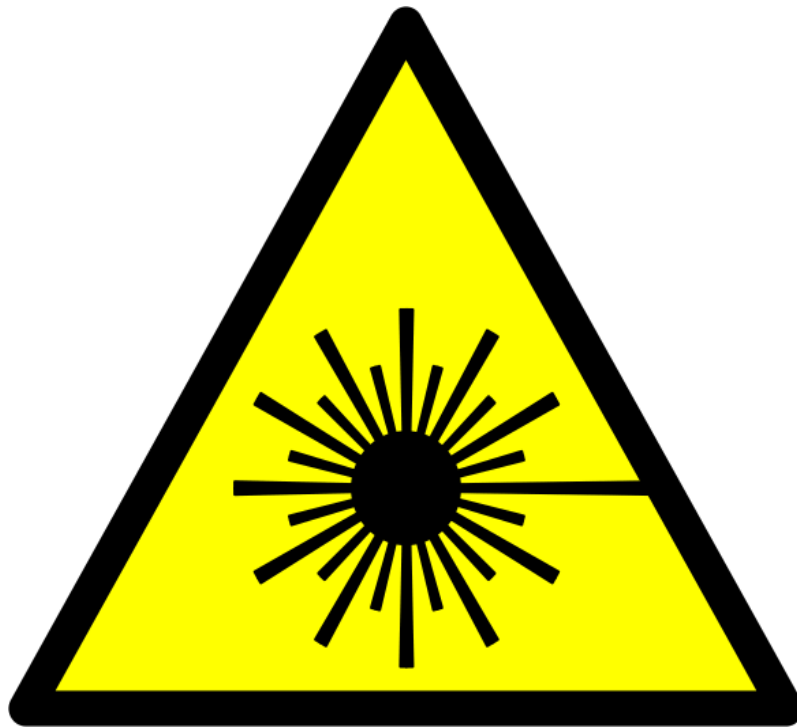


# Loughborough University Laser Safety Code of Practice



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## Introduction

This Code of Practice is approved by the University's HSE 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 information can be found in the following publications:

- Control of Artificial Optical Radiation Regulations (due April 2010 – see <http://consultations.hse.gov.uk/inovem/gf2.ti/f/10018/294085.1/pdf/-/cd227.pdf>)
- Health Protection Agency: A non-Binding Guide to the Artificial Optical Radiation Directive 2006/25/EC  
<http://www.hse.gov.uk/radiation/nonionising/aor-guide.pdf>
- BSEN 60825 2007 (second edition) (parts 1 and 14 have particular relevance)
- Association of University Radiation Protection Officers: Guidance On The Safe Use Of Lasers In Education And Research  
[http://www.aurpo.org/docs/AURPO\\_GN7\\_Lasers\\_0107.pdf](http://www.aurpo.org/docs/AURPO_GN7_Lasers_0107.pdf)
- The Supply of Machinery (Safety) Regulations 2008 SI 2008 No. 1597  
[http://www.opsi.gov.uk/si/si2008/uksi\\_20081597\\_en\\_1](http://www.opsi.gov.uk/si/si2008/uksi_20081597_en_1)

## **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 use, the Head of Department shall

- Adopt local rules for lasers in their Department.
- Appoint a laser safety officer (LSO) in writing
- Ensure that lasers are procured in accordance with the Code of Practice. (see section 7)
- Ensure that Departmental self inspections are carried out in accordance with the Code of Practice

### **1.2 Departmental Laser Safety Officer**

The Departmental Laser Safety Officer 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 Laser Safety Officer shall:

- Carry out a minimum of two self inspections audits per year (one per semester) to verify that Class 3B and 4 lasers are used in accordance with the University 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 Class 3B and 4 lasers are procured in accordance with this policy.
- 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 Laser Safety Officer or by the Supervisor. Staff who use Class 3B and 4 lasers must be registered with the Department Laser Safety Officer who shall ensure that they have attended suitable training before using the lasers without supervision.
- Liaise with the University Laser Safety Advisor
- Attend the laser safety technical group meetings and where requested assist with cross departmental laser audits

### **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 Laser Safety Officer 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 Laser Safety Officer 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 Laser Safety Officer
- 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 central HSE service

NB to appeal against a prohibition order the Department concerned shall apply in writing to the Health and Safety Manager for a formal review.

