Annual doses from natural background radiation vary on average between 1 mSv and 5 mSv worldwide.

The typical dose from a chest X-ray is 20 µSv. (Sv)

The unit of absorbed dose is the gray (Gy). The unit used to quantify the dose in radiation protection is the sievert. One millisievert (mSv) is 1/1000 of a sievert.

One microsievert (µSv) is 1/1000 of a millisievert.

Dosimeters: If dosimeter badges are provided, they should be worn between the shoulders and the hips. Small dosimeters, worn on a finger, can monitor the dose to the hand. Dosimeters must be returned to the provider so that the dose information can be read. Dosimeters must not be shared.

Dosimeters do not provide protection from exposure to ionizing radiation, they are a means of assessing the dose that the wearer has received.

Dose rate is the dose received in a given time. The unit used is microsieverts per hour (µSv/h).

If the dose rate at 1 m from a source is 100 µSv/h, then they will receive a dose of 20 µSv.

Radiotherapy

Radiotherapy is the use of ionizing radiation to kill diseased tissue. Radiation sources used for radiotherapy may be external to the tissue (external beam therapy) or in contact with the tissue (brachytherapy). Radiation therapy sources are designed to deliver very high radiation doses to the treatment area. However, from an occupational exposure point of view:

- safety features are installed and maintained
- staff are trained to follow procedures

then staff doses will be low, typically 1 mSv per year or less

but doses can be very high if there are accidents.

Radiation doses to staff must be kept: As Low As Reasonably Achievable: ALARA

RADIATION PROTECTION FROM EXTERNAL EXPOSURE

Exposure to gamma and X rays can be controlled by consideration of time, distance and shielding.

In an area where the dose rate is 100 µSv/h, the dose received will be:

<table>
<thead>
<tr>
<th>Time</th>
<th>Dose Rate</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 minute</td>
<td>100 µSv/h</td>
<td>10 µSv</td>
</tr>
<tr>
<td>5 minutes</td>
<td>100 µSv/h</td>
<td>50 µSv</td>
</tr>
<tr>
<td>30 minutes</td>
<td>100 µSv/h</td>
<td>300 µSv</td>
</tr>
<tr>
<td>1 hour</td>
<td>100 µSv/h</td>
<td>1000 µSv</td>
</tr>
<tr>
<td>2 hours</td>
<td>100 µSv/h</td>
<td>2000 µSv</td>
</tr>
</tbody>
</table>

Shielding

Shielding material must be appropriate for the type of radiation. For example:

1 cm of plastic will totally shield all beta radiation.

Load and concrete can be used to shield against gamma and X radiations.

BRACHYTHERAPY

Brachytherapy

Brachytherapy treatments may involve placing the source directly against the diseased tissue (direct loading) or placing a source into applicators or tubes for a prescribed time (after loading). Brachytherapy using high dose rate sources must be carried out in a controlled environment where:

- Staff must remain outside the room during the treatments.
- The treatment room must be fitted with interlocked doors and warning signs.
- The patient must be supervised via a shielded window or a closed circuit TV (CCTV).
- A radiation monitor of scattered radiation must be present inside the room to show when the source is in use.

The requirements for using low dose rate sources are not as stringent as those listed above.

Care of sources

Radioactive sources must be:

- Stored in a secure, shielded and labeled storage facility.
- Labelled with the radionuclide name, activity and serial number.
- Checked each day, and whenever a source is moved; a record of these checks must be kept.

EXTERNAL BEAM THERAPY

External beam therapy treatment requires very high dose rates which may be delivered by radioactive sources (e.g. cobalt-60) or radiation generators (e.g. linear accelerators).

Defence in depth

Defence in depth means safety in many layers so that if a single safety feature fails, protection will still be provided. In external beam therapy, this means:

- A treatment room that offers good shielding.
- A maze entrance to the treatment room.
- Interlocked access points.
- Signals in the room and at the entrance when dose rates are high.
- Emergency off switches in the room.

The safety features must be designed such that a component failure will cause the device to attain rest in a safe condition.

The safety features must be regularly serviced.

Radioactive sources emit radiation all the time, but are shielded when not in use.

Radiation generators do not emit radiation when they are switched off. However, generators can sometimes induce activity that will normally take a very short time to decay.

If radiation doses are very high, the effect on the body will appear relatively soon after the exposure. These acute injuries will occur if the absorbed dose is higher than a threshold value; the sources or equipment used in radiotherapy are capable of delivering such doses. It is therefore essential that procedures for work are followed.

Even if the dose is not high enough to cause serious injury, there is still the possibility of inducing other health effects. These effects, e.g. radiation induced cancer, are risk related, i.e. the higher the dose received, the greater the chance of developing the effect. To reduce the possibility of developing late effects, radiation doses must be kept.

AS LOW AS REASONABLY ACHIEVABLE (ALARA)

DO AND EFFECTS

Units of dose

The unit of absorbed dose is the gray (Gy). The unit used to quantify the dose in radiation protection is the sievert (Sv).

- One millisievert (mSv) is 1/1000 of a sievert.
- One microsievert (µSv) is 1/1000 of a millisievert.

- Annual doses from natural background radiation vary on average between 1 mSv and 5 mSv worldwide.

- One microsievert (µSv) is 1/1000 of a millisievert.

Dose rate

- Dose rate is the dose received in a given time.
- The unit used is microsieverts per hour (µSv/h).

- If a person spends two hours in an area where the dose rate is 10 µSv/h, then they will receive a dose of 20 µSv.

Health effects of radiation exposure

If radiation doses are very high, the effect on the body will appear relatively soon after the exposure. These acute injuries will occur if the absorbed dose is higher than a threshold value; the sources or equipment used in radiotherapy are capable of delivering such doses. It is therefore essential that procedures for work are followed.

Even if the dose is not high enough to cause serious injury, there is still the possibility of inducing other health effects. These effects, e.g. radiation induced cancer, are risk related, i.e. the higher the dose received, the greater the chance of developing the effect. To reduce the possibility of developing late effects, radiation doses must be kept.

DO NOT

- Enter the room if the "radiation on" warning light is illuminated.
- Use the room if any of the safety features are damaged.
- Use the room unless you are sure that it is safe.