of the work, the precautions to be followed and any conditions under which they are taking part in the project.

EMERGENCIES IN RADIATION AREAS

In the event of an incident thought to involve accidental personal exposure, or in the case of fire, the Radiation Protection Supervisor and the Radiation Protection Officer must be informed immediately. Outside normal working hours they should be contacted by telephone via University Security.

Emergency arrangements for each radiation area should be included in the Area Local Rules. Radiation workers should be familiar with the action necessary to be taken to deal with the situation.

Radiation workers should be familiar with the arrangements made by the University in the event of fire and for summoning an ambulance. These arrangements are detailed in a printed notice displayed in each radiation laboratory.

THE TREATMENT OF SERIOUS INJURIES MUST TAKE PRECEDENCE OVER OTHER REMEDIAL ACTION.

In the case of an emergency arising from an apparatus producing ionising radiations, the apparatus should be switched off at once.

General Matters

It is a principle of radiation protection in general and of the Regulations in particular that the University must make arrangements to limit the exposure to all persons as far as reasonably practicable. The University will inform individuals of these arrangements when they first register to undertake work with ionising radiation. No work with ionising radiation may be undertaken by unregistered workers, or otherwise not in accordance with the control procedures relating to teaching practicals.

REGISTRATION OF RADIATION WORKERS

All persons, with the exception under certain circumstances of undergraduate students (see appendix), working with X-ray equipment must be registered with the Safety and Radiation Protection Office. A worker registration form, countersigned by the person's Radiation Protection Supervisor, must be submitted to the Safety and Radiation Protection Office. If considered appropriate a personal radiation dosimeter will be issued. The person may not commence work until the registration process has been completed.

INFORMATION, INSTRUCTION AND TRAINING

Introductory sessions on the principles of radiation protection are held at University Park and Sutton Bonington in the autumn and early spring of each year. All new radiation workers are required to attend the first available session. Further instructions on training specific to the individual's work will be given within their School. The notes relating to this are available from the Safety Office web site.

Thereafter every individual working with ionising radiations or radioactive substances has a duty to protect themselves and others from any hazard arising from their work. They must not expose themselves or others to ionising radiations to a greater extent than is reasonably necessary for the purpose of their work. Any such exposure must be as low as is reasonable achievable.

All radiation workers must be aware of the general safe working principles and must attend all training sessions arranged by their School, and be aware of the particular procedures applying within any controlled, supervised or registered area they may enter. (These are available from the Radiation Protection Supervisor whose name is displayed on the notice at the entrance to the area).

PERSONAL DOSEMETERS

Radiation workers are responsible for the care and correct use of their personal radiation dosimeter. In particular it must be worn when carrying out radiation work and at other times kept in an area away from sources of external radiation. The dosimeter must be available for prompt exchange at the end of the wear period, usually 3 months. Loss of a dosimeter will incur a charge to the School.

The Safety Office receives a quarterly report of dosimeter readings. These are reviewed by the Safety and Radiation Protection Officer. Annual investigation levels are set at 1mSv pa annual whole body dose, 4mSv extremities. Furthermore any readings for a quarter that exceed 0.5 mSv for a whole body badge or 2 mSv for an extremity badge are investigated. In either case these are followed up via the Radiation Protection Supervisor. These levels although low exceed normal expectation for the type of work. A Radiation Worker is entitled to information concerning his or her dose history on proof of identity.

The Ionising Radiations Regulations require that workers who might receive a dose in excess of 6 mSv or three-tenths of any other relevant dose limit shall be "Classified". The nature of work with radiation at the University is such that exposures are highly

unlikely to approach this hence workers are normally not classified. Any worker designated as a classified worker will require Medical Surveillance via Occupational Health.

Working Arrangements with X-Ray Equipment

HAZARD

X-ray sets have the potential of delivering very high dose rates over limited areas. Injury can result from a second's exposure or less in the direct beam. Hence all X-ray sets are provided with safety devices to prevent inadvertent exposure as far as is compatible with the function of the equipment.

Exposure to X-rays can also occur through scattering as it reflects off surfaces such as targets, ancillary equipment, walls and floors. Although less intense than the primary beam, significant exposure could occur over a period of time.

Exposure to others not involved in the work may occur if the primary beam is not properly terminated. In addition to those present elsewhere in the room, exposure could affect those on the other side of walls or passing a window.

The safety features that X-ray equipment is provided with include shielding and interlocks. The shielding prevents release of X-rays from unintended parts of the equipment. Interlocks may be provided on critical removable components to cut off X-ray generation if these are not correctly in place. Incorrect replacement of covers removed for maintenance or adjustment may result in X-ray leakage, which may be in the form of narrow, but intense beams with potential for considerable exposure occurring if not detected. Defective interlocks may similarly result in unintended exposures.

Incorrect assembly of the components may also result in radiation leakage; for example mixing up of components between similar sets of equipment with the result that the fit is not perfect.

AUTHORISATION OF WORK

All X-ray generating equipment must be registered with the Safety and Radiation Protection Office, which will ensure that any statutorily required notifications are made. The equipment and its location will be approved to ensure that both are suitable for the purpose.

Regulation 5 of the Ionising Radiations Regulations 1999 requires that unless an activity is covered by a generic authorisation issued by the Health and Safety executive, then formal authorisation must be obtained from them before work commences ("prior authorisation").

