Protection Against Occupational Exposure

Radiation Protection Requirements
Objectives

To provide an understanding of occupational radiation protection requirements.

To be able to apply the principles of the protection to optimize occupational radiation exposure.

To understand the importance of an effective safety program to assure the protection of radiation workers.
Contents

• Optimization of protection
• Conditions of employment relevant to radiation protection;
• Procedures for the designation of areas, workplace and individual monitoring.
• Procedures and timing for investigation and follow-up.
• Procedures for local rules and supervision.
• Health surveillance.
• Personal Protective Equipment
• Staff training.
Optimization of Protection

Risk
Unacceptable

Dose
Limit for workers

Source related constraints

Tolerable

Optimized occupational exposure

Acceptable
“Exposure of workers incurred in the course of their work.”

(GSR Part 3, Definitions)
• is a multidisciplinary approach which involves a variety of staff from different backgrounds;
• Employers are obliged to ensure safe working conditions;
• Optimization of protection is essential,
• The professions involved may vary between facilities.
• The type and magnitude of occupational exposure depends on the occupation or profession, e.g.:
  ➢ In radiotherapy high radiation doses are required and consequently there is a potential risk of high doses to staff.
  ➢ In nuclear medicine facilities there is a potential risk of contamination.
  ➢ In interventional radiology, the staff shall have specific training in radiation protection and strict dose control procedures as the risk of deterministic effects can be significant.
Conditions of Service

• Extra salary or other benefits are not to be used as substitutes for proper protection and safety.

• Female worker are instructed to notify the employer of pregnancy.

• Employers shall adapt working conditions as may be necessary for the protection of embryo or foetus.

• Pregnancy is not a reason to exclude a female worker from work.
Registrant or licensees and employers have primary responsibility for the protection of workers and must ensure that:

- **dose limits** are not exceeded and safety is optimized;
- workers, other than those who are "occupationally exposed", are protected as if they were members of the public;
- workers are informed of their obligations and responsibilities for their own protection and that of others;
- safety related reports from workers shall be recorded and appropriate remedial action be taken by the registrant or licensee or employer.
Responsibilities of registrant or licensee

The registrant or licensee shall:

• before commencing use of the radiation sources, ensure that all new installations and all significant modifications have been approved by the Regulatory Body;

• establish public dose constraints to the satisfaction of the Regulatory Body;

• ensure that shielding and other protective measures are optimized in accordance with the requirements of the regulations or other standards approved by the Regulatory Body.
Shielded Enclosures

• As applicable and where practicable (e.g. industrial radiography) should be carried out in a shielded enclosure in order to keep doses As Low As Reasonably Achievable.

• The shielded enclosure should be purpose-built for the specific range of activities to be performed.

• Basic requirements include: maze entrance; wall thickness; roof; scatter and sky shine; warning lights; and emergency buttons.

• Use of standard data tables / drawings for basic wall thickness based on the device and radiation source to be used.

• Calculation using attenuation coefficients and transmission factors

• ALARA considerations should be incorporated into the design.
Potential exposures

“Prospective exposure *that is not expected* to be delivered with certainty but that *may result* from an anticipated operational occurrence, accident at a source or owing to an event or sequence of events of a probabilistic nature, *including equipment failures and operating errors.*”

(GSR Part 3, definitions)

In principle, potential exposures are *avoidable* but the risk can be minimized by:

- prevention.
- education.
- protective equipment.
- mitigating the effects.
**Occupational Dose Limits**

Recommended limits from the IAEA Basic Safety Standards, (GSR Part 3)

<table>
<thead>
<tr>
<th>Effective Dose Limits</th>
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<tbody>
<tr>
<td><strong>20 mSv per year averaged over 5 years</strong></td>
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<tr>
<td><strong>50 mSv in a single year</strong></td>
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<tr>
<th>Equivalent Dose Limits</th>
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<tr>
<td><strong>Lens of the eye</strong></td>
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<tr>
<td><strong>20 mSv per year averaged over 5 years</strong></td>
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<tr>
<td><strong>50 mSv in a single year</strong></td>
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<tr>
<td><strong>Skin</strong></td>
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<td><strong>500 mSv per year</strong></td>
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mSv – millisievert.

However, optimization procedures should aim for dose minimization.
A controlled area is “a defined area in which specific protection measures and safety provisions are or could be required for:

(a) controlling exposures or preventing the spread of contamination in normal working conditions; and

(b) preventing or limiting the extent of potential exposures.”

(GSR Part 3, Definitions)

e.g. areas such as:

• rooms housing Cat. I and III gamma irradiators; Cat. I electron beam irradiator;

• exposure and control rooms for Cat. II and IV gamma irradiator; Cat. II electron beam irradiator;

• areas used for storage of radioactive sources; or for loading and unloading of well logging tools.
Designation of controlled areas (cont)

All controlled areas shall be:

- identified by a physical barrier and display a warning symbol and appropriate instructions at access points and other appropriate locations within controlled areas;

- effectively restricted to approved persons e.g. qualified operators, authorized maintenance workers, etc.
Designation of supervised areas

Supervised area

“A defined area not designated as a controlled area but for which occupational exposure conditions are kept under review, even though no specific protective measures or safety provisions are not normally needed.” (GSR Part 3, Definitions)

e.g. areas such as:

• product entry, product exit and service areas such as source hoist and water treatment rooms for Cat II and IV gamma irradiators;

