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WORKING WITH IONISING RADIATION

Distance Learning Pack

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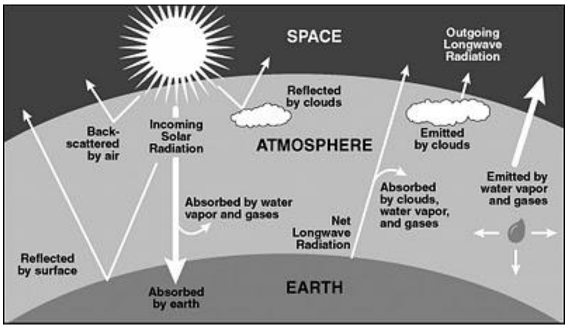
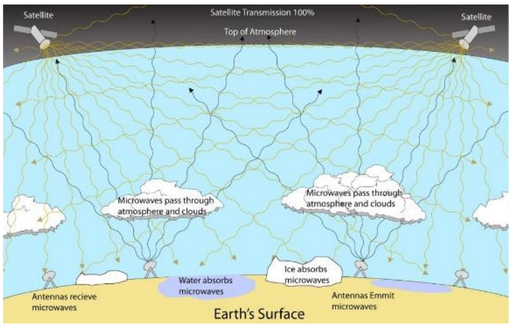
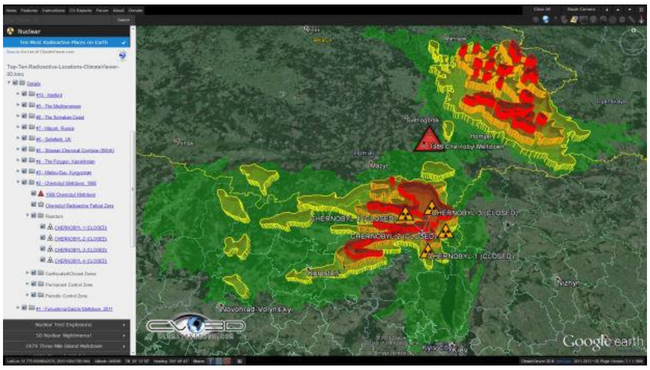
What is Radiation?

Radiation is a general term referring to any sort of energy that can travel through space either as a wave or a particle.

The sources of radiation and the waves emitted by radiation are everywhere and are a part of everyday life







In considering related health risks, radiation may be classed as:

- non-ionising radiation (low energy)
- ionising radiation (high energy)

Everyone is exposed to natural background radiation and much of the population also has occasional exposure through medical or dental x-rays. A person will usually only be exposed to man-made ionising radiation during certain medical tests, but the levels are so low that the chances of problems developing are small.

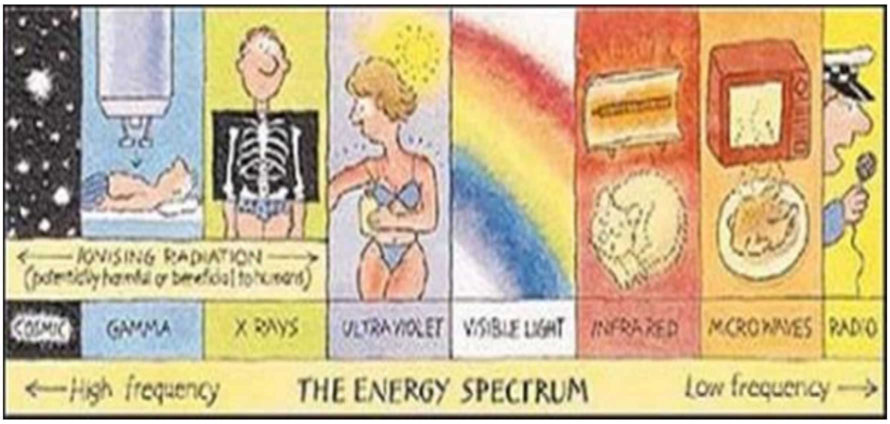
Radiation occurs as either electromagnetic waves (ranging from radio waves through visible light to x and gamma rays) or particles (such as alpha or beta particles and neutrons).

The use of these procedures in healthcare has to be justified by the benefit of the patient – exposure to a small amount of radiation may carry a tiny risk for health, but this may be outweighed by the benefits of diagnosing and then being able to treat serious conditions.

However, these procedures may expose others to small doses of radiation –generally those who carry out the procedure or who are caring for the patient.

Because there is no benefit to these people, exposure is strictly controlled and has to be kept below certain limits. There are strict regulations on the permitted radiation exposure for employees, although the emphasis should be on reducing the exposure as much as possible, not just keeping within legal limits.

Types of Radiation



Non-Ionising Radiation

Examples of non-ionising radiation include:

- ultraviolet radiation
- visible light
- infrared radiation
- microwaves
- radio and radar waves
- wireless internet connections (wifi)
- mobile phone signals

Overall, there is little evidence to suggest most types of non-ionising radiation are harmful at levels you are normally exposed to, but some forms of non-ionising radiation are potentially dangerous.

Ionising Radiation

Ionising radiation includes:

- Ultraviolet radiation, which is found in sunlight
- X-rays, which are used in medical imaging machines
- Gamma rays, which are produced by some radioactive materials

As a result, care needs to be taken when handling ionising radiation. Ionising radiation such as x-rays and alpha, beta or gamma radiation occurs naturally from the decay of natural or manufactured radioactive substances. X-rays can also be generated by high voltage electrical equipment.
Work with ionising radiation is regulated by the Health and Safety Executive (HSE) and local authorities under the Ionising Radiations Regulations 1999 and its associated approved code of practice and guidance.

