LOCAL RULE:  
Control of Non-Ionising Radiation

1. Non-Ionising Radiation
Non-ionising radiation (NIR) is the term used to describe the part of the electromagnetic spectrum covering two main regions, namely optical radiation (ultraviolet, visible and infrared) and electromagnetic fields (power frequencies, microwaves and radio frequencies).

Figure 1: Electromagnetic spectrum.

Electromagnetic fields (EMFs) arise from electric charges and the strength of a field at a point depends upon the distribution and behaviour of the charges involved. The term EMF as used here covers fields in the frequency range below 300 gigahertz (GHz).

Electromagnetic fields include static fields such as the Earth's magnetic field and fields from electrostatic charges, electric and magnetic fields from the electricity supply at power frequencies (50 Hz in the UK), and radio waves from TV, radio and mobile phones, radar and satellite communications.

At the higher frequencies the electric and magnetic fields are coupled together and as the frequency decreases the coupling decreases. At 50 Hz used for electricity generation it is appropriate to think in terms of separate electric and magnetic fields.

The part of the electromagnetic spectrum from 0 to 300 Hz is often termed extremely low frequency (ELF).

2. Effects of Non-Ionising Radiation
Over exposure to optical sources of NIR can cause biological damage, mainly to the eyes and skin. Potential damage is dependent on numerous factors relating primarily to the source of NIR and the environment it is used in.

Exposure of the eyes to ultraviolet radiation can damage the cornea and produce pain and symptoms similar to that of sand in the eye. The effects on the skin range from redness, burning and accelerated ageing through to various types of skin cancer. High-power lasers can cause serious damage to the eye (including blindness) as well as producing skin burns if misused or accidents occur.

Artificial Optical Radiation (AOR) exposure limit values are highly dependent on the part of the optical spectrum under consideration as the biological effects are closely related to the wavelength of the optical source. Variation is particularly significant for the eyes where the wavelength determines the level of penetration and therefore the severity of the hazard.

Exposure of people to high levels of EMFs can give rise to acute effects. The effects that can occur depend on the frequency of the radiation. At low frequencies the effects will be on the central nervous system of the body whilst at high frequencies, heating effects can occur leading to a rise in body temperature. In reality, these effects are extremely rare and will not occur in most day-to-day work situations.

Table 1: Possible effects of wavelengths on the eyes and skin

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Eye</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 – 280</td>
<td>UVC</td>
<td>Photo keratitis</td>
</tr>
<tr>
<td>280 – 315</td>
<td>UVB</td>
<td>Photokeratitis</td>
</tr>
<tr>
<td>315 – 400</td>
<td>UVA</td>
<td>Photokeratitis</td>
</tr>
<tr>
<td>380 – 780</td>
<td>Visible</td>
<td>Photoretinal damage</td>
</tr>
<tr>
<td>780 – 1400</td>
<td>IRI</td>
<td>Cataracts</td>
</tr>
<tr>
<td>1400 – 3000</td>
<td>IRR</td>
<td>Cataracts</td>
</tr>
<tr>
<td>3000 x 10^6</td>
<td>IRC</td>
<td>Corneal burn</td>
</tr>
</tbody>
</table>

Image: © Health Protection Agency (used with permission).
3. **Definitions**

**Control of Artificial Optical Radiation at Work Regulations 2010 (CAORW10)** – the legislation aimed at protection of individuals from exposure to non-ionising artificial sources of radiation. Specifically, it is aimed at protection of the eyes and skin of such workers from hazardous sources of artificial optical radiation.

**Management of Health and Safety at Work Regulations, 1999 (MHSW99)** – legislation which requires employers to assess health and safety risks to employees.

**As Low As Reasonably Practicable (ALARP)** – means ensuring risks from non-ionising radiation are kept to a minimum

**Laser Safety Adviser (LSA)** – a qualified expert, recognised as being suitable, competent, knowledgeable and experienced in the field of laser safety protection.

**Radiation Protection Adviser (RPA)** – a qualified expert, recognised as being suitable, competent, knowledgeable and experienced in the field of radiation protection.

