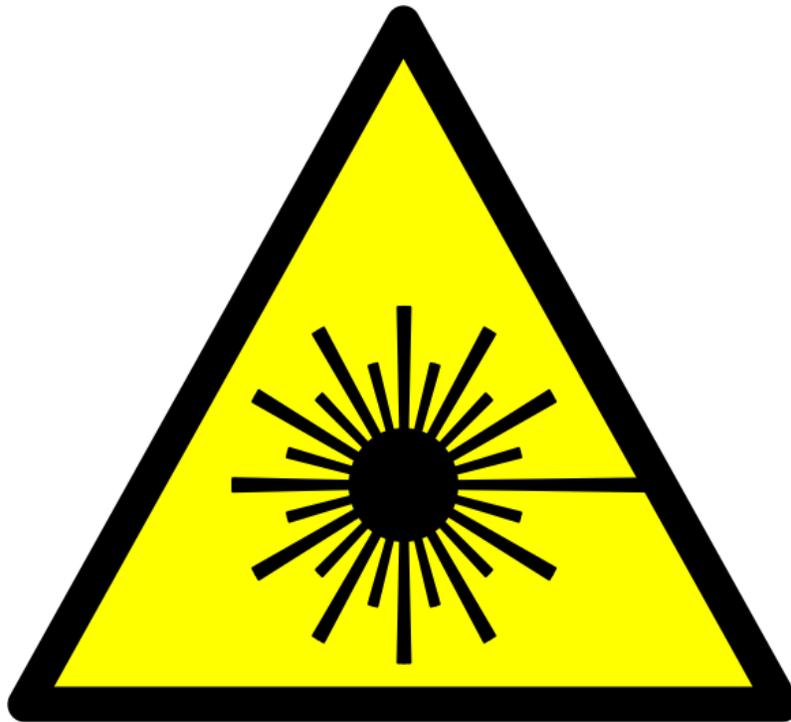


Loughborough University Laser Safety Code of Practice



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Introduction

This Code of Practice is approved by the University Health, Safety and Environment Committee. It supports the University Laser Safety Policy by providing more detailed guidance to all staff and students who use Lasers in their work. It should be read in conjunction with the University Laser Safety Policy.

(Further reading and references can be found in Section 10).

1 Safety Management Structure

1.1 Heads of Department

The Head of Department is responsible for ensuring that all work with Lasers in their Department is carried out in accordance with the University Laser Safety Policy and with this Code of Practice. Where Class 3B and 4 Lasers are used, the Head of Department shall;

- Adopt local rules for Lasers in their Department, and
- Appoint a Laser Safety Officer (LSO)

1.2 Supervisor

The Supervisor has the duty delegated to them from the Head of Department to provide “such supervision as is necessary” to ensure the safety of all students for whom they are responsible. This includes postgraduate students and undergraduate students working with Lasers.

The Supervisor/Principal Investigator has the following responsibilities

- To provide immediate supervision on the use of Lasers in the laboratory.
- To explain and enforce the University Laser Safety Code of Practice.
- To train Laser users in the administration of local rules.
- To consult with the Departmental LSO (see 1.4) when new activity or significant change in activity involving Lasers is planned (Use form [LS1](#)).
- To inform the Departmental LSO of plans to bring new Class 3B and 4 Lasers into the Department.
- To inform the Departmental LSO of the details of changes in users of Class 3B and 4 Lasers.
- To notify the University Laser Safety Advisor (see 1.3) and the University Health and Safety Manager of any accident involving Lasers.
- To attend training.

1.3 University Laser Safety Advisor

The University Laser Safety Advisor has responsibility for the administration and auditing of systems relating to Lasers to ensure compliance with the Health and Safety at Work etc. Act 1974.

The University Laser Safety Advisor shall

- be advised of the intended purchase of a Class 3B or 4 Laser as part of the procurement process. An initial risk assessment must be carried out by the

Departmental LSO using form [LS1](#) before placing an order for a Class 3B or 4 Laser. This assessment shall ensure that the intended work space is suitable and that the Laser meets the standards set by BSEN 60825 part 1. The University Laser Safety Advisor shall review this assessment and inform the Department LSO of any additional safety arrangements that must be adopted before the Laser is used for the first time at Loughborough University. The standards required are those set out in BSEN 60825 part 1.

