**QUEEN’S UNIVERSITY BELFAST**

**LASER SAFETY GUIDANCE NOTE**

1. **Introduction**

In the British Standard “BSEN 60825-1: 2007 Safety of Laser Products – Part 1: Equipment classification and requirements”, a laser is defined as any device which can be made to produce or amplify electromagnetic radiation in the wavelength range from 180 nm to 1 mm primarily by the process of controlled stimulated emission.

The light produced by a laser is unique in that it is spatially coherent, monochromatic and highly collimated. It is this combination of characteristics that make laser radiation so potentially damaging to eyesight and to skin. Notwithstanding the optical and skin hazards presented by lasers, there are often other hazards associated with the operation of a laser itself which present even greater risk to health and safety. In view of the proliferation of use of lasers in teaching and research it is vital that all such users are fully acquainted with these risks; have fully assessed the risks and put in place adequate measures to control these risks.

Although there is no legislation specifically governing work with laser products, the safety of laser products is addressed in the standard above and in a series of additional parts to that document.

It is recommended that users of lasers are fully familiar with the contents of such documents and the University’s laser safety policy.

1. **Organisational Arrangements**

In Schools where Class 3B and Class 4 lasers are used, the Head of School must appoint a local laser safety supervisor (LSS). The LSS must be officially appointed by letter by the Head of School and a copy must be forwarded to the laser safety advisor (LSA). The LSS should be directly involved with the School’s work with lasers, preferably in a line-management position, to ensure that the work is carried out safely and in accordance with the School’s local rules. The principal duties of the LSS are listed below:

* to coordinate the registration of new laser users and new lasers of Class 3R and above and forward the information to Safety Service for central record-keeping;
* to regularly inspect (at least annually) designated laser areas and all laser activities to ensure that safety requirements are followed;
* to identify personnel intending to work with lasers of Class 3R and above and ensure they receive adequate training in the safe user of lasers;
* to give advice on the drawing up of risk assessments, written procedures and local rules;
* to ensure that appropriate laser safety eyewear is provided and worn;
* to ensure that training is given in the use and maintenance of laser safety eyewear;
* to keep records of all undergraduates working with lasers.

In addition, the day-to-day health and safety management of individual research projects falls to the research supervisor/principal investigator. All work involving hazardous lasers must be properly risk assessed and where appropriate written schemes of work and protocols introduced by the research supervisor. The research supervisor should also ensure that the laser workers are adequately trained in the operating techniques and that the inexperienced are adequately supervised until they are deemed to be competent in the work. The research supervisor must ensure that arrangements to control the risk are implemented and followed.

Finally, the individual laser users have the following duties:

* to be aware of the class of the laser they are working with;
* to have read and understood the risk assessment and written procedures for working with the relevant laser;
* to follow the access restrictions in designated laser areas and be aware of the operation of the laboratory door safety interlocks;
* to wear the appropriate laser safety eyewear when directed to;
* not to leave a laser experiment running unattended unless a risk assessment has established that it is safe to do so.
1. **Laser Equipment**
	1. **Laser Classification**

Lasers are grouped into classes to give an indication of their potential to cause harm. The higher the number in the classification series, the greater is the potential for the laser to cause harm. The classification of a laser is determined by its Accessible Emission Limit (AEL). This parameter is the maximum level of laser radiation which the laser can emit over its full range of capability during operation at any time after its manufacture. The AEL is further defined by the wavelength, energy content and pulse characteristics (continuous wave or pulsed) of the laser beam.

The current laser classes are 1, 1M, 2, 2M, 3R, 3B and 4. By way of example the corresponding AELs for a He–Ne laser emitting a narrow beam in continuous wave mode at 633 nm are as follows:

* Class 1 and 1M 0.39 mW
* Class 2 and 2 M 1 mW
* Class 3R 5 mW
* Class 3B 500 mW

***Class 1***: Lasers are safe under reasonably foreseeable conditions of operations because of their inherently low emission or because of engineering design such that they are totally enclosed and human access to higher levels is not possible under normal operation.

***Class 1M***: Laser products emitting in the wavelength range 302.5 to 4000 nm whose total output is in excess of that normally permitted for Class 1 laser products but because of their large diameter or diverging beam do not pose a hazard in normal use and comply with the measurement conditions for Class 1M.