**Dept. Radiation Protection Supervisor (DRPS)** – a person appointed in writing, in a functional role to assist the Head of Dept. in the management and supervision of radiation related activities.

**Exposure Limit Values (ELV)** – limits on exposure which are based on established health effects and biological considerations. Compliance with the limits should protect workers against known adverse health effects.

**Controlled Area** – means an area where the activities within are subject to control and supervision for the purpose of laser radiation hazard protection. This is normally because the

**Local Rules (LR)** – means a written document which summarises the arrangements for controlling work with non-ionising radiations and includes contingency plans for reasonably foreseeable radiation accidents and incidents.

**Artificial Optical Radiation (AOR)** – means any electromagnetic radiation in the wavelength range between 100nm and 1mm which is emitted by non-natural sources.

4. **Exposure Limit Values**

Exposure Limit Values (ELV) and guidelines have been developed based on the recommendations of the International Commission of Non-Ionising Radiation Protection (ICNIRP). These take into account, and assess potential biological effects by considering biological variables, such as the actual mechanisms of injury, the reversibility of damage, the effect of normal biological responses (e.g. normal eye movements). Thus the impact of ELVs varies with the range of frequencies, wavelengths (source intensity) and exposure duration. Protection against exposure to NIR sources is through the risk assessment process.

a) **Optical Radiation ELVs**

For non-coherent optical radiation and laser radiation, ELV’s are specified respectively within Annexes I and II of European Union Physical Agents Directive (Optical Radiation: 2006/25/EC) and as referenced to within the CAORW10 Regulations.

b) **Electromagnetic ELVs**

Future EMF exposure limit values are expected to be based upon existing guidelines and ELV’s provided by the ICNIRP. Legislation on workers exposure to electromagnetic fields is expected in the UK in 2012. This is based upon the European Union Physical Agents Directive (Electromagnetic Fields: 2004/40/EC).

Both of the Directives specify the minimum health and safety requirements regarding the exposure of workers to risks arising from artificial optical and electromagnetic radiation.

5. **Department Radiation Safety Management Arrangements**

Current UK legislation (MHSWR99 and CAORWR10) places specific management responsibilities and requirements on employers in relation to assessing risks and implementing measures to minimise exposure to hazardous sources of non-ionising radiation. Therefore Heads of department or equivalent must ensure the following points are implemented:
a) **Appointments and Notifications**

- appoint suitable and appropriate numbers of trained RPS’s (RP2 Form) to help ensure compliance with non-ionising legislation and for the supervision of arrangements set out in departmental safety arrangements and local rules. This should take account of the nature, range, complexity and locations of the non-ionising radiation work.
- ensure DRPSs receive appropriate and suitable training, time and support for their roles as DRPS (Safety Services can advise on this area)
- ensure that any notifications and/or investigations required are carried out when requested (or as appropriate) and in line with any specified time period.
- ensure no high risk non-ionising radiation sources or equipment is brought into or removed from departmental or University premises without appropriate notification / authorisation with the DRPS.

b) **Procedures and Arrangements**

- ensure that appropriate health and safety management arrangements are put in place and implemented (where applicable) for the various aspects relating to non-ionising radiation work and that these are regularly reviewed and updated where necessary.
- ensure a register/list of all non-ionising radiation workers is maintained.
- ensure all non-ionising radiation workers are given appropriate information, instruction, training and supervision and that a record of the training given is retained (Refer to Section 10 also).
- ensure suitable and appropriate arrangements are in place for visiting staff, contractors, service engineers, cleaning, maintenance and security staff in relation to access arrangements to designated areas, induction, training etc.
- identify all work activities and equipment which may present a non-ionising radiation risk and ensure a risk assessment is undertaken, is in place prior to starting work and is regularly reviewed or reviewed if significant changes occur (Refer to Sections 6-9 also).
- ensure arrangements are available and in place for health surveillance and medical examinations (via Occupational Health) if the risk assessment indicates that adverse health effects to the eyes or skin are likely or that ELV’s are likely to be exceeded (Refer to Section 11 also).
- ensure that all high risks areas and locations are suitably identified and designated as Controlled Areas (CA) or Controlled Areas (CA) in line with any specified time period.
- ensure suitable Local Rules are available for any areas designated as Controlled Areas (CA).
- work with the University/Safety Services and external consultants (RPA/LSA) in meeting all legal requirements and specifically those covering non-ionising radiation sources and activities.
- consult and seek additional advice where necessary with a RPA/LSA and supporting Occupational Health and Safety staff.
- ensure that any recommendations issued by the RPA/LSA/Safety Services following safety audit visits or (if advised outwith) are addressed as soon as possible.

