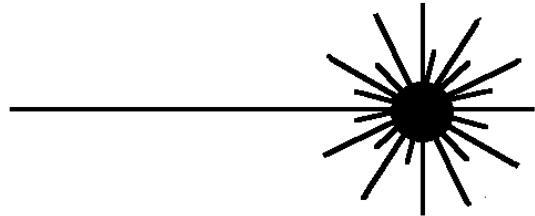


Radiation Protection Advice & Guidance no 26

LASER RADIATION **HEALTH & SAFETY**



HAZARDS

A laser beam consists of a highly concentrated beam of infrared, ultraviolet or visible light. Laser radiation can cause tissue damage, due in the main to rapid heating of the irradiated area. Laser light is particularly hazardous to the eye, as the lens of the eye will focus the laser beam onto a tiny 25 micron spot on the retina, causing an even greater concentration of energy over a small, but critical area. It should be noted that specular (i.e. mirror-like) reflections of laser beams may be just as hazardous as the primary beam itself.

For some very powerful laser beams, even diffuse reflections (e.g. from a matt surface) can be hazardous. Such lasers may also present a fire hazard, particularly where laser beams are used in close proximity to anaesthetic gases.

Laser products are classified and marked according to different degrees of hazard (see table 1).

Class 3B laser devices are particularly hazardous to the eye, but will not damage skin or start fires. With Class 4 laser devices even reflections off matt surfaces can damage the eye. Class 4 devices may be able to damage skin and start fires. Other lower classes of laser device are either completely safe, or only hazardous if the beam is shone directly into the eye without blinking or turning away.

In the rest of this document, the term “laser” is used to refer to class 3B, and 4 lasers only.

EYE SAFETY

The Nominal Ocular Hazard Distance (NOHD) is the distance from the laser where the laser is no longer an eye hazard. If the NOHD is not stated in the laser device’s user manual, then the Laser Protection Adviser (LPA) can calculate the NOHD from the wavelength (“colour”), power and divergence of the laser.

For some medical lasers NOHD is only a few centimetres, but for others the NOHD is tens of metres. In nearly all cases laser safety eyewear should be worn if a person may be

within the NOHD. It is important to note that if different delivery attachments are used with the laser, then each attachment may have a different NOHD.

Table 1. Laser device safety classes

Laser safety class	Laser type	Potential eye or skin hazard
Class 1 (embedded)	Laser completely enclosed	Generally safe during use. Hazards according to power of enclosed laser when interlocks are overridden.
Class 1	Very low power level	Emitted power generally safe for long-term intrabeam viewing, even with optical instruments such as magnifying glasses.
Class 1M	Low power level. Collimated large beam diameter or divergent	Safe for long-term intrabeam viewing, but potentially hazardous with magnifiers (divergent beams) or binoculars (large diameter collimated beams).
Class 2	Low power level Visible wavelengths only	Safe for brief (accidental) direct exposure with naked eye and optical instruments. Prolonged staring may injure eye, especially blue wavelengths.
Class 2M	Low power visible Collimated large beam diameter or divergent	Safe for brief exposure with the naked eye, but potentially hazardous when exposure occurs with magnifiers (divergent beams) or binoculars (large diameter collimated beams).
Class 3R (visible)	Low power Typically alignment lasers	Accidental exposure usually not hazardous, but eye injury possible for intentional intrabeam viewing
Class 3R (non-visible)	Low power	Accidental exposure usually not hazardous, but eye injury possible for intentional intrabeam viewing.
Class 3B	Medium power	Exposure (including brief accidental exposure) of the eye to the direct beam may cause serious eye injuries. Very limited skin hazard. Viewing of diffuse reflections are normally safe.
Class 4	High power	Exposure (including brief accidental exposure) of the eye to the direct beam and close viewing of diffuse reflections may lead to serious eye injuries. May cause serious skin hazard. Presents fire hazard.

When eye protection is used it is vital that the wavelength of the filters matches that of the laser and that the strength of the protection is sufficient to prevent eye damage. Eyewear

which is very effective for one type of laser may offer little or no protection whatsoever for a different type of laser.

Laser safety eyewear must be labelled with the wavelength and strength of protection. The LPA should be consulted to ensure that the correct eyewear is purchased and used.

OTHER HAZARDS

When lasers are used to vaporise a target material (e.g. laser scalpel) fumes will be produced. These could obscure the site of interest, leading to incorrect aiming of the laser beam, or if inhaled present a biological hazard. Therefore proper smoke/fume extraction apparatus must be used, where necessary.

Class 4 laser devices can ignite dry dressings and other such material. A bowl of sterile water kept close at hand can be used to douse any small fires.