They may, however be hazardous to the eyes if gathering optics are used with them:

* if optics are placed within 100 mm of the source such that the divergent beam is collimated or focussed;
* if a large diameter collimated beam is viewed with binoculars or a telescope;

***Class 2***: Lasers that only emit visible radiation in the wavelength range

400 – 700 nm and whose output is less that the appropriate AEL. They are safe for accidental viewing as eye protection is afforded by aversion responses, including the blink reflex.

***Class 2M***: Laser products that only emit radiation in the wavelength range 400 - 700 nm, whose total output is in excess of that normally permitted for Class 2 laser products but because of their large diameter or diverging beam are safe for accidental viewing during normal use and comply with the measurement conditions for a Class 2M product. They may be hazardous to the eyes if gathering optics are used with them (as for Class 1M, above.)

***Class 3R***: Lasers that emit in the wavelength range 302.5 nm – 1 mm where direct intrabeam viewing is potentially hazardous but the risk is lower than for Class 3B lasers, and fewer manufacturing requirements and control measures for the user apply. The AEL is restricted to ≤ 5 times the AEL for Class 2 for visible wavelengths and ≤ 5 times the AEL for Class 1 for other wavelengths.

***Class 3B***: Lasers that are normally hazardous where direct intrabeam exposure occurs. Viewing diffuse reflections is normally safe. Output levels must be less that the appropriate AELs for Class 3B devices.

***Class 4***: High power lasers that exceed the AELs for Class 3B products. Direct intrabeam viewing is always hazardous. Reflected beams are always harmful to the eye and to the skin and are likely to result in severe injury. They are also capable of producing hazardous diffuse reflections. Both scattered, reflected and direct beams can present a fire hazard. Their use requires extreme caution.

It is the responsibility of the laser manufacturer to provide the correct classification of a laser product. The classification procedure is described fully in BSEN60825-1: 2007. The AELs are formulated in Tables 4 – 10 of that document.

* 1. **Maximum Permissible Exposures**

The maximum permissible exposure (MPE) is that level of laser radiation to which in normal circumstances, the eye or skin may be exposed without suffering adverse effects. The levels are related to the wavelength of the laser radiation, its pulse duration or exposure time, the tissue at risk, and for radiation in the range 400 – 1400 nm the size of the retinal image.

The main criterion therefore for assessing the optical safety of a given laser in a given set of operating circumstances it the MPE.

Ocular exposure to laser light should not exceed the MPE. MPE levels are specified in Tables 5 – 7 of the Standard PD IEC TR 60825-14: 2004.Safety of Laser Products – Part 14: A user’s guide. Examples of calculations of MPE for different circumstances are given in Annex B of that standard. In addition, software packages are available (Lasermet and LaserBee) to assist in the calculation of MPEs.

1. **Risk Assessment**
	1. **Hazards and Risks**

A hazard is any physical condition, chemical or biological agent which has the potential to cause harm. Harm is usually understood to mean personal injury, but it can also include financial loss (eg damage to equipment or property.) In the context of laser equipment, one of the major hazards is the laser radiation itself. Excessive exposure to laser radiation will result in biological damage to the tissue exposed. The main areas to which laser radiation is hazardous are the eyes and the skin. Exposure can lead to the loss of visual acuity and severe blistering of the skin. However, there are additional hazards associated with laser use. These hazards include:

* electricity (high voltage laser power supplies);
* collaterial radiation (pumping radiation, plasma formation)
* hazardous substances (active media such as dyes or corrosive and toxic gases);
* fume (interaction of laser radiation with a target material);
* noise (air cooled lasers, discharge of capacitor banks);
* mechanical hazards (trailing leads, cuts from fibres);
* fire, explosion;
* heat, cold (cryogenic cooling, hot surfaces).

Risk is a combination of the likelihood of harm occurring and the severity of the harm that could be caused.

* 1. **Stages in Risk Assessment**

There are 5 basic steps in risk assessment:

* identify the hazards;
* evaluate the risks from these hazards and identify who is at risk;
* determine and implement the necessary control measures;
* assess residual risk - repeating stage 2 if necessary;
* record the findings.

The risk assessment process should include all the circumstances in which the laser is used, including installation, normal operation, maintenance, service and reasonably foreseeable misuse of failure. This process should also consider the laser environment including the location of the equipment, the state of the workplace and the level of access to that workplace. Finally, the process must consider the people at risk including operators, service personnel, cleaners, contractors and visitors.

