THE RADIATION PROTECTION NOTE 10: NON-IONISING RADIATION

ELECTROMAGNETIC SPECTRUM

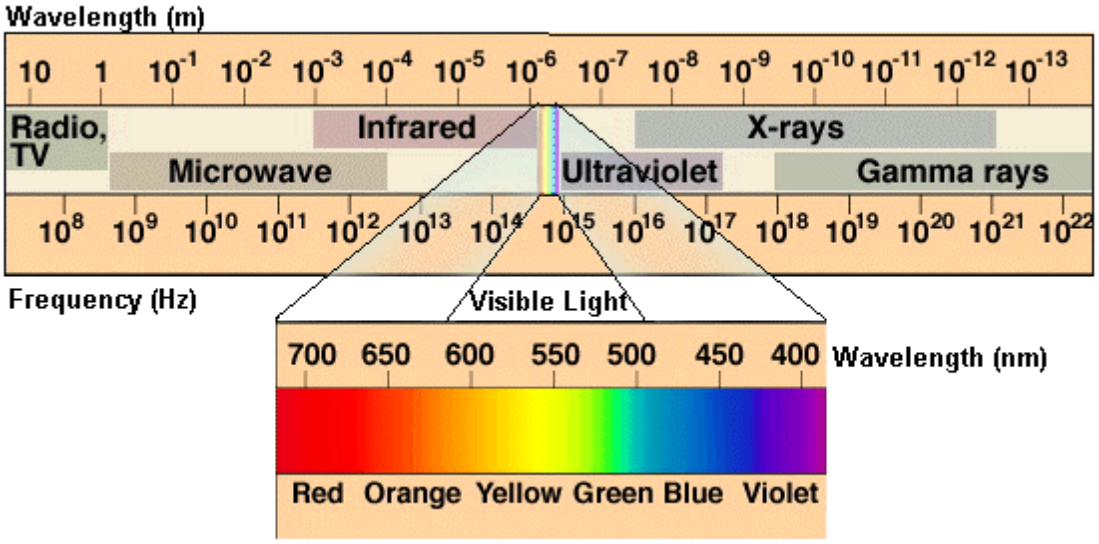

Figure 1 – The Electromagnetic Spectrum

Non-ionising radiations cover the electromagnetic spectrum from Ultra Violet (UV) to Radio waves. In the University the most common types of non-ionising radiation which you may encounter include:

Lasers, UV sources, microwave sources, RF generators, VDU screens and ELF radiation. Lasers, UV and Microwave sources are the most hazardous from a non-ionising radiation viewpoint.

LASERS

The term LASER is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. Lasers have useful characteristics that can be exploited for research and consumer products. These include:

Monochromatic – narrow bandwidth
Coherence – electromagnetic waves are in phase spatially and/or temporally.
Small angular divergence
Small beam diameter
High irradiance – power density

Hazardous Characteristics of Lasers

Eyes – the main hazard associated with lasers. To prevent injury, operators should not look directly into the laser beam or its specular reflections. This rule applies regardless of the protective eyewear worn. All experiments using lasers should be designed in such a way as to minimise the possibility of direct eye contact eg, site the laser below eye level.

Skin – the beam from high power lasers can cause severe skin burns. Wear protection where appropriate and know where the beam is.

Fire – laser beams can ignite flammable materials therefore all work areas should be kept clear of combustible materials.

Others – laser systems sometimes require high voltage power supplies, water cooling or cryogenic liquids. These are all hazardous in their own right and should be taken into account at the design stage.

Classification of Laser Systems

Class 1 Class 1 laser systems are considered safe either because of their low output or due to engineering design. These lasers do not need additional controls eg, CD player, laser printer.

Class 1M These lasers are safe under reasonably foreseeable conditions provided optical instruments (mainly magnifiers) are not used. There is no cap on the total output of the laser product. They are likely to be lasers or LEDs with divergent beams but include products with wide collimated beams.

Class 2 These lasers are visible (400 to 700 nm). They are safe provided the blink or aversion responses operate.

Class 2M These lasers are visible. They are safe provided no optical instruments are used and the blink or aversion response operates. There is no cap on the total output of the laser. They are likely to be lasers or LEDs with divergent beams but include products with wide collimated beams.

Class 3R Another new class, 3R, covers lasers with accessible emission less than five times the Class 2 limit between 400 nm and 700 nm, or less than five times the Class 1 limit at other wavelenths. There is no Class 3R for the range 180 nm to 302.5 nm.

Class 3B These lasers are capable of causing injury. See existing standard. Some current class 3B products will qualify for class 1M or 2M.