• product entry, product exit and service areas for Cat II electron beam irradiators.
Local Rules and Supervision

The registrant or licensee / employer shall:

- prepare written safe working rules and procedures;
- identify investigation levels and determine the procedures to be followed if these are exceeded;
- through appropriate supervision, ensure that the safe working rules and procedures are followed;
Local Rules and Supervision

The registrant or licensee / employer shall provide:

- information to workers on perceived health risks including information to female workers on radiation and pregnancy;
- information, instructions and training on emergency procedures.
Workplace Monitoring

- A workplace monitoring programme is required.
- The licensee must have an appropriate number of portable radiation survey instruments, including spare instruments to replace those undergoing calibration or repair. (Electron beam facilities $\geq 10$ MeV shall also be monitored for neutrons.)
- Survey instruments must have an appropriate energy response; be in good working condition; be able to measure normal and accident condition dose rates without saturation or fold back; have readily available batteries and a built-in battery check.
Workplace Monitoring (cont)

- Survey instruments must be calibrated by an organization approved by the Regulatory Body before they are first used, immediately after repair, and at regular intervals prescribed by the Regulatory Body.

- Example: No person should enter the irradiator room without a working, survey meter even if ambient radiation levels are believed to be normal.
Individual Monitoring

- Individual monitoring is required for all workers employed in a controlled area.

- Monitoring of worker in supervised areas is not required but their occupational exposure must be assessed.

- The frequency of monitoring shall be specified by the Regulatory Body;

- The monitoring service provider shall be approved by the Regulatory Body.
Dose monitoring

• “For any worker who usually works in a controlled area, or who occasionally works in a controlled area and may receive a significant dose from occupational exposure, individual monitoring shall be undertaken where appropriate, adequate and feasible. In cases where individual monitoring of the worker is inappropriate, inadequate or not feasible, the occupational exposure shall be assessed on the basis of the results of workplace monitoring and information on the locations and durations of exposure of the worker.”

(GSR Part 3, 3.100)
Dose monitoring

Staff who are not regularly at risk may be monitored temporarily. e.g. using a film badge, TLD or pocket electronic dosimeter.

However, readings should be recorded for review by the RPO and Regulatory Body.
Health Surveillance

The health surveillance of radiation workers:

- is defined by the GSR Part 3 as “medical supervision intended to ensure the initial and continuous fitness of workers for their intended task”;
- is based on general principles of occupational health;
- should be designed to assess the initial and continuing fitness of workers for their intended tasks.
Worker doses are minimized by the application of the principles of time, distance and shielding.

In addition to the principles of time, distance of shielding, operators dealing with unsealed radioactive sources may need to use protective clothing (coats, gloves, etc) and, if the source is volatile (e.g. iodine), may need a suitable respirator to prevent inhalation.

Adequate and appropriate protective equipment shall be made available where necessary.
Records of Worker Exposure

Records are to:

- include the nature of work and the periods of employment;
- include doses, intakes received under normal work conditions;
- include doses, intakes in emergency intervention or accidents;
- be accessible by individual workers and the Regulatory Body;
- be retained by the registrant or licensee and employer or the Regulatory Body (typically 30 years after the end of work or until the worker would be 75).
Investigation and follow-up is required:

- when individual dose limits are exceeded;
- when indicated by QA activities;
- after equipment failure;
- after any accidental exposure.
Investigation and follow-up is required:

- as soon as possible after the event;

  A written report should be prepared showing:
  - the doses received;
  - the causes of the event;
  - the corrective actions taken.

 Regulations may require a copy of the report to be submitted to the Regulatory Body without delay.
Investigation (cont)

Investigations and reports

- Provide an important opportunity to learn (and promote the facility’s safety culture).
- The aim should not be to lay blame.
- Publication of the incident / accident will help others to avoid similar problems.
- It may be useful to include an external expert in the investigation.
- Documentation is essential, particularly where there is a risk of litigation.
Follow-up

• Medical follow-up of exposed individuals may be required.
• Check that the corrective measures actually work.
• Include the corrective measures in ongoing employee education.
Pregnant workers

Occupationally exposed female staff should notify the RPO / licensee of pregnancy as soon as possible.

- A 2 mSv dose constraint should be readily achievable provided licensees maintain appropriate protection standards and both staff and management have a sound safety culture.
- Notification of pregnancy should not be a reason to exclude a female worker from her normal duties.
Age limitations

• No person under the age of 16 years shall be subjected to occupational exposure.

• No person under the age of 18 years shall be allowed to work in a controlled area unless supervised, and only for the purpose of training.
“Response organizations and employers shall ensure that no emergency worker is subject to an exposure in an emergency in excess of 50 mSv other than:

• for the purposes of saving life or preventing serious injury;
• when undertaking actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment; or
• when undertaking actions to avert a large collective dose”

(GSR Part 3, 4.15.)
“Employers, in cooperation with registrants and licensees:

• (a) Shall provide all workers with information on health risks due to their occupational exposure in normal operation, anticipated operational occurrences and accident conditions, instruction and training and periodic retraining in protection and safety, and information on the significance of their actions for safety;

• (b) Shall provide those workers who could be involved in or affected by the response to an emergency with information, instruction and training and periodic retraining, for protection and safety;

• (c) Shall maintain records of the training provided to individual workers…”

(GSR Part 3, Requirement 26)