* 1. **Selecting Control Measures**

When the level of risk is found to be unacceptable, control measures must be introduced to reduce the risk to an acceptable value. Engineering control should be given primary consideration as the means for reducing risk of laser injury. Personal protective equipment should only be used as a last resort where a combination of engineering and administrative controls cannot reasonably provide a sufficient level of protection.

1. **Control Measures**
	1. **Control Measures for Specific Classes of Laser**

***Class 1*** laser products/systems are normally safe under reasonably foreseeable conditions of use and hence do not require any special precautions or formal control measures. However, if for example during servicing of an embedded laser product, access to levels of laser radiation in excess of the limits for Class 1 could occur, then the protection requirements of the appropriate higher class apply.

***Class 1M and 2M*** products can be hazardous if the output is collimated or is viewed with optical instruments (such as binoculars, telescopes, microscopes and magnifying lenses.) Therefore, avoid placing optical devices in the emitted beam that could cause concentration of the laser radiation. Do not direct the beam into areas where people may be present.

***Class 2*** laser products are normally safe for accidental eye exposure because of the eye’s natural aversion blink reflex to bright light. Therefore protection is afforded by not staring into the beam and by terminating the beam at the end of its useful path. The laser beam should not be aimed at people and care must be taken if the natural aversion blink reflex is likely to be compromised by the use of drugs or alcohol.

***Class 3R*** laser products are controlled by the following measures:

* prevent direct eye exposure to the beam;
* guard against unintentional specular reflections of the beam;
* avoid beam paths at eye level;
* terminate the beam at the end of its useful path;
* install safety interlocks on all access panels;
* provide adequate and sufficient instruction and training;
* where non-visible wavelengths are used an emission indicator device is to be used to indicate the laser is energised.

***Class 3B and 4*** laser products must not be used without first carrying out a risk assessment to determine the protective control measures necessary to ensure safe operation. The safe operating procedures should be set out in clear laser local rules and should be displayed in a prominent position within the work area. Where reasonably practicable engineering means should be used to reduce the laser class to a totally enclosed Class 1 laser product. In addition to the control measures indicated for Class 3R lasers, the following measures should be taken:

* prevent exposure of the skin to the beam;
* guard against diffuse reflections (scattering) of the beam;
* protect against beam interaction hazards such as fire and fume;
* control access to the designated area by use of remote interlock;
* key control (laser is inoperative when the key is removed);
* provision of a beam shutter to temporarily block the beam;
* so far as is reasonably practicable remove reflecting surfaces that could be struck by an errant beam;
* enclose the beam wherever practical;
* use eye protection and protective clothing as appropriate;
* appoint a laser safety supervisor.
	1. **Control Measures for Optical Hazards**

The simplest control measure in avoiding an eye injury is not to look directly into a laser beam or its specular reflection regardless of the laser’s power output, its classification, or the laser eyewear being worn. The MPE must be calculated for the laser sources present and engineering and administrative controls should be used to keep exposures below that MPE whenever possible. Laser safety eyewear and skin protection should only be used where such controls are impractical and open beam work unavoidable.

* + 1. **Engineering Controls**

***Beam enclosure/Beam control***

Hazardous laser beams should be enclosed where reasonably practicable within flight tubes. Where this is not practicable local screening (such as viewing windows or other types of screening) should be placed around sources of scattered radiation such as laser dye cells, mirrors and prisms. Open beams should be kept to the minimum useful length and terminated with a robust beam stop. Open beams should not be permitted to cross walkways and should ideally be placed well below or well above head height ie < 1.3m or > 2.5m for a person standing. The laser and all optical components should be securely fixed to the optical bench to avoid accidental displacement and unintended beam paths. Where possible optical components should be shrouded or coated to minimise the chance of stray reflections. The optical bench should be free from clutter and the wearing of jewellery and wrist watches discouraged to again minimise stray reflections.

***Interlocks***

Access to laser safety panel or laser designated areas should be controlled by safety interlock. The activation of a safety interlock should cause an interruption in the laser power supply and terminate the laser emission. The interlock systems should be designed so that after activation, the system can only be reset by a deliberate action. In addition, resetting the interlock system should not itself restart the laser but should prepare the system to accept a start command.