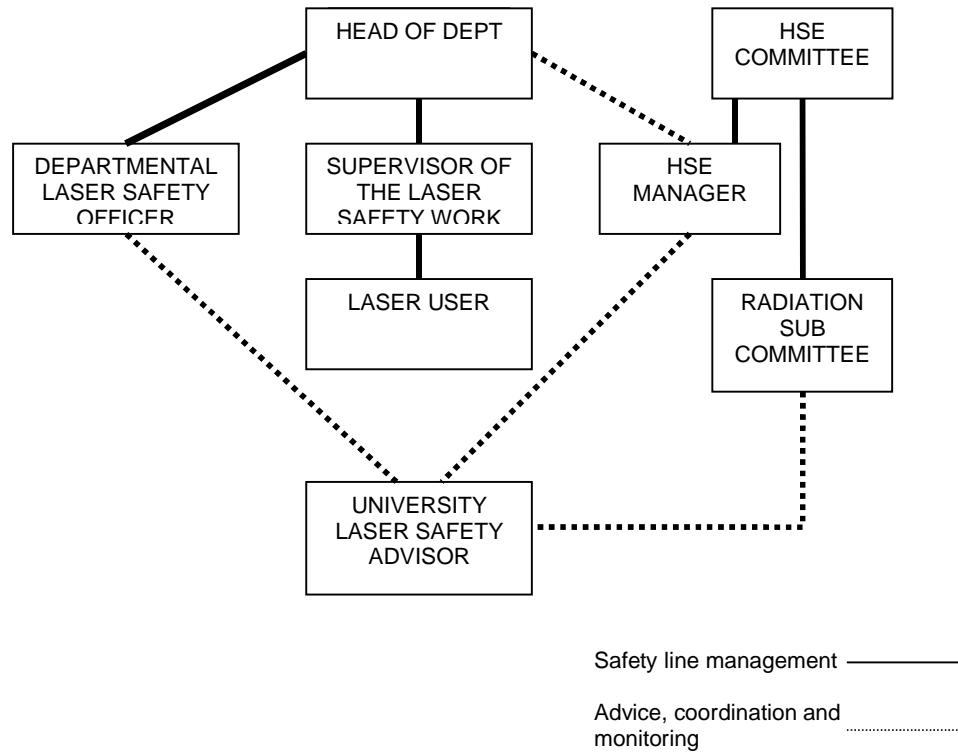
#### **1.4 Supervisor**

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 Laser Safety Officer when new activity or significant change in activity involving lasers is planned (Use form [LS1](#))
- To inform the Departmental Laser Safety Officer of plans to bring new Class 3B and 4 lasers into the Department.
- To inform the Departmental Laser Safety Officer of the details of changes in users of Class 3B and 4 lasers.
- To notify the University Laser Safety Advisor and the Health, Safety and Environment Manager of any accident involving lasers
- To attend training.

## 2. Organisational Structure



### 3. Training

The following training is mandatory:

#### 3.1 University Laser Safety Advisor

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 HPA/Loughborough University five day laser management course. (NB the current post holder delivers this course.)

#### 3.2 Departmental Laser Safety Officer and Supervisors

Departmental Laser Safety Officers 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 Health and Safety Office.

#### 3.3 Laser Users

All users of Class 3B and 4 lasers **MUST** attend one of the Laser Safety Training Sessions as soon as possible. Training is held twice per academic year. **No unsupervised work can take place until laser users are trained. Visit the Staff Development Website to register your interest for the next available course**

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 Laser safety Officer.

**All users of Class 3B and 4 lasers must be registered with the HSE office. Please use the form [LS2](#)**

## 4 Risk Assessment

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

**Use of pulsed lasers may result in higher exposures to harmful radiation and a risk assessment must be discussed with the Departmental Laser Safety Officer**

**Your Risk Assessment should be recorded using the University laser risk assessment form [LS3](#)**

- 4.2. Guidance on risk assessment is available in section 6 of the Non Binding Guide to the Artificial Optical Radiation Directive.