Types of Ionising Radiation

Alpha – consist of two protons and two neutrons and has a positive charge.
They have little power to penetrate the skin and can be stopped using a flimsy material such as paper. The main route into the body is by ingestion and once in your body alpha particles can cause intense local radiation and immense damage to the affected tissues.

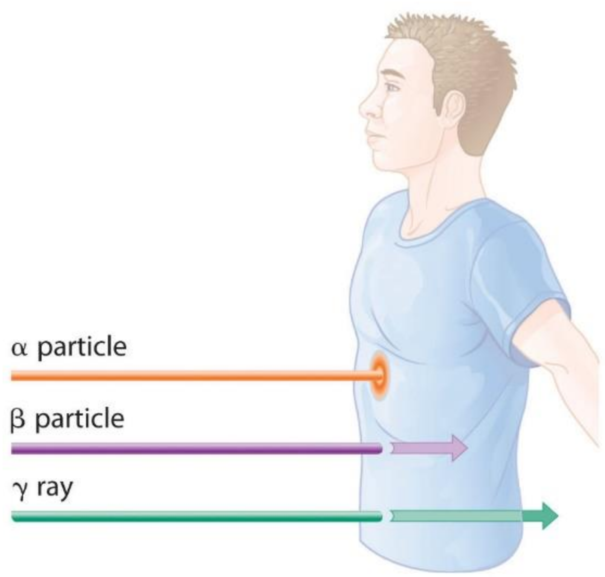
Beta – particles have greater penetrating power than alpha particles but the ionising is less severe. Beta particles are high speed electrons whose power of penetration depends on their speed, but penetration is usually restricted to two centimetres of skin tissue. They can be stopped using aluminium foil. There are normally two routes of entry into the body – inhalation and ingestion.

Gamma – electromagnetic radiations that have far greater penetrating power than alpha or beta particles. They are produced from nuclear reactions and can pass through the body with great penetrating power. Gamma is caused by radioactive decay and emits radiation all the time.

X-rays – electromagnetic radiations whose penetrating power depends on their energy. Commonly created in X-ray machines, the radiations cease when the machine is switched off.

Neutrons – neutrons are emitted during nuclear fission and have very great penetrating powers. They can cause intense ionising.

Bremsstrahlung – electromagnetic radiations produced by the slowing down of a beta particle. They can have considerable penetrating powers.



Sources of Ionising Radiation

The use of ionising radiation covers the use of radioactive materials and radiation generators in work activities. Ionising radiation sources are used in the following industries:

- Nuclear
- Manufacturing
- Construction
- Engineering
- Oil and gas production
- Non-destructive testing
- Medical and dental sectors
- Education and research establishments (eg universities and colleges).

However healthcare is one of the main workplaces where ionising radiation is deliberately used. Ionising radiations can also occur naturally, the best example of this being radon, which is a radioactive gas that occurs mainly at or near granite outcrops where there is a presence of uranium.

We are all exposed to a little radiation in the environment, but at levels which are not considered harmful. This is referred to as background radiation. When radiation is used in healthcare, staff may be exposed to a small dose during the procedure or while they are caring for a patient who has received treatment with radioactive substances.

X-rays

X-rays are the most common use of ionising radiation in medicine. X-rays are transmitted through tissues but different tissues allow varying amounts through, creating a shadow image of the structures of the body. X-rays don't make the patient radioactive and expose them to low doses of radiation – typically a chest X-ray is equivalent to the normal background dose of radiation received every three days. However, healthcare workers who are routinely involved in X-rays risk multiple exposures to very small amounts of radiation unless precautions are taken.

CT scans provide a 3D view of the body by using multiple images produced by an X-ray beam. CT examinations give doses of radiation equivalent to that received from background radiation in three to four years.

Nuclear medicine

This uses radioactive substances attached to drugs to reach certain parts of the body. The substances used have a short half-life – which means the radioactivity declines very quickly – which minimises the radioactive dose to the patient.

These radiopharmaceuticals are used in the diagnosis of many diseases of the internal organs and also in the treatment of some conditions, such as hyperactive thyroid glands and prostate cancer.

Radiotherapy

Radiotherapy works by using high doses of radiation targeted to kill cancer cells but to leave surrounded tissues unharmed. This is either through a beam of radiation or by planting sources of radiation close enough to the tumour to kill it.

The doses received from radiotherapy are hundreds of thousands of times greater than those from diagnostic procedures

Harmful effects of ionising radiation

Ionising radiation can break molecules into smaller fragments. These charged particles are called ions. Ions can then take part in other chemical reactions in the living cells. As a result, ionising radiation damages substances and materials, including those in the cells of living things. The ions themselves can take part in chemical reactions, spreading the damage. This may result in the living cells dying or becoming cancerous. Radiation can also affect DNA, causing mutations.

The effects of these ionising attacks depend on the following factors:

- The size of the dose – the higher the dose then the more serious will be the effect
- The area or extent of exposure of the body – the effects may be far less severe if only a part of the body (like an arm) receives the dose
- The duration of the exposure – a long exposure to a low dose is likely to be less harmful than a short exposure to the same quantity of radiation.