***Laser Laboratory Design***

There should be a high level of illumination that will minimise pupil size and reduce the risk of stray laser light reaching the retina. Walls, ceilings and fittings should be painted with white matt emulsion to enhance illumination and minimise specular reflections. Highly reflecting surfaces such as glass-fronted cupboards should be avoided. Windows should be covered with blinds that are non-reflective and fireproof where high-powered lasers are used.

* + 1. **Administrative Controls**

***Labelling***

All laser products should carry the appropriate warning labels in accordance with BSEN 60825-1: 2007. Examples are given in Appendix I.

***Designation of Laser Controlled Areas***

A laser controlled area should be established wherever there is a reasonably foreseeable risk of harm arising from the use of the laser equipment. It must present a robust physical boundary capable of adequately containing the laser radiation generated within it, thereby protecting those outside the boundary from hazardous exposure to laser radiation. Warning signs should be clearly displayed on all points of access to these areas. Access to the area where Class 3B and Class 4 lasers are used must be controlled by door interlocks.

Illuminated warning signs may be used on the outside of laser controlled areas to indicate when the laser is in use and the door interlocks (if fitted) are operational. These signs should clearly indicate when it is safe, and when it is not safe, to enter the area.

* + 1. **Personal Protective Equipment**

***Eyewear***

Whenever there is a risk of laser exposure above the calculated MPE, safety eyewear is one of the commonest and important elements of personal laser protection. However, it should be regarded as the last line of defence against exposure to laser radiation. All other options of protection must be considered and implemented where possible. Safety eyewear should never be relied upon to provide against deliberate exposure to a laser beam but should be regarded as a means of providing some protection against accidental exposure. The Laser Safety Advisor and Laser Safety Supervisor must be consulted regarding the specification and selection of safety eyewear. When choosing eyewear, it is important to consider not only the ability of the eyewear to attenuate the incident radiation to below the specified MPE but also to have a damage threshold high enough to withstand the maximum possible exposure long enough for avoiding action to be taken.

Information on specifying eye protection is given in clause 8.4.5 of

PD IEC TR 60825-14.

***Protective Clothing***

In some instances it may also be necessary to provide other protective clothing for work with Class 3B of Class 4 lasers. In addition to the general lab coat it may be necessary to wear face masks and gloves.

* 1. **Control Measures for Alignment Procedures**

Since about 60% of laser accidents in research occur during the alignment process, the following controls should be put in place in addition to those above:

* unauthorised personnel should be excluded from the area;
* laser protective eyewear must be worn at all times;
* lowest possible power output must be used during alignment;
* use low power He-Ne when possible for preliminary alignments;
* carefully identify any situations where the beam is directed out of the horizontal plane and take avoiding action..
	1. **Control Measures for Service and Maintenance Procedures**

Laser products are classified on the basis of the level of laser radiation accessible during operation. Maintenance and servicing on the other hand may require removal of protective covers, disabling of the product’s protective features and/or a significant change to the performance of the laser product, thereby increasing the risk of injury. Such procedures must therefore be undertaken by those who have received the appropriate training, who are authorised, and preferably by a service engineer. In such instances there should be a system of work (permit-to-work) for handing over the equipment to the engineer’s control and for accepting it back when the work is completed. It is also useful to introduce a post-maintenance/post-service checklist to ensure that tools have been removed, interlocks returned to normal operation and covers replaced. During servicing consideration should be given to:

* reducing the level of output to that necessary;
* limit the range of beam steering components to reduce the uncertainty in beam position during alignment;
* consider the use of screens to define a temporary laser hazard area;
* use non-reflective coatings or diffusely-reflecting surfaces on tools.
	1. **Control Measures for Undergraduate Work**

Schools should endeavour to use lasers of lower power and class for undergraduate class experiments (ie classes less than 3R.) Clear written instructions should be provided for each student experiment and local rules should be drawn up and posted in the laboratory to introduce the students to good safety practice. In those instances, where students are involved in project work and work with higher class lasers (3B and 4), they should be treated as laser workers and subject to normal registration and training procedures.

* 1. **Control of Non-Ocular Hazards**

The hazards listed in section 4.1 may be found in any given laser area and must be adequately assessed and the risks controlled. The manufacturer’s safety guidance material should help in such a process. Further information on chemical, electrical and mechanical hazards is given elsewhere.

* 1. **General Safety Procedures and Control Measures**
		1. **Laser Inventory**

The LSS should maintain an inventory of all laser products of Class > 2 held within areas under their direct control. This inventory (pro-forma in Appendix 2) should be updated as necessary and a copy forwarded to the LSA.