<http://www.hse.gov.uk/radiation/nonionising/aor-guide.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](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. 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. You should justify your choice of laser in the risk assessment.

### *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*

These are the steps that are 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 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 jewellery 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 for the particular laser under all circumstances. PPE is the last choice as a means of protection because people are apt to forget to wear the item or make errors in selecting appropriate PPE types. PPE also needs to be maintained and replaced when necessary - which can be overlooked and can be expensive. Your 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.

- Where PPE has been deemed necessary its use is compulsory and is not a matter of personal choice.
- The purpose of eyewear is to control accidental exposure to damaging laser radiation and not to view the laser beam deliberately.
- Because reliance on laser safety eyewear as a means to prevent injury is prone to failure, there is a presumption at Loughborough University that it is generally inappropriate and must be justified in the written risk assessment.
- 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 there is the possibility that eyewear for different lasers can get mixed up, a system of colour coding or other means should 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 or there will be a temptation to defeat the guarding arrangement. The most effective guard completely encloses the beam. This will prevent access to the beam rather than preventing the beam escaping. If all the optics are secure, there is no reason why the beam enclosure cannot be transparent. Simple plastic pipes make good beam enclosures. Fixed guards make the management of the hazard easier and, in most cases, much cheaper. Guards should conform with the [Supply of Machinery Regulations 2008](#)

**There are very few activities where enclosing the beam is not practical.** If you feel that you must use open beams you must justify this to the Departmental Laser Safety Officer and the University Laser Safety Advisor before the work goes ahead. It is your responsibility to contact the departmental laser safety officer to discuss your intentions. If you decide to go ahead with the work you **MUST** submit your written risk assessment 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 - n.b. interlocks fitted by the user should comply with BSEN 626-1 and BSEN 1088 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 value for other classes of lasers may be exceeded. Signage must comply with the Health and Safety (Safety Signs and Signals) Regulations. 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 Laser Safety Officer. The Designated Laser Controlled Area must be registered with the Health and Safety Office. 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 Safety of laser products — Part 1: 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 Laser Safety Officer 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 procurement office will not process your order until confirmation is given that you have submitted your risk assessment and that this has been approved by the University Laser Safety Advisor.

## 8. Medical Surveillance and 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 exposure limit value.

Please contact the Queens Medical Centre Nottingham on the following number 0115 9249124 ext 61135.

A laminated information sheet giving relevant information about the laser specification i.e. 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 an eye injury caused by laser radiation.

*Please report any suspected injury or accidental exposure to laser radiation above the EXPOSURE LIMIT VALUE to the University HSE office on 222181 or to [c.m.moore@lboro.ac.uk](mailto:c.m.moore@lboro.ac.uk).*

## **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. Form LS1
2. A copy of the Laser Safety Policy
3. Training records
4. Form LS2 for each user
5. The risk assessment for the laser
6. Local Rules
7. Audit reports – results of twice yearly audits carried out by the Department Laser Safety Officer
8. Calibration reports, maintenance records, service records
9. External contacts
10. Any other relevant information



## Appendix: 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 shaded boxes

<b>NB LASER SURVEY FORM</b>					<b>DEPT:</b>		
<b>Date:</b>				<b>LAB:</b>			
<b>Make:</b>				<b>Type:</b>		<b>Mode:</b>	
<b>Model &amp; s/n:</b>				<b>λ:</b>		<b>Power:</b>	
<b>Precautions</b>	<b>1</b>	<b>1M</b>	<b>2</b>	<b>2M</b>	<b>3R</b>	<b>3B</b>	<b>4</b>
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:

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.....

.....