- Carry out audits in accordance with an agreed programme and report findings to the Head of Department.
- Conduct random inspections and report findings to the Departmental LSO.
- Provide assistance to the DLSO and Heads of Department.
- Carry out suitable training for staff using Class 3B and 4 Lasers for the first time.
- Report to the Radiation Sub Committee annually.
- Investigate accidents.
- Restrict or stop* Laser activities that do not comply with this code of practice or which the ULSA considers to be a serious and imminent risk.
- To work with the University Health and Safety Service.

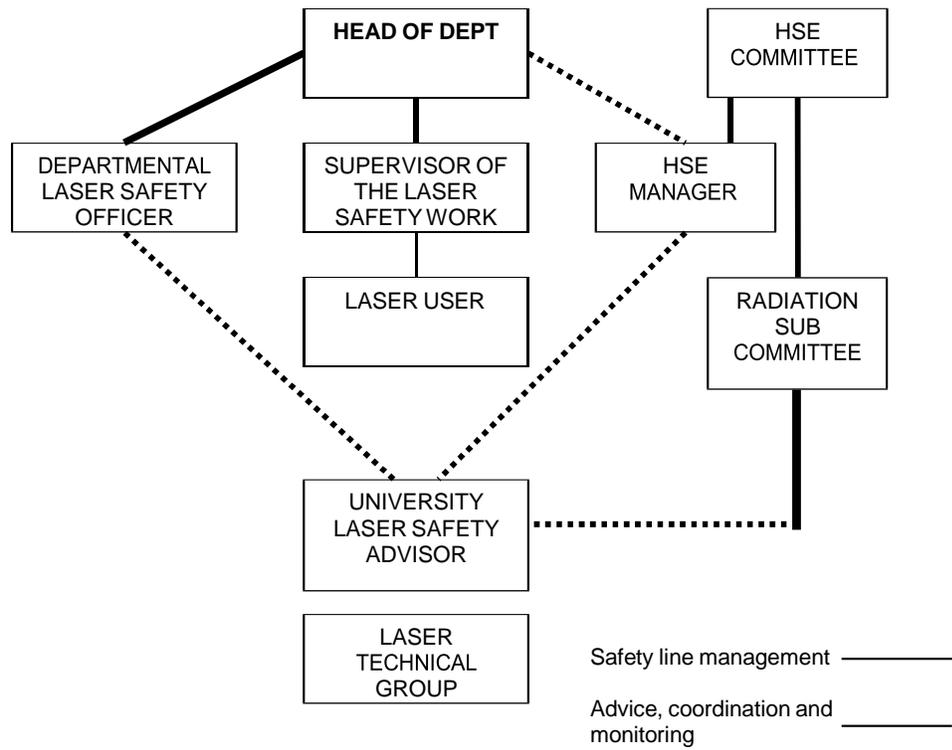
(NOTE; To appeal against a prohibition order the Department concerned shall apply in writing to the University Health and Safety Manager for a formal review.)

1.4 Departmental LSO

The Departmental LSO plays a fundamental role in assisting the University Laser Safety Advisor and ensuring that the Department complies with the University Laser Safety Policy. This person shall be closely involved with the Department's use of Lasers, preferably in a line management position. The Department LSO shall:

- Carry out a minimum of two audits per year (one per semester) to verify that Class 3B and 4 Lasers are being used in accordance with the University Laser Safety Code of Practice. The findings of the audit shall be sent to the University Laser Safety Advisor and Head of Department within 1 week of carrying out the audit.
- Ensure that the following records are maintained: local rules, registered users, registered Lasers, risk assessments, training, maintenance and servicing.
- Ensure that Lasers are procured in accordance with the Laser Safety Code of Practice (see section 7). An initial risk assessment must be carried out by the Departmental LSO using form LS3 before placing an order for a Class 3B or 4 Laser.
- Carry out an initial risk assessment as part of the procurement procedure.
- Ensure that staff are trained to use Lasers in the Department. Training covering local rules and risk assessments may be delivered by the Department LSO or by the Supervisor. Staff who use Class 3B and 4 Lasers must be registered with the Department LSO (and University Health and Safety Service), who shall ensure that they have attended suitable training before using the Lasers without supervision.
- Liaise with the University Laser Safety Advisor