* + 1. **Registration of Laser Users**

The LSS should identify and register users of lasers of Classes > 2. An example of the pro-forma is given in Appendix 3. Copies of registrations should be copied to the LSA.

* + 1. **Training**

All Class 3R, Class 3B and Class 4 laser workers must attend training before commencing any laser work. Safety induction training will be provided by the University Safety Service. The worker will be required to work through the “Limits” interactive training system, view the “Laser Safety in Higher Education” video and then complete a laser safety training questionnaire. The pass mark of 80% must be attained before the user is allowed to commence laser work. In addition the School will provide specific training on the laser equipment, local rules and “in-house” emergency procedures.

* + 1. **Ten Golden rules for Laser Safety**

A list of suggested “does” and "don’ts” whilst working with lasers is reproduced in Appendix 4.

1. **Laser Accidents**
	1. **Accident Causes**

Some common unsafe practices that have resulted in laser accidents are listed below:

* lack of pre-planning and failure to follow local rules;
* misaligned optics and upwardly directed beams;
* safety eyewear not worn during alignment procedures;
* wrong safety eyewear worn;
* bypassing safety interlocks;
* insertion of reflective materials into beam paths;
* lack of control of non-beam hazards;
* improper handling of high voltages;
* operating equipment without proper familiarisation.
	1. **Laser Incident – Grab Sheet**

In the event of an ocular injury occurring from exposure to laser radiation, it is vital that an eye examination is carried out as quickly as possible by an ophthalmologist at the nearest casualty eye clinic. It is also essential to provide the ophthalmologist with as much information about the laser radiation as possible. To assist in these matters, every laser system of Class > 2 should have a completed grab sheet posted near the system (example in Appendix 5.) In the event of an incident this sheet can be “grabbed” and presented to the ophthalmologist at the time of the eye examination.

1. **Safety Audits**

The LSS should carry out an annual audit of all laser systems of Class >2 in his/her School using the checklist given in Appendix 6. The LSS should advise the Head of School of any problems that the audits reveal. It is the responsibility of the project supervisor to address such problems. The LSS has the authority to recommend to the Head of School that use of a certain facility should cease until remedial action has been taken.

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APPENDIX 1

**Class 1M**

No hazard warning label.

Explanatory label bearing the words:

**LASER RADIATION**

**DO NOT VIEW DIRECTLY**

**WITH OPTICAL INSTRUMENTS**

**CLASS 1M LASER PRODUCT**

NB-'Optical Instruments' can be supplemented with either 'Binoculars or Telescopes' (for a large diameter collimated beam) or 'Magnifiers' (for a highly diverging beam).

**Class 2**

Label with hazard warning symbol.

Explanatory label bearing the words:

**LASER RADIATION**

**DO NOT STARE INTO BEAM**

**CLASS 2 LASER PRODUCT**

**Class 2M**

Label with hazard warning symbol.

Explanatory label bearing the words:

**LASER RADIATION**

**DO NOT STARE INTO BEAM OR VIEW**

**DIRECTLY WITH OPTICAL INSTRUMENTS**

**CLASS 2M LASER PRODUCT**

NB-'Optical Instruments' can be supplemented with either 'Binoculars or Telescopes' (for a large diameter collimated beam) or 'Magnifiers' (for a highly diverging beam).

**Class 3R**

Label with hazard warning symbol.

Explanatory label bearing the words:

For λ 400nm-1400nm ONLY.

**LASER RADIATION**

**AVOID DIRECT EYE EXPOSURE**

**CLASS 3R LASER PRODUCT**

NB - For other λ replace 'AVOID DIRECT EYE EXPOSURE' with 'AVOID EXPOSURE TO BEAM'

**Class 3B**

Label with hazard warning symbol.

Explanatory label bearing the words:-

**LASER RADIATION**

**AVOID EXPOSURE TO BEAM**

**CLASS 3B LASER PRODUCT**

**Class 4**

Label with hazard warning symbol.