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deeed necessary from the (risk assessment), used and stored correctly and that arrangements are in place for the regular maintenance and examination of such equipment.

6. **Assessing the Risks from Ionising Radiation**

Departments must identify all work activities, equipment and location which may present a non-ionising radiation exposure risk to staff, students and others. For all such activities and equipment sources, a risk assessment must be carried out to assess and then control any identified risks.

**Figure 2:** Initial process to identify AOR risks

![Flowchart]

- **Do you use sources of Artificial Optical Radiation (AOR)?**
  - **No action required**
  - **Do you use hazardous sources of AOR that could harm workers?**
    - **No action required**
    - **Do you have adequate controls in place to manage the risks?**
      - **This is a legal requirement and you need to take action**
      - **Make sure you have recorded action and informed staff**

**Source:** HSE: Guidance for employers AOR Regulations 2010

The risk assessment should include the following:

- types of non-ionising sources involved (including power, wavelength, duration of exposure etc.)
- potential exposures (generally for high risk sources), that could possibly exceed ELVs and may require additional controls and health surveillance
- manufacturer’s advice on safe use and maintenance
- engineering control measures and design features in place or planned
- any planned safe systems of work
- effectiveness and suitability of personal protective equipment to be provided
- likelihood and potential severity of possible accident situations
- consequences of possible failures of control measures
- measures implemented to prevent identified accident / incident situation, or to limit their consequences
- contingency and emergency arrangements
- Hazards in addition to the non-ionising ones should be considered. For example, laser risk assessments should consider both beam and non-beam hazards.

Any particular conditions or activities which could increase the risks to staff and students should also be considered within the risk assessment. Examples include:

a) pre-existing medical conditions made worse by light
b) use of chemicals such as skin creams which could react with light to make health effects worse
c) staff and students who may be exposed to multiple sources of light at the same time
d) situations in which exposure could present unrelated risks (e.g. temporary blindness if exposed to bright light)

7. **Evaluating Non-Ionising Radiation Risks**

Working with Safety Services, the University RPA/LPA can advise on risk assessments, measurements and calculations, control measures, working practices and arrangements for restricting exposure to ionising radiations and ensuring legal compliance with both CAORW10 and MHSWR99. A regular inspection of departmental locations and auditing of radiation safety management arrangements will be normally be undertaken by Safety Services and the RPA/LSA. Departments should also monitor the effectiveness of their own arrangements on a regular basis.

8. **Deciding on and Implementing Risk Control Measures**

Where Departments have identified hazardous sources of non-ionising radiation which present a ‘reasonably foreseeable’ risk of harming the eyes and skin of staff
and students, they must implement measures to reduce this risk of to as low as reasonably practicable (ALARP).

Departments must seek ways of reducing the risk of exposure to non-ionising radiation, by considering the following hierarchy of controls:

- **elimination** – does the non-ionising radiation source need to be used in the first place?
- **substitution** – can an alternative, safer source (e.g. of light) achieve the same result?
- **engineering** – this is the main way of reducing exposure to non-ionising radiation exposure. The main types of engineering controls include the use of filters, screens, enclosures, protective housings, shutters, key and password access controls for equipment, emergency stop controls, remote viewing, specialist curtains, safety interlock systems, clamping of work pieces, dedicated room, remote controls and time delays
- **administrative** – use of safe systems of work/standard operating procedures, training of workers, organisation of work schedules and use of warning signage
- **personal protective equipment** – issue of appropriate and suitable clothing, goggles, eyewear and face shields where applicable