Depending on the size of the dose acute exposure can cause, blood cell changes, nausea, vomiting, skin burns, blistering, collapse and death. Chronic exposure can lead to anaemia and/or leukaemia and other forms of cancer.

Ionising radiation can also have an adverse effect on the function of human reproductive organs and processes. Increases in the cases of sterility, stillbirths and malformed foetuses have also been observed.

The health effects of ionising radiation may be summarised into two groups – somatic effects, which refer to cell damage in the person exposed to the radiation dose and genetic effects, which refer to damage done to the children of the irradiated person.

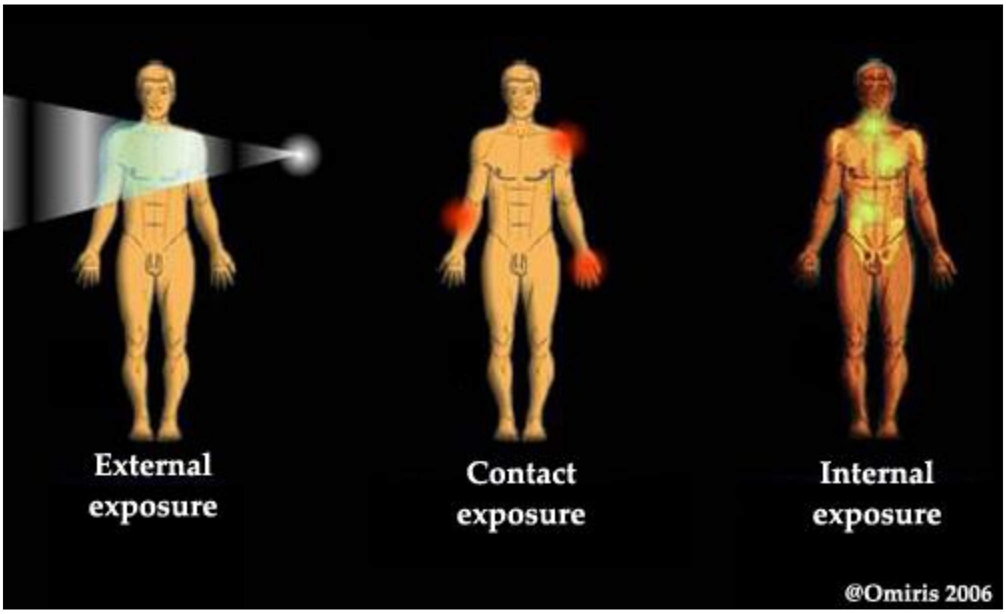
Type of Exposure

Radiation exposure may be internal or external, and can be acquired through various exposure pathways.

Internal exposure to ionizing radiation occurs when a radionuclide (Radionuclides are often referred to by chemists and physicists as **radioactive isotopes** or **radioisotopes)** is inhaled, ingested or otherwise enters into the bloodstream (e.g. injection, wounds). Internal exposure stops when the radionuclide is eliminated from the body, either spontaneously (e.g. through excreta) or as a result of a treatment.

External contamination may occur when airborne radioactive material (dust, liquid, aerosols) is deposited on skin or clothes. This type of radioactive material can often be removed from the body by simply washing.

Exposure to ionizing radiation can also result from external irradiation (e.g. medical radiation exposure to X-rays). External irradiation stops when the radiation source is shielded or when the person moves outside the radiation field.



How Ionising Radiation Affects the Body

Radiation damage to tissue and/or organs depends on the dose of radiation received, or the absorbed dose which is expressed in a unit called the gray (Gy). The potential damage from an absorbed dose depends on the type of radiation and the sensitivity of different tissues and organs. The sievert (Sv) is a unit of radiation weighted dose also called the effective dose. It is a way to measure ionizing radiation in terms of the potential for causing harm. The Sv takes into account the type of radiation and sensitivity of tissues and organs. The Sv is a very large unit so it is more practical to use smaller units such as millisieverts (mSv) or microsieverts (µSv). There are one thousand µSv in one mSv, and one thousand mSv in one Sv. In addition to the amount of radiation (dose), it is often useful to express the rate at which this dose is delivered (dose rate) e.g. µSv/hour or mSv/year.

If the dose is low or delivered over a long period of time (low dose rate), there is greater likelihood for damaged cells to successfully repair themselves. However, long-term effects may still occur if the cell damage is repaired but incorporates errors, transforming an irradiated cell that still retains its capacity for cell division. This transformation may lead to cancer after years or even decades have passed. Effects of this type will not always occur, but their likelihood is proportional to the radiation dose. This risk is higher for children and adolescents, as they are significantly more sensitive to radiation exposure than adults.

Epidemiological studies on populations exposed to radiation (for example atomic bomb survivors or radiotherapy patients) showed a significant increase of cancer risk at doses above 100 mSv.

Prenatal exposure to ionizing radiation may induce brain damage in foetuses following an acute dose exceeding 100 mSv between weeks 8-15 of pregnancy and 200 mSv between weeks 16-25 of pregnancy. Before week 8 or after week 25 of pregnancy human studies have not shown radiation risk to foetal brain development.

Small localised exposure can cause:

- Redness of the skin
- Cataracts in the eyes
- Loss of fertility.

Sun Burn

General whole body exposure can result in:

- Nausea, vomiting and diarrhoea
- Cancer of the skin and other organs
- Leukaemia.