2. Organisational Structure



3. Training

The following training is mandatory:

3.1 University Laser Safety Advisor (ULSA)

The ULSA shall be an academic member of staff with substantial expertise in the field of Laser safety. The minimum qualification for this role is attendance on the joint Health Protection Agency (HPA)/Loughborough University five day Laser management course.

3.2 Departmental LSO and Supervisors

Departmental LSO's and supervisors of Laser work shall attend either a University course of 2 day duration or an equivalent course (subject to the approval of the University Laser Safety Advisor). Appropriate refresher training, recommended by the ULSA, shall be received every 5 years. Training is arranged by the University Health and Safety Service and delivered by the ULSA.

3.3 Laser users

All users of Class 3B and 4 Lasers MUST attend one of the Laser safety training sessions. Training is held twice per academic year. **No unsupervised work can take place until Laser users are trained.**

All Laser users must be informed by the Supervisor of the findings of risk assessments and local rules for their working area. Users must sign a copy of the local rules where these apply and the signed copy shall be retained by the Departmental LSO.

All users of Class 3B and 4 Lasers must be registered with the University Health And Safety Service. (Please use the form [LS2](#))

4 Risk Assessment

4.1 Class 3B and 4 Laser products emit accessible Laser radiation that could lead to the exposure limit values being exceeded and any experiment or work which involves the use of these Lasers must always be subjected to a thorough risk assessment. However, under some circumstances, lower hazard class Lasers may also need assessment.

A suitable and sufficient risk assessment is required before any work is carried out with Lasers where exposure limits for any class of Laser may be exceeded. Generally a risk assessment is required in the following circumstances (this list is not exhaustive):

Class	Circumstance
Class 1 and Class 2	<ul style="list-style-type: none">Laser systems that are classified as Class 1 or 2 are safe by design. There is no requirement to carry out a Laser risk assessment unless the system is altered.

Class 1M and 2M	<ul style="list-style-type: none"> • The beam is altered using a loupe or lens • Maintenance or service
Class 3R	<ul style="list-style-type: none"> • As above • Direct viewing of the beam is possible.
Class 3B and Class 4	<ul style="list-style-type: none"> • All novel uses for existing equipment • All new equipment

Use of pulsed Lasers may result in higher exposures to harmful radiation and a risk assessment must be discussed with the Departmental LSO

Your risk assessment should be recorded using the University Laser risk assessment form [LS3](#)

4.2 Guidance on risk assessment is available in the Control of Artificial Optical Radiation Regulations 2010. (<http://www.hse.gov.uk/radiation/nonionising/employers-aor.pdf>)

4.3 The risk assessment must consider the specification of the Laser and identify where Exposure Limit Values (ELV) may be exceeded. These values are set out in tables 2.2, 2.3 and 2.4 of Annex II of the Directive 2006/25/EN http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_114/l_11420060427en00380059.pdf

Further guidance on the assessment of ELVs is available in PD IEC TR 60825-14 2004:- (“Safety of Laser products; A users guide”). It should be noted that the document uses the term Maximum Permissible Exposure (MPE) instead of ELV.

4.4 The risk assessment must be kept up to date and the controls identified in it must be implemented.

4.5 Where necessary the risk assessment should be developed into the local rules for working with Lasers in a designated area.

4.6 Training for all Laser users must include the significant risks identified in the risk assessment.

5. Risk Controls

A risk control hierarchy must be applied to remove or, where this is not practicable, to reduce risk. The hierarchy is:

Elimination/substitution

It is unlikely that the Laser can be removed entirely but the substitution of a Laser with one from a less hazardous class must be considered e.g. change the use of a Class 3B Laser to a Class 2 Laser.