Class 4 Class 4 lasers are high power devices. In addition to the possibility of severe eye and skin damage, class 4 lasers are capable of igniting combustible materials. Class 4 lasers require strict administrative and engineering controls.

For further information on laser safety and a description of the administration and engineering controls required, please refer to the University's 'Laser Users Guide' http://www.gla.ac.uk/media/media_287686_en.pdf

UV SOURCES

UV sources can be found throughout the University and are used for a variety of purposes from cell irradiation to photolithography. UV radiation (UVR) is placed into one of three classes dependent on wavelength. The classes and their respective Maximum Permitted Exposure (MPE's) are:

UV-A = 315 – 400 nm - MPE is 10000 Jm^{-2}
UV-B = 280 – 315 nm - MPE is 100 Jm^{-2}
UV-C = 100 – 280 nm - MPE is 30 Jm^{-2}

Hazards

Table 1 gives a summary of the main hazards associated with excessive exposure to UV radiation. The table clearly indicates that the most serious wavelengths are UVB & UVC and exposure to these wavelengths should be kept to an absolute minimum.

WAVELENGTH	***EYE***	***SKIN***
UVC (180-280 nm)	Photokeratitis	Erythema/skin ageing/possible cancer
UVB (280-315 nm)	Photokeratitis	Erythema/skin ageing/possible cancer
UVA (315-400 nm)	Photochemical cataract	Pigment darkening

Table 1: Hazards associated with UV radiation

For the exposures that are probable within the University, the more serious effects are those of the eye. Photokeratitis is inflammation of the eye and is very painful. The symptoms may not appear for hours after exposure and can last for several days. Long term exposure to UVA radiation may result in photochemical opacity, sometimes called cataracts, and this may take several years to appear. For these reasons, it is important to protect your eyes whilst using any UV emitting equipment and to wear the eyewear provided.

Skin exposure is not considered as serious as eye exposure, however, over-exposure to UV radiation can cause skin burns and there is the long-term possibility of developing skin cancer in later life. For these reasons, it is advisable to protect the skin when working with UV radiation.

Any equipment identified as a source of UV radiation should be used in appropriately shielded enclosures whenever possible and the enclosures should be interlocked to the power supply and should never be defeated. For further information on the hazards of using UV radiations see http://www.gla.ac.uk/media/media_287686_en.pdf

MICROWAVE SOURCES

There are a number of microwave ovens used as heating sources around the University. Although microwave ovens are a familiar sight in most homes, they are still potentially hazardous and should be treated with respect. Typical microwave ovens operate at between 500 – 1000 W @ 2.45 GHz and radiation of this type can produce rapid heating of soft tissue. The following common sense rules should therefore be followed.

- Door shields are present to prevent radiation from escaping the enclosure – never operate the equipment with the door opened.
- Do not operate the oven with metallic objects inside.
- Be aware of the possibility of superheating liquids.
- Do not operate the oven when empty – this can damage the magnetron.

RF GENERATORS

RF generators are low frequency devices for applications such as induction heating, plasma etching, sputtering etc. They operate by emitting low frequency (LF) electromagnetic fields which induce similar fields in metals and other polar materials. The following points should be noted.

- High power RF fields can induce electrical currents in the human body.
- Metal jewellery entering the field will heat up very quickly.
- People wearing pacemakers should not operate this type of device and warning signs alerting people with pacemakers should be posted in the vicinity of the equipment.

MOBILE PHONES

The numbers and usage of mobile phones have increased exponentially in recent years and concerns whether the technology is safe have also arisen. As yet there is no definitive scientific evidence to suggest that the technology is unsafe. The amount of research into the subject is growing almost as fast as the usage but it will still be some time before conclusions can be made. The following is for information purposes only and should not be construed as Official University Policy.

- Mobile phones are low power devices operating at about 900 MHz and 1000 MHz.
- The present limit for radio waves is 100 mW absorbed in 10 g of tissue (time averaged over 6 minutes) gives < 1°C rise in tissue.
- Typical mobile phone emits < 2 mW.
- Radio waves of this frequency do not have enough energy to disrupt DNA directly.
- Other effects – not enough evidence to decide.
- There is evidence to suggest that they can disrupt sensitive electronic equipment.

COMMON SENSE APPROACH

- Do not use a mobile phone near sensitive equipment eg, in a hospital.
- Do not use near inflammable solvents, eg, in a petrol station.
- Limit phone use to a few minutes at a time.

Further information on this subject can be found at the following web site: (this is the Government's 'Independent Expert Group on Mobile Phones' official web site) http://www.iegmp.org.uk/