Radiotherapy Burn

Optical radiation and non-visible

Optical radiation is another term for light, but as well as visible light it also includes ultraviolet radiation and infrared radiation. The greatest risks are posed by UV radiation from the sun. The effect of exposure on the eyes can be damage to the cornea and pain and symptoms similar to those experienced when you get sand in your eye. The effect on the skin can range from redness, burning and accelerated ageing through to various types of skin cancer. Recent research has also identified the increased risk to the public of using sun beds.

In the medical sector, one of the greatest hazards is the misuse of powerful lasers, which can cause serious damage to the eye (including blindness) as well as causing skin burns or starting fires. Other hazards from optical radiation in the medical sector include photodynamic therapy and ultraviolet phototherapy.

Work with radiation is governed by the following pieces of legislation:

- Management of health and safety at work regulations 1999 (MHSWR)
- Ionising radiation regulations 1999 (IRR99)
- Radiation (emergency preparedness and public information) regulations 2000 (REPPIR)
- Ionising radiation (medical exposures) regulations 2000
- Radioactive substances act 1993 (RSA)
- Medical administration of radioactive substances 1978 (MARS)
- Medical devices regulations (MDR)
- Physical agents (optical radiation) directive
- The physical agents (EMF) directive
-

As with all health and safety legislation, the ultimate duty for compliance lies with the chief executive of the organisation. Day to day management of health and safety, and of services involving the use of radiation within the organisation, may be delegated to a director or senior manager, but it should be remembered that the duty of compliance still stays with the chief executive.
IR(ME)R is made as a Statutory Instrument under the Health and Safety at Work etc. Act 1974. This means that the Regulations form part of health and safety legislation and are thus criminal legislation.

Ionising Radiation (Medical Exposure) Regulations 2000 (IRMER)

The IRMER is legislation intended to protect the patient from the hazards associated with Ionising Radiation. The regulations control the exposure of people to radiation for medical purposes, including diagnosis, therapy and research. Diagnostic exposures include x-ray, CT, nuclear medicine, and bone density scans, but not MRI or ultrasound. The regulations aim to protect patients by restricting who may request, justify and carry out radiation exposures of patients. Training requirements are specified for those justifying and carrying out exposures.

The management of ionising radiation and radioactive sources should be carried out effectively and in full accordance with all legal requirements. In particular, sources of ionising radiation should only be used where there is no safer alternative, and exposures will be prevented where this is reasonably practicable. Where there is a perceived risk of exposure, appropriate dosimetric monitoring should be carried out, and the results recorded. The generation and disposal of radioactive waste material should be minimised and undertaken in accordance with the requirements of EPR2010.

Current legislation places a range of duties on employers, which include a duty to:

- Eliminate or reduce to as low as reasonably practicable (ALARP) the risk of exposure. Where exposure cannot be eliminated they are required to devise measures by which the levels of exposure can be reduced below the exposure limit value (ELV) for non-ionising radiations and to a level which is ALARP for ionising radiations. Equipment for medical exposures is selected to restrict doses to patients so far as is reasonably practicable
- Ensure that radiation dose limits are not exceeded
- Provide suitable personal monitoring and ensure staff are suitably designated
- Ensure that environmental levels of radiation are assessed and areas suitably designated
- Arrange for risk assessments to be carried out and assess exposures
- Provide details of the risk assessments to the person with nominated responsibility for health surveillance
- Notify the regulator of any suspected overexposure of persons. Notify the regulator of exposures of patients which are much greater than intended
- Consult or appoint a radiation protection adviser
- Appoint suitable and sufficient radiation protection supervisors
- Ensure that suitable information instruction and training is provided.

Employees have a duty to:

- Attend training programmes as required and maintain own competence via recognised programmes of Continuing Professional Development (CPD).
- Only undertake work for which they have been adequately trained and are entitled to do so.
- Never use equipment on which they have not been trained.
- Must wear as directed, and return as required, any personal dose meter issued.
- Report any incident immediately in line with their employers Healthcare's Incident Reporting Policy.
- Do not recklessly endanger the safety of others.
- Should advise managers as soon as possible that they are pregnant so that appropriate precautions can be taken.
- Any case of a suspected or known over-exposure of a patient or a member of staff must be brought to the immediate attention of the RPS and the relevant Head of Service and Locality Manager.

Care Quality Commission (CQC)

Since November 2006 the Care Quality Commission (CQC) has been responsible for enforcing the Ionising Radiation (medical exposure) Regulations 2000 (IR(ME)R) in England, as a result of amendments made to the regulations in 2006. Inspections are also carried out by HSE, MHRA and the IR(ME)R inspectorates in the devolved administrations.

If CQC is notified of an "exposure much greater than intended" they will investigate it, usually through correspondence or clarifying the circumstances by telephone.

Protective Measures

Any establishment where radiation is used needs to carefully assess and minimise the risks to staff, in line with the Ionising Radiation Regulations. The aim should be to achieve as low an exposure as reasonably practical.