Engineering controls

These are the most effective methods of control for a given Laser and should always be considered first - see section 6: Guarding and signage

Management controls

Steps should be taken to change behaviour so that people do not inadvertently or deliberately put themselves at risk. Examples include:

- Training
- Designating Laser Controlled Areas where exposure can exceed the ELV (MPE) for the particular wavelength of Laser radiation
- Signage and warning lights
- Preventing unauthorised access to a controlled area
- Controlling access to keys
- Keeping beam paths as short as possible
- Containing the beam in fibres, flight tubes or other forms of containment
- Written Safe Operating Procedures for high risk activities including maintenance and alignment of the beam
- Controlling the use of equipment or the wearing of items that may give rise to specular reflections
- Local rules
- Use of alignment aids during routine maintenance to realign the beam path e.g. use of a lower power sighting Laser or use of mask or target
- Displaying Emergency Action notices as laminated sheets near to the entrance to any Designated Laser Controlled Area to give instructions on how to obtain emergency assistance and medical help.

Personal Protective Equipment (PPE)

PPE are the items worn by an individual to protect against residual risks. PPE is the last form of control that should be considered as a safety measure and it should only be provided if it is not possible to guarantee that exposure to radiation will be less than the ELV (MPE) for the particular Laser under all circumstances. PPE also needs to be maintained and replaced when necessary – which can be overlooked and can be expensive.

Attention is drawn to the following guidance.

- PPE should be provided if, despite using other means of control, there is still a risk that eyes can be exposed to Laser radiation above the ELV (MPE).
- Where PPE has been deemed necessary its use is compulsory.

- Laser eyewear must be carefully selected to ensure that the wavelength of light emitted by the Laser is selectively blocked by the filter in the eyewear.
- Where Lasers of different wavelengths are in use, a system of colour coding or other means must be used to match the Laser with the appropriate eyewear.
- Eyewear must be permanently marked to show a) the operating wavelength and b) the optical density at the operating wavelength.
- Eyewear must be replaced if it is exposed to a single incident of accidental exposure to a high level of incident radiation or if the filter has degraded with prolonged or accumulative exposure to Laser radiation.

6. Guarding and signage

6.1 Guards

Guards are an example of an engineering control. Guarding a Laser system in such a way that it is not able to cause harm under all foreseeable circumstances of use is the most effective and the preferred means to reduce the risk from a Laser. It is important that the guard does not impede operation of the Laser system. The most effective guard completely encloses the beam. Fixed guards make the management of the hazard easier and, in most cases, much cheaper. Guards must conform with the Supply of Machinery (Safety) Regulations 2008, as amended by the Supply of Machinery (Safety) (Amendment) Regulations 2011.

There are very few activities where enclosing the beam is not practical. If the use of open beams is considered, it is necessary to obtain the agreement of the Departmental LSO and the University Laser Safety Advisor before the work goes ahead. It is the user's responsibility to contact the departmental LSO. In these cases a written risk assessment must be submitted to the University Laser Safety Advisor.

Other forms of engineering control are:

- a shutter or beam stop at the Laser aperture – this can be controlled by door or other interlocks.
- light curtains or brushes
- use of CCTV cameras to view experiments on a TV screen,
- beam attenuation (to reduce power during alignment of the beam or other manual manipulation of the Laser system.)
- temporary beam stops – a means to reduce risk while adjusting any part of the Laser system.
- Interlocks – (NB interlocks fitted by the user should comply with BSEN 626-1 BS EN 626-1:1994+A1:2008: "Safety of machinery. Reduction of risks to health from hazardous substances emitted by machinery. Principles and specifications for machinery manufacturers", and BS EN 1088:1995+A2:2008: "Safety of machinery. Interlocking devices associated with guards. Principles for design and selection", to ensure that the system fails to safety and to design out potential faults such as arcing or a contact weld on a relay. The interruption of the power supply should also be accompanied by the

dumping of any residual energy to prevent further pulses from being generated unexpectedly.