The following types of activities are covered by HSE generic authorisations:

- Diagnostic use of X-ray sets in medical and dental practice
- Use of X-ray sets for routine analytical, diagnostic or investigation purposes
- Use of X-ray sets in baggage, postal or food screening
- Use of X-ray gauging and detection systems in measurement processes
- Diagnostic or therapeutic use of X-ray sets for veterinary purposes
- Accelerators (other than electron microscopes) which emit ionising radiation at energies greater than 1 MeV. This includes all aspects of accelerators such as beamlines and remote target stations.

These do not require prior authorisation providing that the conditions associated with the generic authorisation can be met. These conditions represent Safe Practice and are summarised in the following section.

SAFE PRACTICE

Regulation 8 of the Ionising Radiations Regulations 1999 requires that all necessary steps be taken to keep exposure to ionising radiation as low as reasonably practicable.

The specific steps required to be taken before starting the work include at least the following engineering controls, design features, safety devices and warning devices:

Contained or Enclosed Facility

1. Where the work is to be carried out in a room, purpose made structure, other enclosure or a cabinet:
 - a. adequate shielding as far as reasonably practicable; and
 - b. except in the use of X-ray sets for radiotherapy at or below 50kV, interlocks or trapped key systems or other appropriate safety devices in order to prevent access to high dose rate areas (e.g. in which employed persons could receive an effective dose greater than 20 mSv or an equivalent dose in excess of a dose limit within several minutes when radiation emission is underway). The control system for such safety devices should comply with the performance criteria for safety devices as described in the section below.

Uncontained or Open Facility

2. In other cases, adequate local shielding as far as reasonably practicable and, in the case of site radiography, a suitable system for ensuring that:
 - a. persons other than those directly involved in the exposure are excluded from the area by means of a barrier or other suitable means;
 - b. where employees of another employer may be present in the same workplace, there is co-operation and co-ordination with the other employer(s) for the purposes of restricting access to the controlled area;

- c. warning notices are displayed at the perimeter of the controlled area; and
- d. radiation levels are monitored to establish that controlled areas have been properly designated;

General Requirements

1. Where there is a risk of significant exposure arising from unauthorised or malicious operation, equipment should be fitted with locking-off arrangements to prevent its uncontrolled use;
2. Initiation of exposures should be under key control, or some equally effective means, to prevent unintended or accidental emission of a radiation beam;
3. Suitable warning devices should be provided which indicate when the tube is in a state of readiness to emit radiation and, except for diagnostic radiology equipment, give a signal when the useful beam is about to be emitted and a distinguishable signal when the emission is underway, unless this is impracticable;
4. Adequate and suitable personal protective equipment should be provided where appropriate, for example lead impregnated rubber gloves or aprons where there is a risk of hand or body exposure that cannot otherwise be prevented;
5. Suitable maintenance and testing schedules for the control measures provided should be in place. These include visual checks of shielding and warning devices etc, functional checks of interlocks, periodic monitoring for radiation leaks. In particular these should be carried out after repair, modification or adjustment etc affecting shielding. The equipment will also be monitored annually during the Safety Office inspection.
6. For non-routine operations such as setting up or aligning equipment, where the safeguards for routine operation are

not in use, a procedure for an alternative method of working that affords equivalent protection from the risk of exposure should be produced, documented and incorporated into the local rules. Such procedures are only to be carried out by named "Authorised Persons" working in accordance with the written procedure.

Performance Criteria for Safety Devices

Safety devices provided, as referred to in paragraph (a) (ii) above, should be configured so that the control system will ensure that an exposure:

1. cannot commence while any relevant access door, access hatch, cover or appropriate barrier is open, or safety device is triggered;
2. is interrupted if the access door, access hatch, cover or barrier is opened; and
3. does not re-commence on the mere act of closing a door, access hatch, cover or barrier.

If there is any doubt consult the Radiation Protection Supervisor before use.

Appendix - Procedures for Registering Undergraduate Work with X-ray Equipment

Registration of Work	
Research project work:	<p>The following must be submitted to the Safety Office:</p> <ul style="list-style-type: none"> • a radiation project registration form • risk assessment with dose estimate <p>Based on the equipment used, a decision will be reached as whether or not a dosimetry badge is required for the individual workers.</p>
Practical classes:	<p>The following must be submitted to the Safety Office:</p> <ul style="list-style-type: none"> • a radiation project registration form • risk assessment with dose estimate • experimental procedure/method must be submitted to the Safety Office <p>The project approval for the practical will specify any requirements relating to registration/dosimetry of students.</p>
Registration of Workers	
Undertaking Research Project work:	<p>Registration may be required depending on the nature of the equipment and procedures to be used, as outlined in the project registration form. The formal approval for the research project will specify any requirements relating to registration or dosimetry.</p>
Undertaking Supervised Laboratory Practical Class work:	<p>Registration is not required. It is expected that this will generally not be applicable as the experiment should be inherently safe for undergraduates to carry out under supervision and will not contravene guidance contained within IRR 99. The conditions specified in the project approval for the practical will describe what dosimetry, if any, will be required.</p>
Placements	<p>Registration and dosimetry requirements will depend on the nature of the work.</p>

NB. There are particular limits and prohibitions concerning work with sources of ionising radiation by those under 18 years of age.