Survey performed by:

**This form should be completed by the Departmental Laser Safety Officer 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

<b>REGISTRATION FORM FOR LASER USERS</b>	
Surname:	Prenames(s):
Title (Mr, Ms, Dr etc)	Status (Lecturer, RA, Technician, RS etc)
email:	Supervisor:
Department:	
Lasers to be used:	
Experiments to be performed:	
Labs to be used:	
Training given	

### LS3 USE OF CLASS 3B & 4 LASERS – HAZARD & 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 <b>LASER IDENTIFICATION AND SPECIFICATIONS</b> <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)				
<b>LASER CLASSIFICATION</b>				

<b>3</b>	<p><b>DESCRIPTION OF ACTIVITY OR RESEARCH PROJECT</b>  <i>Provide a brief description of the laser set up, its purpose and operational parameters</i></p>
	<p><b>DURATION OF ACTIVITY/PROJECT</b>  <i>Is the work ongoing or for a limited period?</i></p>
<b>4</b>	<p><b>DENTIFICATION OF NON-BEAM HAZARDS</b></p> <p><b>Electrical Hazards</b>  <i>Most lasers contain high-voltage power supplies and often large capacitors/capacitor banks that store lethal amounts of electrical energy.</i>  <b>Are any special precautions/procedures required?</b>  <b>Yes/No</b></p> <p><b>Laser Dyes</b>  <i>Laser dyes are often toxic and/or carcinogenic chemicals dissolved in flammable solvents</i>  <b>Are Laser dyes used?</b>  <b>Yes/No</b>  Give details if yes.</p> <p><b>Compressed and Toxic Gases</b>  <i>Hazardous gases may be used in laser applications, i.e., excimer lasers (fluorine, hydrogen chloride).</i>  <b>Are compressed gases and/or toxic gases used?</b>  <b>Yes/No</b>  Give details, if yes.</p> <p><b>Cryogenic Fluids</b>  <i>Cryogenic fluids can create hazardous situations. Adequate ventilation must be provided.</i>  <b>Are Cryogenic fluids used?</b>  <b>Yes/No</b>  Give details if yes.</p> <p><b>Fumes/Vapours/laser generated Air Containments from Beam/Target Interaction</b>  <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>  <b>Is there potential for fumes/vapours/laser generated air contaminants</b>  <b>Yes/No</b>  Give details if yes.</p> <p><b>UV and Visible Radiation/Plasma Emissions</b>  <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>  <b>Is there a potential for significant UV/visible radiation?</b>  <b>Yes/No</b></p> <p><b>Explosion Hazards</b>  <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>  <b>Is there an explosion hazard?</b>  <b>Yes/No</b>  Give details if yes.</p> <p><b>Ionising Radiation (X-rays)</b>  <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>  <b>Is there an ionising radiation hazard?</b>  <b>Yes/No</b></p> <p><b>Other hazards not identified above.</b>  Please specify.</p>



<b>9</b>	<b>ASSESSMENT OF RISK (ASSOCIATED HAZARDS identified in Section 4)</b>					
	<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" style="width: 100%;"> <thead> <tr> <th style="width: 50%; text-align: center;">Hazard/Risk</th> <th style="width: 50%; text-align: center;">Control Measure</th> </tr> </thead> <tbody> <tr> <td style="height: 100px;"></td> <td></td> </tr> </tbody> </table>	Hazard/Risk	Control Measure		
	Hazard/Risk	Control Measure				

<b>10</b>	<b>MONITORING</b>
	<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 suspected then laser users should report these. Supervisors should monitor that users are complying with procedures as should the School and University laser Safety Officers by carrying out periodic checks.</p>

<b>11</b>	<b>REVIEW</b>
	<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>

<b>12</b>	<b>EMERGENCY ACTION</b>	
	<b>TO CONTROL HAZARDS</b>	To stabilise situation e.g. turn off power source, etc.
	Turn off power.	
	<b>TO PROTECT PERSONNEL</b>	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.	
	<b>TO RENDER SITE OF EMERGENCY SAFE</b>	Power, ventilation
	Turn off power.	

<b>13</b>	<b>EMERGENCY CONTACT</b>	NAME	<input style="width: 90%;" type="text"/>	PHONE	<input style="width: 90%;" type="text"/>
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