A number of protective measures should be employed:

- Personal radiation exposure can be measured using a film badge, which is worn by the employee over a fixed time interval. The badge contains a photographic film which, after the time interval, is developed and an estimate of radiation exposure is made. A similar device, known as a radiation dose meter or detector, can be positioned on a shelf in the workplace for three months, so that a mean value of radiation levels may be measured.
- Instantaneous radiation values can be obtained from portable hand-held instruments, known as Geiger counters, which continuously sample the air for radiation levels. Similar devices are available to measure radon levels.
- Physical avoidance – in rooms where X-rays and CT scans are being carried out, access will often be limited to essential staff and staff will position themselves to minimise exposure. Increasing the distance between the primary beam and the operator is an effective way of reducing exposure.
- Limiting the time staff spent in an environment where radiation is being used. Some procedures will take longer than others. Staff in cardiovascular labs, for example, are often involved in lengthy procedures that may expose them to a larger cumulative dose.
- Protective equipment includes lead aprons, gloves, collars to cover the thyroid gland and glasses. Sometimes a lead screen is also used to protect the brain.
- Well-maintained equipment that is used in accordance with instructions will also help to lessen the exposure of staff.
- If a patient is suffering from radiation exposure, advice should be sought on how to protect staff caring for them. Alpha particles, for example, can be excreted in urine or faeces, although risks to staff are likely to be small.

Health Protection Agency has advice on the assessment of contaminated patients and the procedures that should be followed to protect staff in the event of an emergency involving radioactive material. These are likely to be reflected in organisations' emergency planning.
There will be times when staff may need to be excluded from work involving radiation. This may be because they are judged to have already been exposed to an acceptable limit or are judged to be particularly at risk.

Pregnant women are subject to much lower exposure limits because of the effects of radiation on rapidly dividing cells in the foetus during the early weeks of pregnancy. Potential problems from excess exposure include miscarriage, birth defects, intrauterine growth retardation and induction of childhood cancers. In some cases, it may be appropriate for them to be reassigned to duties which do not involve exposure. Women who are breast feeding will also need special consideration.

The role of RPS and the role of RPA

An employer working with radiation must consult a Radiation Protection Adviser – a specialist in radiation safety and the application of the legislation.

The radiation protection supervisor (RPS) role is to supervise the work so that it is done in accordance with the local rules. The legal responsibility for management of radiation safety, however, remains with the employer.

The employer has a specific duty to provide appropriate training for all employees working with ionising radiation (see Regulation 14). This training is to ensure that they know enough about radiation protection principals and procedures, the requirements of the regulations and the arrangements in local rules to enable them to supervise the work safely and maintain the precautions that will restrict exposure. The length of training, including refresher training, depends upon the experience of the RPS and the complexity of the work being undertaken.

The role of the RPA is to advise an employer on compliance with IRR99 and related legislation. RPAs must hold a "certificate of competence".

Medical Physics Expert (MPE)

IR(ME)R requires employers to involve the services of a medical physics expert in managing risk, a role which is separate to those of the RPA and RPS.

Risk Assessment and Risk Management

A manager of people who work with ionising radiation is legally obliged to carry out a prior risk assessment under the Ionising Radiation Regulations 1999 (IRR99) and supporting guidance. They must also ensure that reliable dose information is recorded to help ensure that employees' exposures are as low as reasonably practicable (ALARP) and dose limits are not exceeded.

For people who have been have classified under Regulation 20 IRR99 the manager must engage an approved dosimetry service (ADS) to make systematic assessments of all radiation exposures that are likely to be significant.

There is also a need to keep under review the doses of other people who enter controlled areas and keep a suitable record of such reviews. The purpose is to demonstrate that employees doses remain as low as reasonably practicable and to trigger investigations if they are not. Monitoring such doses might involve a dosimetry service, the radiation protection adviser (RPA) or other suitable experts.

Dose limits

The **Ionising Radiations Regulations 1999 Approved code of practice and guidance** specify dose limits. However, they also require you to keep your employees' exposure as low as you reasonably can.

Employees (over 18 years old) except employees in special cases	20 mSv per year
Trainees (aged 16 to 18)	6 mSv per year
Any other person	1 mSv per year

Dose limitation for employees in special cases

This occurs when an employer is able to demonstrate in respect of any employee that the dose limit specified is impracticable having regard to the nature of the work undertaken by that employee. Any employer wishing to apply the special dose limit of 100 millisieverts in five years (and no more than 50 millisieverts in any single year) for an individual employee would have to establish a need.

The employer would normally consider the work that individual is likely to do in the year ahead and make a judgement as to whether or not that employee’s annual dose would exceed 20 millisieverts, based on predicted doses. The judgement would take account of past experience and any plans for restricting future exposures from particular jobs as far as is reasonably practicable. The employer would also need to be satisfied that the employee’s dose would not exceed the five-year limit (or any other relevant dose limit)

Danger level	Radiation dose	Effect
	2 millisieverts per year (mSv/yr)	Typical background radiation experienced by everyone (average 1.5 mSv in Australia, 3 mSv in North America)
	9 mSv/yr	Exposure by airline crew flying New York-Tokyo polar route
	20 mSv/yr	Current limit (averaged) for nuclear industry employees
	50 mSv/yr	Former routine limit for nuclear industry employees. It is also the dose rate which arises from natural background levels in several places in Iran, India and Europe
	100 mSv/yr	Lowest level at which any long-term increase in cancer risk is clearly evident.
	350 mSv/lifetime	Criterion for relocating people after Chernobyl accident

Danger level	Radiation dose	Effect
	400 mSv/hr	The level recorded at the Japanese nuclear site, 15 March
	1,000 mSv single dose	Causes (temporary) radiation sickness such as nausea and decreased white blood cell count, but not death. Above this, severity of illness increases with dose
	5,000 mSv single dose	Would kill about half those receiving it within a month

SOURCE: WORLD NUCLEAR ASSOCIATION

Dosimetry

Your manager is responsible for ensuring that each employee receive adequate training and instruction about the care and proper use of dosimeters. So they know how and when to wear them, look after them properly and return them on time.