LASER CONTROLLED AREAS

A Controlled Area must be established around any laser where there is a risk of harm. The occupancy and activity of all persons within a Controlled Area are subject to control and supervision to prevent exposure to laser radiation in excess of the safe levels and the boundaries of the Controlled Area will normally be the walls, floor and ceiling of the room. Controlled Areas must be defined in the Local Rules, together with the conditions under which they exist. In so far as is reasonably practicable, no person should be in a Controlled Area while the laser is in use unless that person's presence is required.

Care should be taken to limit the laser beam to the LCA. Doors should be closed, and windows may need to be fitted with fire-resistant curtains or blinds. Doors should be close fitting so that a laser beam cannot pass through any gaps. Entrances to the Controlled Area should be labelled with appropriate signs, approved by the Laser Protection Adviser (LPA).

Each operating theatre/outpatient treatment room in which a laser is to be used shall have an approved warning sign at each entrance. Signs should be consistent throughout the department and "secret" until illuminated.

LOCAL RULES

Local Rules for the safe use of lasers for specific purposes must be drawn up for all Lasers. These will define laser Controlled Areas and should ensure that no person is exposed to laser radiation in excess of the safe level (unless this is a specific part of that person's treatment as a patient). The Laser Protection Supervisor should ensure that the Local Rules are implemented in the areas for which they are responsible. Lasers should

not be used in areas outside those defined in Local Rules without consultation with the Laser Protection Adviser.

GENERAL USER SAFETY MEASURES

- a) The laser should not be fired unless aimed at the chosen tissue site or at a suitable external beam stop. The Operator's role is of crucial importance for "open" systems in which either almost unlimited free-hand aiming of the beam or a fibre transmission system not having a fixed distal termination point.
- b) If there is any hazard to staff, the Laser Operator must warn them orally that the laser is about to be fired the laser or a series of exposures is about to commence.
- c) Adequate protection for the eyes must be worn by all staff who could be exposed to laser radiation in excess of the Maximum Permissible Exposure (MPE) level.
- d) All protective eyewear must be marked to indicate the operational wavelength for which it is suitable and the Optical Density (OD) of the filter at that wavelength. Protective eyewear may not provide adequate protection for viewing the direct beam. (The minimum OD required to reduce the power density of the primary beam to a level below that of the MPE will be calculated by the Laser Protection Adviser.)
- e) The patient's eyes must be protected where appropriate.
- f) Any tubes carrying oxygen or oxidised anaesthetic gas should be protected (e.g. wrapped in aluminium foil) if there is any possibility of their being damaged by exposure to the laser beam.
- g) When a class 4 laser device is used care should be taken to avoid the possibility of ignition of flammable materials, particularly in oxygen enriched atmospheres.
- h) Medical lasers should not be operated if any target indicating or aiming device is faulty (e.g. aiming system misalignment with laser beam or aiming beam not present). The alignment of the main laser beam and aiming system should be checked regularly.
- i) The power output or energy indicators incorporated in class 3B and 4 lasers should be calibrated regularly against beam power or energy measurements made with an appropriate meter.

UNTOWARD INCIDENTS

Untoward Incidents include

- inadvertent eye exposure, even where protective eyewear is worn
- inadvertent skin exposure
- fires, however minor

- exposure to laser radiation of an area outside the Controlled Area
- failure of target indicating or aiming device, e.g. aiming system misalignment with laser beam or aiming beam not present
- failure of the beam to terminate correctly

In the event of inadvertent eye exposure, access to the Ophthalmic Department is available through Accident & Emergency at Hull Royal Infirmary.

All Untoward Incidents should be reported to the Laser Protection Supervisor (LPS) and the Laser Protection Adviser (LSA). A standard hospital accident form should be completed.

The Notification of Accidents and Dangerous Occurrences Regulations 1980 may require the reporting of certain Untoward Incidents to the appropriate authorities. Such reporting will normally be made by the LSA in consultation with the LPS and other relevant persons.

When an inadvertent skin or eye exposure has occurred, an estimate of the exposure time is needed, in order to assess whether the Maximum Permissible Exposure (MPE) has been exceeded, and the extent of the risk to the exposed person.

EQUIPMENT LOANS

The Laser Protection Adviser (LPA) should always be consulted before new or loaned laser equipment is used. It will usually be necessary to define a temporary Laser Controlled Area for demonstrations.

MAINTENANCE

There are a number of well documented cases where laser users have been permanently harmed by medical laser devices which have not been properly maintained.

Maintenance and adjustment of the laser must only be undertaken by authorised persons with appropriate technical expertise in accordance with manufacturers' instructions. The Laser Protection Supervisor should be informed of all maintenance and adjustments.

If any work is carried out which alters the characteristics of the laser beam, then the LPS and LPA must be informed, preferably in writing. The LPS should then ensure that all Authorised Operators are informed of and understand the changes. Maintenance policy and a record of maintenance work should be kept by the LPS.