- Viewing windows – polycarbonate or glass filters inset into the fixed guard

6.2 Signage

6.2.1 Designated Laser Controlled Areas

Hazard warning signs must be displayed at eye level at the entrance to all Designated Laser Controlled Areas. These are areas where Class 3B and 4 Lasers are used or where the ELV (MPE) value for other classes of Lasers may be exceeded. Signage must comply with the Health and Safety (Safety Signs and Signals) Regulations 1996. A notice must also be clearly displayed giving the name of the person responsible for the area, emergency contact details and the name of the Department's LSO. The Designated Laser Controlled Area must be registered with the University Health and Safety Service.

The use of illuminated warning signs in Laser designated controlled area is strongly recommended. Where illuminated signs are displayed lights should only become illuminated when the Laser is in use and the rules for working in the area must be written into the local rules.

6.2.2 Information labels

All Lasers (except Class 1) must display information labels. The required information is set out in BS EN 60825-1 2014:- "Safety of Laser Products, Equipment classification and requirements".

Normally the manufacturer is responsible for labelling a Laser but if the user modifies the Laser it may need reclassifying.

7. Procurement

All plans to procure or supply a Class 3B or Class 4 Laser must be discussed in advance with the Departmental LSO and the University Laser Safety Advisor. An initial risk assessment must be submitted to the University Laser Safety Advisor using form [LS1](#) before the order is placed.

The University Procurement office will not process an order until confirmation is given that a risk assessment has been submitted and that this has been approved by the University Laser Safety Advisor.

8. Accident Reporting

An eye examination must be carried out if it is suspected or known that someone has been exposed to artificial optical radiation in excess of the optical ELV (MPE). In an emergency, contact the Eye Casualty Department, located at the Eye, Ear, Nose and Throat Centre on Floor A at the Queens Medical Centre. The opening hours are 0700hrs to 2200hrs. Telephone: 0115 9249924 - Ext 62882.

(Please note; between 2200hrs and 0700hrs, emergencies are treated at Ward C25; (Inpatient Ward – Head and Neck Unit).

A laminated information sheet giving relevant information about the Laser specification e.g. the name, power, wavelength, pulse duration etc, should be collected from a designated point (such as a wall mounted pouch) near to the entrance of a Designated Laser Controlled Area. This information will be needed by medics treating any eye injury caused by Laser radiation.

(Please note; Accidental exposure to Laser radiation above the ELV (MPE) must be reported to the University Health and Safety Service by calling 222181, or emailing to; hse@lboro.ac.uk. A Dangerous Occurrence Near Miss form must also be completed and returned to the University Health and Safety Service office in Facilities Management building.)

9. Record Keeping

The following records are required for all Class 3B and 4 Lasers. The information should be kept in a suitable folder and should be available for inspection in the department:

For each Laser:

1. Laser Form LS1
2. A copy of the University Laser Safety Policy
3. Training records
4. Laser Form LS2 for each user
5. The risk assessment for the - Laser Form LS3
6. Local Rules
7. Audit reports – results of twice yearly audits carried out by the Department LSO
8. Calibration reports, maintenance records, service records
9. External contacts
10. Any other relevant information (e.g. the University Laser Safety Code of Practice)

10. Technical references and further reading

- The Control of Artificial Optical Radiation Regulations 2010.
(<http://www.hse.gov.uk/radiation/nonionising/employers-aor.pdf>)
- European Commissions non-binding guide to good practice for implementing the Artificial Optical Radiation Directive 2006/25/EC
- BS EN 60825; (Parts 1 and 14 have particular relevance)
- The Association of University Radiation Protection Officers (AURPO) Guidance on the safe use of Lasers in education and research (GN 7) 2012.
- Supply of Machinery (Safety) Regulations 2008, as amended by the Supply of Machinery (Safety) (Amendment) Regulations 2011.
(<http://www.legislation.gov.uk/ukxi/2008/1597/contents/made>)

11. Document management table

Version	Owner	Revised by	Summary of revision	Date of revision
1	UH&SS	UH&SS		February 2010
2	"	H Weaver	Up date references logo etc	January 2016

Appendices: Laser Forms

LS1 Laser Survey Form

The following Laser survey form takes all the manufacturing and user requirements into account and provides a checklist to see if the Laser installation is observing all the requirements recommended by BS EN 60825. Where a box cannot be 'ticked off' the user should be employing some other protective measure justified by a risk assessment.