Each employee must make themselves familiar with the arrangements for issue, out-of-hours storage and return dosimeters on time. Employees have a legal responsibility under Regulation 34 IRR99 and Section 7 of the Health and Safety at Work etc. Act 1974 to co-operate with the policies and procedures on the proper use of dosimeters. Suitably secure storage locations for dosimeters must be provided when they not being worn, in a low radiation are away from contamination, chemicals, hot pipes, nonionizing radiation etc which might affect them. Advice from the ADS should tell you what to avoid.

Employees must not store dosimeters in overalls, toolboxes or other places where they may be inadvertently exposed to ionising radiation when not being worn.

Dosimeters must not be screened by x-ray surveillance equipment such as mail/package monitors, otherwise they may register an incorrect dose. Make sure that used dosimeters are returned in packages clearly labelled as containing radiation sensitive materials. At the end of each issue period an accurate list of those employees who wore each numbered dosimeter - identify any late, lost, damaged or contaminated dosimeters must be given to the ADS. Any missing or late dosimeters must be followed up promptly.

Personal Dosimetry

Dosimeters measure an individual's exposure to radiated energy. Ionizing radiation, such as X-rays, alpha rays, beta rays, and gamma rays, are undetectable by the human senses, therefore a measuring device is used to detect, measure and record these, and in some cases give an alarm when a preset level is exceeded.

Ionising radiation damage to the human body is cumulative, and is related to the total dose received, for which the SI unit is the sievert. Therefore, workers exposed to radiation are required to wear dosimeters so their employers can keep a record of their exposure to verify that it is below legally prescribed limits. Such devices are known as "legal dosimeters", meaning that they have been approved for use in recording personnel dose for regulatory purposes.

Best practice guidance on radiation protection and the use of radiation protective equipment from the Royal College of Nursing RCN advices that staffs radiation exposure levels should be monitored using dosimeters. Worn at waist level and beneath protective equipment, dosimeter records are reviewed by a Radiation Protection Supervisor (RPS) who may suggest the use of additional monitors, such as thyroid or eye level. In the event of an identified excessive dosage, the member of staff will be notified and their working practice and environment investigated.

Responsibility for care of film badges

Classified radiation workers have a duty to wear a statutory dosimeter while working with ionising radiations. Failure to do so is taken very seriously by inspectors, because there have been a number of deliberate attempts to disguise bad practices and hide high radiation exposures in this way. Prosecution of the individual is always considered in such cases as failure to wear a dosimeter is seen as a deliberate attempt to break the law.

Managing levels of personal exposure

Non-classified employees who have been provided with a dosimeter by their employer to ensure compliance with Regulation 18(2) (c) (ii) of the IRR99 have a duty to look after that dosimeter and return it for processing as required. Provided the employer has informed the employees of that duty and is exercising the appropriate level of supervision, employees who persistently fail to wear, look after or return their dosimeters promptly are liable to enforcement action by inspectors up to and including prosecution under Section 7 of the HSW Act 1974.

Overexposures

Employers are obliged under **Regulation 4(5)** IR(ME)R to investigate where an incident has occurred or may have occurred in which a person has been exposed to ionising radiation to an extent much greater than intended.

Overexposures are serious but should not lead to the suspension of an employee from radiation work, unless this is the advice of the appointed doctor. If you suspect an overdose has occurred, investigate it immediately (Regulation 25 IRR99).

Where it can’t be ruled out, notify HSE and the appointed doctor and instigate a thorough investigation with the help of your RPA and ADS. Involve any appointed safety representative. If the overdose is confirmed, the employee will need a pro-rata dose limit for the remainder of the year. If the person is not your employee you will need to tell his or her employer as soon as possible.

Informing employees

Employees are entitled to see copies of their own dose summaries and termination records (Regulation 21(6) IRR99) and it is good practice to provide such information automatically.

Employees can also request a copy of their full dose record, which should be obtained from the ADS (record keeping) within a reasonable period of any such request.

Agency workers and employees who also work elsewhere

Agency workers working in any premises should be treated in the same way as external or short term workers and the employer/manager should assure themselves of the dose history and fitness to work of the agency worker.

Regulation 11(5) states: “Where the employer enters into a contract with another to engage a practitioner or operator otherwise employed by that other, the latter shall be responsible for keeping the records and shall supply such records to the employer forthwith upon request.

It is essential that companies supplying radiography agency staff provide their HPC registration and relevant training details to allow employers to entitle them as an IR(ME)R duty holder.”

The regulations also require that female employees who are engaged in work with ionising radiation are informed of the possible risk arising from ionising radiation to the foetus and to a nursing infant, and of the importance of informing the employer in writing as soon as possible:

1. After becoming aware of their pregnancy, or
2. If they are breast feeding.

Role of Occupational Health

The health effects of ionising radiation and the medical management of exposure are complex.
An occupational health programme for classified radiation workers must include medical surveillance and personal exposure monitoring, together with the ability to carry out accident investigation, and medical intervention where necessary. This requires a coordinated approach by the safety professional, the medical physicist, the occupational physician and other health workers, and the radiation workers themselves.