Explanatory label bearing the words:-

**LASER RADIATION**

**AVOID EYE OR SKIN EXPOSURE TO**

**DIRECT OR SCATTERED RADIATION**

**CLASS 4 LASER PRODUCT**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **LASER LIST SURVEY** | **APPENDIX 2** |  |  |  |
|  | **Department ........................................** | **Laser Safety Supervisor ………………………….** |  |  | **Date ...../...../.....** |
|  | **Holder ..........................................** | **Tel .....................** |  |  |  |  |  |
|  | **Manufacturer** | **Laser Type** | **Class** | **Wavelength** | **Max Output (W or J)** | **CW/Pulsed** | **Pulse Length** | **Model No** | **Serial No** | **Location** |
| **1** |   |   |   |   |   |   |   |   |   |   |
| **2** |   |   |   |   |   |   |   |   |   |   |
| **3** |   |   |   |   |   |   |   |   |   |   |
| **4** |   |   |   |   |   |   |   |   |   |   |
| **5** |   |   |   |   |   |   |   |   |   |   |
| **6** |   |   |   |   |   |   |   |   |   |   |
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| **8** |   |   |   |   |   |   |   |   |   |   |
| **9** |   |   |   |   |   |   |   |   |   |   |
| **10** |   |   |   |   |   |   |   |   |   |   |
| **11** |   |   |   |   |   |   |   |   |   |   |
| **12** |   |   |   |   |   |   |   |   |   |   |
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| **14** |   |   |   |   |   |   |   |   |   |   |
| **15** |   |   |   |   |   |   |   |   |   |   |
| **16** |   |   |   |   |   |   |   |   |   |   |
| **17** |   |   |   |   |   |   |   |   |   |   |
| **18** |   |   |   |   |   |   |   |   |   |   |
|  | **Example:** |  |  |  |  |  |  |  |  |  |
|  | Uniphase | He Ne | 3B | 632.8nm | 5mW | CW |   | 1105P | 372422 | EC 21 |
|  | Spectra-Physics | Nd:YAG | 4 | 1064nm | 350mJ | Pulsed | 100ns | DCR 11 | 140 | EB6 |



APPENDIX 3

**REGISTRATION OF USERS OF LASER EQUIPMENT OF CLASS > 2**

Before commencing work with ionising radiations it is necessary to register with the University’s Laser Safety Advisor (LSA).

In addition, it is vital that you are familiar with your Departmental Local Rules concerning work with laser equipment. If you have any doubts or queries please contact either your Departmental Laser Safety Supervisor (LSS) or the University’s LSA at Ext 5638.

***Please complete the following details and forward the form to your Departmental LSS who will send it to the LSA under sealed envelope.***

Surname: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Forenames: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sex: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date of Birth:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

School/Department: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Laboratory/Room Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Details of Laser System to be used: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Please read the following carefully and sign:***

I have read, am fully familiar with and will carefully follow the Departmental Rules for work with laser systems.

I wish to be registered as a Laser Worker and am confident that my practical ability will allow me

to work safely and without danger to myself or my colleagues.

Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Project Supervisor’s Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**TEN GOLDEN RULES FOR LASER SAFETY** APPENDIX 4

*This is a list of suggested “do’s and don’ts” to bear in mind when working with lasers. It will help you to work safely but shouldn’t be regarded as an exhaustive list.*

1. **Do not look into a laser beam**

Don’t look down specular reflections (eg: from mirrors or other reflective surfaces.) Don’t stare at diffuse reflections. Don’t look back along the optical path through an experiment with the laser energised.

If it looks bright - don’t stare at it.

1. **Keep room lights on brightly if possible**

The brighter the ambient lighting level, the smaller the eye’s pupil will become, and the chance of a laser beam entering the eye will be lessened.

1. **Remove personal jewellery**

Watches, rings etc act as reflectors. When entering a laser lab, remove anything which may pose a reflection hazard. This is to protect you and your co-workers.

1. **Locate and terminate all laser beams**

Make sure that all beams are terminated with a suitable beam dump which is capable of handling the power of the laser beam. Remember all transmitting components also back-reflect causing stray beam. With IR or UV lasers these will not be visible! Stainless steel vacuum chambers and VDU screens found in many laser labs are good reflectors of stray incident beams.

1. **Secure all optical components in position**

Use good quality optical mounts, firmly clamped to the table top etc; this helps prevent your experiment from becoming misaligned and reduces the chances of a component moving and sweeping a laser beam over you.

Blu-Tak is definitely NOT a good way to mount optics!

1. **Keep beams in a horizontal plane below eye level, preferably at waist height**

Horizontal beams are easier to work with and are predictable. Avoid vertical and skew beams if possible. Change beam height only if absolutely unavoidable and then with a periscope, and be careful when aligning it.