The specified precautions apply to all the unshaded boxes

NB LASER SURVEY FORM					DEPT:		
Date:				LAB:			
Make:				Type:		Mode:	
Model & s/n:				λ:		Power:	
Precautions	1	1M	2	2M	3R	3B	4
Remote interlock							
Safety interlocks							
Key control							
Emission indicator							
Beam stop/shutter							
Beam terminator							
Beam level							
Beam enclosure							
Eye protection							
Protective clothing							
Training							
Laser labels							
Door/Area signs							

Laser installation: satisfactory/ not satisfactory

Additional control measures required:

.....

Survey performed by:

This form should be completed by the Departmental LSO and sent to the University Laser Safety Advisor for approval before a Class 3B or 4 Laser is purchased or supplied to the University.

LS2 Registration form for users of Class 3B and 4 Lasers

REGISTRATION FORM FOR LASER USERS	
Surname:	Prenames(s):
Title (Mr, Ms, Prof., Dr, etc)	Appointment (Lecturer, RA, Technician, RS etc)
Email:	Supervisor:
Department:	
Laser(s) to be used:	
Experiment(s) to be performed:	
Lab(s) to be used:	
Training given	

LS3 Use of class 3B & 4 Lasers – Hazard and Risk Assessment

Class 3B and 4 Lasers are capable of causing eye injury to anyone who looks directly into the beam or its specular reflections. In addition, diffuse reflections of a high-power (Class 4) Laser beam can produce permanent eye damage. High-power Laser beams (Class 4) can burn exposed skin, ignite flammable materials, and heat materials releasing hazardous fumes, gases and debris. Equipment and optical apparatus required to produce and control Laser energy may also introduce additional hazards associated with high voltage, high pressure, cryogenics, noise, other forms of radiation, flammable materials and toxic fluids. Thus, each proposed experiment or operation involving a Laser must be evaluated to determine the hazards involved and the appropriate safety measures and controls required.

School/Dept.

Assessment Number

Assessor

Date of Assessment

1 **LOCATION OF THE ACTIVITY**

2 LASER IDENTIFICATION AND SPECIFICATIONS				
<i>Complete the following chart, list all Lasers, including low power alignment Lasers</i>				
	Laser 1	Laser 2	Laser 3	Laser 4
Type:				
Manufacturer:				
Model:				
Serial				
Maximum Power				
Maximum Pulse Energy				
Wavelength Range				
Wavelength Used				
Power Used				
Pulse Energy Used				
Pulse Length				
Pulse Repetition Rate				
Beam Diameters (x,y)				
Beam Shape (e.g. ellipse, box, circular)				
Beam Divergence (x,y)				
LASER CLASSIFICATION				

3	<p>DESCRIPTION OF ACTIVITY OR RESEARCH PROJECT <i>Provide a brief description of the Laser set up, its purpose and operational parameters</i></p>
	<p>DURATION OF ACTIVITY/PROJECT <i>Is the work ongoing or for a limited period?</i></p>
4	<p>IDENTIFICATION OF NON-BEAM HAZARDS</p> <p>Electrical Hazards <i>Most Lasers contain high-voltage power supplies and often large capacitors/capacitor banks that store lethal amounts of electrical energy.</i> Are any special precautions/procedures required? Yes/No</p> <p>Laser Dyes <i>Laser dyes are often toxic and/or carcinogenic chemicals dissolved in flammable solvents</i> Are Laser dyes used? Yes/No Give details if yes.</p> <p>Compressed and Toxic Gases <i>Hazardous gases may be used in Laser applications, i.e., excimer Lasers (fluorine, hydrogen chloride).</i> Are compressed gases and/or toxic gases used? Yes/No Give details, if yes.</p> <p>Cryogenic Fluids <i>Cryogenic fluids can create hazardous situations. Adequate ventilation must be provided.</i> Are Cryogenic fluids used? Yes/No Give details if yes.</p> <p>Fumes/Vapours/Laser generated Air Containments from Beam/Target Interaction <i>When Laser beams are sufficiently energised to heat up a target, the target may vaporise, creating hazardous fumes or vapours that may need to be captured or exhausted.</i> Is there potential for fumes/vapours/Laser generated air contaminants Yes/No Give details if yes.</p> <p>Ultra Violet (UV) and Visible Radiation/Plasma Emissions <i>UV and visible radiation may be generated by Laser discharge tubes, pump lamps or plasmas. The levels produced may be eye and skin hazard.</i> Is there a potential for significant UV/visible radiation? Yes/No</p> <p>Explosion Hazards <i>High pressure arc lamps, filament lamps, and capacitors may explode if they fail during operation. Laser targets and some optical components also may shatter if heat cannot be dissipated quickly enough.</i> Is there an explosion hazard? Yes/No Give details if yes.</p> <p>Ionising Radiation (X-rays) <i>X-rays can be produced from two main sources, high volume vacuum tubes of Laser power supplies such as rectifiers, Thyratrons and electric discharge Lasers. Any power supplies that require more than 15 kV may produce X-rays.</i> Is there an ionising radiation hazard? Yes/No</p>