**Figure 3: Hierarchy of control measures**

1. Eliminate (get rid of)
2. Substitute (change)
3. Engineering controls (make something new)
4. Administrative controls (instructions and signs)
5. Personal protective equipment (gives equipment)

- Increased Effectiveness
- Increased Supervision

9. **Recording the Significant Findings**

The significant findings of the risk assessment process must be recorded and include the following:

- the activities/equipment assessed;
- the risk of exposure to non-ionising radiation and who could be affected;
- the control measures already in place to manage the risk;
- the relevant information, instruction and training to be provided to staff and students;
- the details of any health surveillance in use or planned; and
- the action plan of additional controls to reduce the risk

The risk assessment will need to be reviewed if there is any reason to suspect that the original assessment is no longer valid or there has been a significant change in the work to which the assessment relates. In any case the risk assessment should be reviewed at least every 3 years.

10. **Providing Information, Instruction, Training and Supervision (IITS)**

The requirement for information, instruction, training and supervision applies to all people who could be exposed to non-ionising radiation. However, different categories of people (for example, DRPSs, laser workers, managers, cleaning and maintenance staff etc.) will require different levels of IITS depending on their activities, the levels of risk involved, their past training and their roles.

IITS should be appropriate to the nature of the work and the needs of the individual and in most cases will consist of basic core training, along with departmental training in arrangements and procedures.

Non-ionising workers will need to be aware of:
- the main risks to them, including accidental exposure risks
- control measures to prevent or minimise the risks
- contingency plans and what to do in an emergency
- Where to obtain further help and advice
- When to contact the DRPS/Safety Services/RPA etc.

A record of all training provided should be maintained and where necessary refresher training undertaken.
11. Health Surveillance and Medical Examinations

Health surveillance and medical examinations may be required in certain circumstances if the risk of adverse health effects to the skin or eyes has been identified from the risk assessment; as a result of an ELV being exceeded or following an accident or incident (e.g. laser eye strike).

12. Further Information and Guidance

Publications free to download on the Health and Safety Executive and other websites:

- **General**
  - HSE Non-ionising radiation
  - The Control of Artificial Optical Radiation Regulations 2010
  - Guidance for Employers on the Control of Artificial Optical Radiation at Work Regulations (AOR) 2010
  - Physical Agents (Artificial Optical Radiation) Directive 2006/25/EC
  - Physical Agents (Electromagnetic Fields) Directive 2004/40/EC
  - Safe use of work equipment, Provision and use of Work Equipment Regulations, 1998, ACOP L22
  - Health Protection Agency - Non-ionising radiation
  - International Commission on Non-ionizing Radiation Protection (ICNIRP) (www.icnirp.de/)

Association University Radiation Protection Officers Guidance Notes

Various Publications and guidelines on Optical and EMF radiation
- Health and Safety Executive website (non-ionising radiation index)
- European Committee for Electrotechnical Standardization (CENELEC)
- International Electrotechnical Commission (IEC)
- European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR)
- Health Protection Agency - Various information sheets on non-ionising radiation
- International Commission on Illumination (ICE): Division 6: Photobiology and Photochemistry
- Buying new machinery INDG271

Lasers
- British Standard EN 207: 1999. Filters and Equipment used for Personal Eye-Protection Against Laser Radiation
- Health Protection Agency - FAQs about lasers

Ultraviolet (UV) Radiation
NRPB (now part of the Health Protection Agency) publications:

External exposure in relation to Outside Workers
- Working in the sun
- Sun Protection
- Keep your top on: Health risks from working in the sun INDG147
- Sun protection: advice for employers of outdoor workers INDG337
- SunSmart: the UK’s national skin cancer prevention campaign
Electromagnetic Radiation

- Health Protection Agency - FAQs about Electromagnetic Fields
- ICNIRP Factsheet - Limits of exposure to static magnetic fields, 2009
- ICNIRP Guidelines for Limiting Exposure to time-varying Electric, Magnetic, and Electromagnetic Fields (up to 300GHz)
- National grid information site on EMFs: www.emfs.info

University of Strathclyde

- Insert link for Guidance doc on non-ionising radiations
- Insert link to Safety Services radiation form