1. **Don’t bend down below beam height**

If you drop something, block the laser beam at the laser before picking the object up. If you can’t stop the beam (for instance, if you are in the middle of an experiment run), kick the object out of the way so that you don’t trip over it. If you must sit down in a lab, make sure that the stool is high enough that your head is above beam height.

1. **Remember, optical components reflect, transmit and absorb light**

Often, a transmitting component will also reflect light, a reflecting component will transmit light etc. This can lead to stray beams. Beware that the reflectivity etc of components may be different in different spectral regions or with different light polarisation. Beware also that optical components may change their characteristics when used with high power lasers ie: neutral density filters can bleach, crack or even explode.

1. **Don’t forget non-optical hazards**

Don’t trip over, electrocute yourself, spill solvents, burn yourself on liquid nitrogen etc. Remember that laser dyes and solvents are nasty chemicals (COSHH assessments required.)

1. **Wear laser safety protection**

Be certain that you have suitable eyewear provided and wear it.

Protect skin as well as eyes. Don’t put bare hands into a laser beam.

**If in doubt, FIND OUT**



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APPENDIX 5

**Laser incident - Grab sheet**

**Introduction**

**In the event of an ocular injury resulting from a laser incident an examination should be carried out by an ophthalmologist at the nearest Casualty Eye Clinic. The examination should be carried out as soon as possible after the injury and the information contained in this sheet should be made available to anyone treating the injury. The Laser Protection Adviser must also be contacted within 24 hours of the incident.**

**Casualty “Eye” Clinics**

**Royal Victoria Hospital (available 24 hours) 🕿 02890 240503**

**Altnagelvin Hospital (available 24hours) 🕿 02871 345171**

**Mater Hospital (daytime only) 🕿 02890 741211**

**Laser system Details**

**Location/RoomNo**

**ManufacturerTSI**

**Class 3B**

**Model PDPA/LDV**

**Serial No**

**Type Argon ion**

**Wavelength 514.5nm**

**Possible Injury** **See chart overleaf at output wavelength (indicated by blue cursor) Retinal Burn**

**Name of injured person :-**

**Date and time of injury :-**

**Laser settings at time of injury:-**

**Other comments:-**

**Contacts**

**Laser Protection Supervisor –**

**Laser Protection Adviser (RVH) – Dr Ian Gillan*,* NIRMPA 🕿 02890 944383**

**Laser Protection Adviser (QUB) – Dr John Wilson, QUB 🕿 02890 97563**

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APPENDIX 6

**LASER SAFETY AUDIT CHECKLIST**

***If work with laser systems of class > 2 is conducted in your School/Department:***

1. (a) Have the workers received adequate information, instruction Y/N/NA

 and training?

 (b) Are records kept of the training given? Y/N/NA

 (c) Has a local laser supervisor been appointed? Y/N/NA

1. Is there an up-to-date inventory of all laser systems in the Y/N/NA

 School/Department?

1. Have risk assessments been completed for work with each system? Y/N/NA

(f) Does the local laser supervisor retain copies of the risk assessments? Y/N/NA

1. Are regular inspections of the workplace conducted to ensure any Y/N/NA

 control measures prescribed in the risk assessments are being

 used properly?

 (h) Are local rules on display in the workplace? Y/N/NA

 (i) Is the laser work area suitably demarcated and signposted? Y/N/NA

 (j) Is the laser system adequately labelled with warning signs? Y/N/NA

 (k) Have the door(s) to the laser lab(s) been safety interlocked? Y/N/NA

***In the event of an emergency involving a laser system:***

2. (a) Have arrangements been put in place to deal with such incidents? Y/N/NA

 (b) Are “laser incident grab sheets” available on each laser system? Y/N/NA

 (c) Are trained first-aiders and first-aid kits readily available? Y/N/NA

 (d) Is fire-fighting equipment readily available? Y/N/NA

 (e) Are laser users trained in the use of fire-fighting equipment? Y/N/NA

***If laser safety eyewear is used as a control measure:***

3. (a) Does the safety eyewear meeting the appropriate safety standard? Y/N/NA

 (b) Is the wavelength of use clearly marked on the eyewear? Y/N/NA

 (c) If a laser system emits radiation at a number of wavelengths, is Y/N/NA

 safety eyewear available to provide protection at each of those

 wavelengths?

 (e) Is the laser safety eyewear inspected before use for defects? Y/N/NA