Classified radiation workers are those who have been designated as such by their employers under Regulation 20, due to their work meaning they are likely to receive an effective dose of radiation that exceeds three tenths of a relevant dose limit during a calendar year.

Classified persons are those likely to receive more than 6 mSv per year. Because these people receive higher radiation doses than others, their employer has to provide medical surveillance and keep their dose records for 50 years. The employer must ensure that non-classified persons (employers in the medical radiation field do not usually classify their employees) do not exceed 6 mSv per year.

Medical surveillance programme is only required by law for classified radiation workers and is a duty imposed under Regulation 24. When designating an employee as a classified radiation worker, the employer must ensure that they have been certified fit for the intended type of work within the last

12 months. This may require a medical examination. The employer will then need to ensure that that the employee is in receipt of continuing medical surveillance by an appointed doctor or employment medical adviser. For classified radiation workers, or those being considered for classification, the medical review must be carried out by an appointed doctor under IRR99.

Periodic medical reviews

Although there is no legal requirement for periodic medical reviews of non - classified radiation workers, it is good practice to do these annually or more frequently if recommended by the appointed doctor.

The reviews do not have to include a face to face consultation with the appointed doctor; most will be 'paper reviews' of sickness absence and dosimetry. A face to face medical consultation should, however, take place every five years.

Treatment of acute radiation exposure

The acute management of an employee with acute radiation exposure is not one of the duties of an appointed doctor. This is an area for which specialist training and expertise will be required and does not fall within the remit of the appointed doctor.
However, the appointed doctor should be able to advise on the use of biological dosimetry.

Ionising Radiations Regulations 1999 Approved code of practice and guidance state that radioactive materials, including those in the form of sealed sources, should not be held or directly manipulated in the hand (or close to the hand) if it is practicable for the task to be completed by other means, unless the skin of the hand is unlikely to receive a significant dose and the employee is unlikely to become significantly contaminated with radioactive substances.

This ACOP advice implies that, normally, for research and other laboratories, small quantities of radioactive substances should only be handled where there are no practicable alternatives. In general, it would be practicable to use local shielding and protective gloves in these circumstances so that external radiation and skin contamination risks are controlled effectively.

In general, it is impracticable to avoid handling a syringe containing a radiopharmaceutical for the injection of a patient, although it would usually be practicable to provide a syringe shield to restrict exposure to external radiation.

Types of physical control measures

Engineering controls and design features are normally those physical controls built into the facility or device; they include all aspects of the design and construction which restrict exposure. Where appropriate, these controls will be intrinsic to the operation of the facility or device, for example by the construction of suitable containment and shielding of sources and the design of safety-related control systems to ensure that radiation sources are accessible to no greater extent than is necessary for the work being undertaken by the radiation employer. In other cases, engineering controls and design features will be put in place specifically to allow the safe use of the device. Examples include beam collimation, local shielding to reduce emitted radiation and local containment, ventilation or other steps aimed at minimising contamination during work with unsealed radioactive materials.

Safety Room

Ventilation

Safe storage

Safety features are intended both to help ensure the safe use of the equipment in normal operation and to prevent unintended exposure in the event of a failure of control devices or systems of work. Examples include locks on exposure controls, search and lock-up systems, door interlocks for enclosures and emergency exposure controls ('off' buttons).
Warning devices indicate the status of the equipment in normal operation and alert operators to faults or failures which have occurred and which reduce the safety integrity of the installation. These devices will not of themselves prevent exposure but they will indicate to the equipment operators what action to take and not to take. Examples include pre-exposure and exposure signals and external radiation or contamination alarms.

Access to controlled areas must be restricted to:

- Classified persons; or
- Outside workers, for whom a method of personal dose assessment is available, who have been appropriately trained in local procedures and who has been certified fit for the type of radiation work to be carried out; or
- Non-classified persons working in accordance with written arrangements to restrict their exposure to a level below three tenths of any relevant dose limit; or
- Any other person so long as their exposure does not exceed any relevant dose limit.

Enclosure and radiation shielding

Ionising Radiations Regulations 1999 Approved code of practice and guidance state that where reasonably practicable, work involving exposure to external radiation should be done in a room, enclosure, cabinet or purpose-made structure which is provided with adequate shielding. In other cases, adequate local shielding should be used as far as reasonably practicable. Shielding, including beam collimation, will normally be adequate if designed to reduce dose rates below 7.5 microsieverts per hour in specific locations where persons will be working.

If the device is designed for use in public areas or where there is continuous access to the working area by employees or other persons not directly involved in the work, the shielding should be designed to reduce dose rates to the lowest level that is reasonably practicable. In this case, the dose rate should be so low that it is unnecessary to designate the area around the device as a supervised area.

In many cases, shielding will either form part of the equipment (eg covers, shutters and collimators) or an enclosure around the device (eg a room or purpose-made structure). Local shielding around sources - including purpose-made covers, drapes, free-standing screens and even bags of lead shot - can also be used to restrict exposure where an enclosure is not reasonably practicable.