RESPONSIBILITIES & TRAINING

Laser Protection Adviser (LPA):

Mr John Saunderson,

Radiation Physics Department, Queen's Centre for Oncology & Haematology, Castle Hill Hospital

Tel. (01482) 461329

Departments should consult the LPA on the use of all class 3B laser devices (e.g. low level laser therapy units), all class 4 (e.g. surgical) laser devices, and all intense pulsed light sources ("IPL"). Departments may in some circumstances also wish to consult the LPA on class 3R and other laser devices.

The LPA provides help and guidance on the safe use of lasers. The LPA should always be consulted before new or loaned laser equipment is used. The LPA will assist the Laser Protection Supervisor (LPS) in the drafting of appropriate Local Rules. The LPA should be consulted whenever a laser is to be used outside the area defined in the Local Rules for that laser.

Laser safety incidents should be reported to the LPA, who will ensure that an investigation is carried out, and will liaise with the appropriate authorities (e.g. DoH, HSE, etc.)

Duties of Laser Protection Supervisor (LPS)

In accordance with DH guidance, departments using class 3B or class 4 laser devices, or INTENSE PULSED LIGHT sources ("IPL") should appoint suitable LASER PROTECTION SUPERVISOR ("LPS"). Heads of department should inform the consultant LPA of the appointment of each individual as an LPS.

The LPS is the person "on site" responsible for laser health and safety matters. The LPS should be directly involved with work with lasers, preferably in a line management position that will allow the LPS to exercise close supervision to ensure that work is done in accordance with the Local Rules, though the LPS need not be present the whole time. The LPS will maintain a list of the Authorised Users, the Local Rules and any other relevant records. The LPS should ensure that Local Rules are kept up to date. The LPS is responsible for organising security of the laser equipment's keys. The LPS must receive sufficient training to ensure an understanding of the LPS responsibilities to all persons within the LCA.

The LPS should be informed immediately of any problems that arise with regard to safe use of the equipment or any accidental exposure to the eyes. Any laser safety incidents should be reported by the LPS to the LPA.

Authorised Operators

The AUTHORISED OPERATOR is the individual who operates the laser or IPL.

Laser may only be operated by an AUTHORISED OPERATOR, or in special circumstances by other persons under the direct supervision of an AUTHORISED OPERATOR. AUTHORISED OPERATOR should be classed as clinical (e.g. surgeons) or non-clinical (e.g. maintenance staff).

The AUTHORISED OPERATOR 's manager, LPS or LPA will specify and assess the level of competence required. The AUTHORISED OPERATOR will have received suitable laser/IPL equipment training. They should also have attended an appropriate safety course. The Authorised User must be knowledgeable in how to operate the particular device, how the controls will effect the treatment and the LOCAL RULES for the safe use of that particular device.

The AUTHORISED OPERATOR is responsible for using the laser in a safe manner for both staff and patients. The AUTHORISED OPERATOR should see that eye protection is worn by staff where this is laid down in the LOCAL RULES.

A register of AUTHORISED OPERATOR of Class 3B or 4 lasers and IPL systems should be held by the LASER PROTECTION SUPERVISOR (LPS)

If there is any hazard to staff, the AUTHORISED OPERATOR must warn them orally when the laser is about to be fired or a series of exposures is about to commence.

Authorised Assistant

Some lasers require a second person to assist the AUTHORISED OPERATOR. For example, most surgical lasers require an assistant to operate the laser console while the surgeon controls the fibre optic, or other delivery system, and a footswitch which fires the laser. The responsibilities of the AUTHORISED ASSISTANT should be detailed in the LOCAL RULES. These duties may include ensuring that all members of staff in the CONTROLLED AREA have goggles, ensuring that warning signs are displayed at entrances, preparing the laser for use, etc.

AUTHORISED ASSISTANT should have received training on general laser safety, and should normally have assisted in at least five or six treatments under the supervision of a previously trained AUTHORISED ASSISTANT. A list of AUTHORISED ASSISTANT should be kept by the LPS.

Others

General laser safety training is provided by the Radiation Physics Department. Depending on the nature of the laser/IPL used, departments should decide which members of their staff who work in laser CONTROLLED AREAS should attend this course.

Members of staff working in laser CONTROLLED AREAS should read the LOCAL RULES for those areas, and sign a record that they have read, understood and will follow them.

BIBLIOGRAPHY

Guidance on the safe use of lasers, IPL systems and LEDs in medical, surgical, dental and aesthetic practices, DB2008(03), April 2008, MHRA/DoH

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Radiation Protection Adviser
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Layout. New laser classes. New MHRA guidance referenced.