Other hazards not identified above.
Please specify.

5 RISK ASSESSMENT and CONTROL MEASURES	
PERSONS WHO MAY BE AT RISK	Specified Authorised Laser Users Project Supervisors Others

6 MEASURES TO REDUCE LEVEL OF RISK (LASER BEAM HAZARD)			
Are open or partially enclosed beams used during the following?	1. Initial setting up and beam alignment; 2. Addition of new optical elements/Lasers; 3. Day to day operation; 4. Maintenance	Yes/No/n/a Yes/No/n/a Yes/No/n/a Yes/No/n/a	
Are there protocols/procedures to control risks from the optical (and if applicable, skin) hazards?	1. Initial setting up and beam alignment; 2. Addition of new optical elements/Lasers; 3. Day to day operation 4. Maintenance	Yes/No/n/a Yes/No/n/a Yes/No/n/a Yes/No/n/a	
List the operating protocols with references/dates/location. ALL OPEN BEAM WORK MUST HAVE AN APPROPRIATE PROTOCOL/OPERATING PROCEDURE			

7 INSTRUCTION/TRAINING Authorised Laser users must receive appropriate training and instruction

Specify the instruction and training arrangements.

A list of authorised Laser users is to be displayed

8 PROTECTIVE EYEWEAR Detail how Optical Density (OD) was determined.
--

Number available	Location	Manufacturer	Optical Density	Wavelength

9	ASSESSMENT OF RISK (ASSOCIATED HAZARDS identified in Section 4)				
	<p>Detail the significant risks and the control measures necessary (i.e. by reference to protocols/procedures or safety manual).</p> <p>For hazardous substances, specify the location of the appropriate COSHH assessments</p>	<table border="1"> <thead> <tr> <th>Hazard/Risk</th> <th>Control Measure</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> </tbody> </table>	Hazard/Risk	Control Measure	
Hazard/Risk	Control Measure				

10	MONITORING
<p>Performance of control measures</p> <p>It is the individual responsibility of each Laser operator to follow the guidelines on Laser safety. Where control measures have failed or have been suspect then Laser users should report these. Supervisors should monitor that users are complying with procedures as should the School and University LSOs by carrying out periodic checks.</p>	

11	REVIEW
<p>Enter the date or circumstances for review of assessment (maximum of 3 years or the length of the particular project if shorter).</p> <p>Where new Lasers or components are introduced then these changes need to be assessed; protocols may need to be modified. A review would also be required where a new Laser worker starts ensuring that they are informed of the relevant risks and protocols.</p>	

12	EMERGENCY ACTION	
TO CONTROL HAZARDS		To stabilise situation e.g. turn off power source, etc.
Turn off power.		
TO PROTECT PERSONNEL		Evacuation, protection for personnel, Special First Aid
Once power has been turned off the Laser does not present an optical hazard to personnel in the area.		
TO RENDER SITE OF EMERGENCY SAFE		Power, ventilation
Turn off power.		

13	EMERGENCY CONTACT	Name	<input type="text"/>	Tel.No.	<input type="text"/>
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