Mobil Screens

Small individual Screens

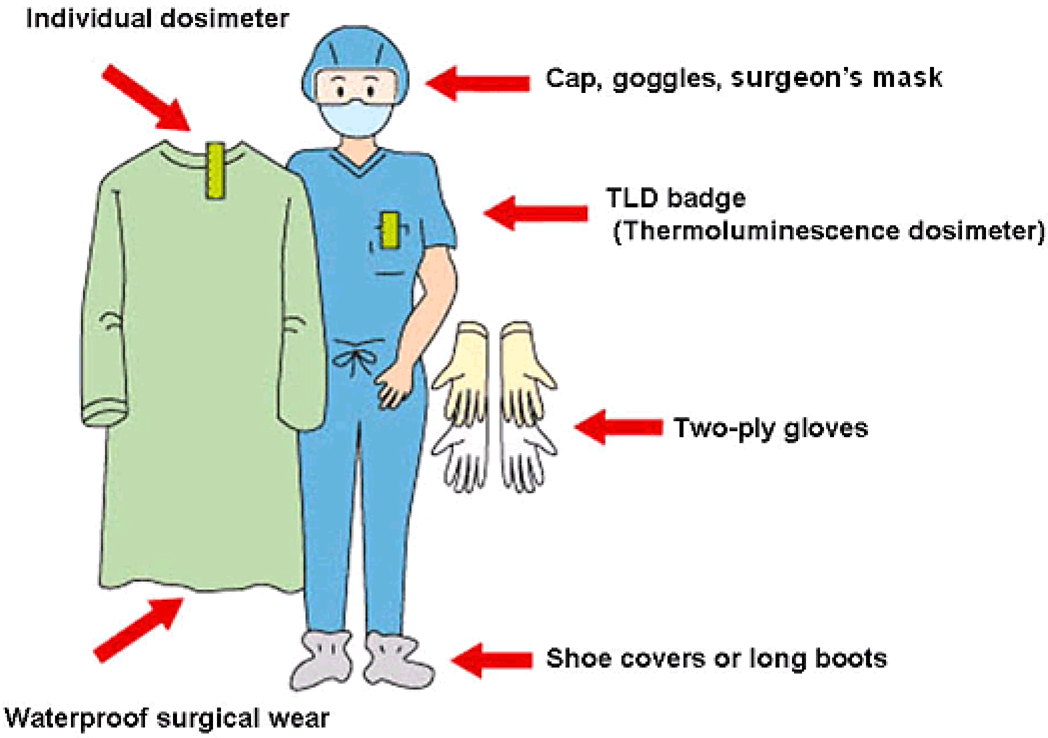
Fluoroscopic devices

Fluoroscopic devices should be provided with viewing facilities which do not permit direct vision of the fluoroscopy screen.

For medical imaging applications and security inspection, an image intensifier would normally be used with a TV camera and monitor.

Personal Protective Equipment at Work Regulation 1992 (PPE)

The purpose of PPE at Work Regulation 1992 is for employee to be provided with equipment that will protect the user against health or safety risks at work.



The Regulations also require that:

- PPE's are properly assessed before use to make sure it is fit for purpose
- PPE's are maintained and stored properly
- Employees are provided with instructions on how to use them safely
- PPE's are used correctly by employees
- Employees are informed why PPE's are needed, when to use them and what its limitations are
- Exemptions are never allowed for those jobs that 'only take a few minutes'
- Employees are informed that if in doubt, seek further advice from a specialist adviser

Personal protective equipment (PPE) includes respiratory protective equipment (RPE), protective clothing, footwear and equipment to protect the eyes. Types of PPE specific to protection against external ionising radiation include lead aprons and gloves. Various types of respiratory protective equipment (including pressurised suits) provide protection specific to the risk of inhaling radioactive material.

The risk assessment should be used to decide on the choice of PPE. The purpose of the assessment, in this case, is to ensure that the employer chooses PPE which is adequate and suitable, ie correct for the circumstances of use.

For RPE this implies that it provides an adequate margin of safety and is matched to the job, the environment, the anticipated air concentration of radioactive material and to the wearer. The performance of RPE which relies on a tight-fitting facepiece will be adversely affected if there is not good contact between the wearer's skin and the face seal of the mask, eg because the wearer is not clean shaven. RPE from more than one manufacturer and of more than one type may be needed to meet the face fit requirements of all the employees in a particular area. Proper testing of the correct fit for facepieces intended to fit tightly is a necessary part of the selection process.

Best practice guidance on radiation protection and the use of radiation protective equipment from the Royal College of Nursing RCN advices that the following appropriate protective equipment must be available to use during normal duties:

- Lead aprons reduce the exposure of breast tissues; the wrap-around version should be fitted with a lumbar support belt to reduce strain on back and shoulders. A well-chosen lead apron can reduce the effective dose by 75 to 90 per cent. Available from 0.25 to 0.5mm lead equivalent, the RPS will advise on the actual weight required

- Thyroid shields provide protection for both the thyroid and the oesophagus. Fully adjustable, these shields are only required when staff are standing within one metre of the patie

- The RPS will be able to advise if operators require radiation protective glasses and can initiate recording eye exposure, using thermolucent detectors.

For Further Infomation:

- Medical Physics and engineering in Leeds
- Health and Safety Services
- Procedure for Ionising Radiation Safety – Manchester University
- The Society for Radiological Protection
- Work with ionising radiation Ionising Radiations Regulations 1999 Approved Code of Practice and guidance
- COSHH
- RIDDOR
- A guide to the Radiation (Emergency Preparedness and Public Information) Regulations 2001
- NERC HEALTH & SAFETY PROCEDURE WORKING WITH IONISING RADIATION
- Working with radiation in the NHS Advice for managers and staff