|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Business Unit:** | | **Building & Room/Lab No:** | | | | | **Risk Assessment Ref:** | | |
| **Activity Title:** | | | | | | | | | |
| **Description and duration of activity:** | | | | | | | | | |
| **Those at risk / affected parties:** (consider authorised laser workers, non-laser workers, others e.g. cleaners, maintenance, contractors, visitors) | | | | | | | | | |
| **Risk Assessor**  Name: | | Signature: | | | | | | Date: | |
| **Responsible person: PI / Line Manager**  Name: | | Signature: | | | | | | Date: | |
| **Related procedure references or links (e.g., SOPs):** | | | | | | | | | |
| **Review Period** (UoN policy - 2 yearly unless there are intervening significant changes)**:** | | | | | | | | | |
| **Please refer to the Guidance towards the end of the document ahead of undertaking the Laser Risk Assessment. The risk assessment should be completed for a full laser experiment if there are multiple within a given set-up.** | | | | | | | | | |
| **Section 1a: Continuous wave (CW) Lasers in Use (Check if required -  )**  **Please seek aid from your laser data sheet or, subsequently, your LSO if you cannot provide the data requested below.** | | | | | | | | | |
| **Data** | **Laser 1** | | **Laser 2** | | | **Laser 3** | | | **Laser 4** |
| **L Number:** | **L** | | **L** | | | **L** | | | **L** |
| **Laser Class:** |  | |  | | |  | | |  |
| **Maximum Power/ mW:** |  | |  | | |  | | |  |
| **Power in normal use/ mW:** |  | |  | | |  | | |  |
| **Wavelength Range/ nm:** |  | |  | | |  | | |  |
| **Wavelength(s) Used/ nm:** |  | |  | | |  | | |  |
| **Beam Shape** |  | |  | | |  | | |  |
| **Beam Size (x,y)/ mm** |  | |  | | |  | | |  |
| **Beam Divergence (x,y)/ mrad** |  | |  | | |  | | |  |
| **NOHD/ m (if necessary)** |  | |  | | |  | | |  |
| **Spectral Irradiance**  **(Laser Power ÷** **(3.14\*** [**Limiting Aperture**](#Limiting_ap) **radius2)) / Wm-2** |  | |  | | |  | | |  |
| **MPE/ Wm-2** |  | |  | | |  | | |  |
| **MPE Excess (Sp Irr ÷ MPE)** |  | |  | | |  | | |  |
| **Section 1b: Pulsed Lasers in Use (Check if required -  )**  **Please seek aid from your laser data sheet or, subsequently, your LSO if you cannot provide the data requested below.** | | | | | | | | | |
| **Data** | **Laser 1** | | **Laser 2** | | | **Laser 3** | | | **Laser 4** |
| **L Number:** | **L** | | **L** | | | **L** | | | **L** |
| **Laser Class:** |  | |  | | |  | | |  |
| **Maximum Pulse Energy/ mJ/pulse:** |  | |  | | |  | | |  |
| **Pulse Energy Used/ mJ/pulse:** |  | |  | | |  | | |  |
| **Pulse width/ (please provide unit):** |  | |  | | |  | | |  |
| **Pulse Repetition Rate/ Hz:** |  | |  | | |  | | |  |
| **Wavelength Range/ nm:** |  | |  | | |  | | |  |
| **Wavelength Used/ nm:** |  | |  | | |  | | |  |
| **Beam Shape** |  | |  | | |  | | |  |
| **Beam Size (x,y)/ mm** |  | |  | | |  | | |  |
| **Beam Divergence (x,y)/ mrad** |  | |  | | |  | | |  |
| **NOHD/ m (if necessary)** |  | |  | | |  | | |  |
| **Radiant Exposure**  **(Laser Energy ÷ (3.14\***[**Limiting Aperture**](#Limiting_ap) **radius2)) / Jm-2** |  | |  | | |  | | |  |
| **Most limiting MPE (single, avg or train) / Jm-2** |  | |  | | |  | | |  |
| **MPE Excess (Rad exp ÷ Limiting MPE)** |  | |  | | |  | | |  |
| **Section 2: Laser Controlled Area** | | | | | | | | | |
| **Details of Laser Controlled Area** | | | | | | | | | |
| Briefly describe area where the laser experiment is carried out, e.g., interlocked lab single experiment, sectioned area of a larger controlled area | | | |  | | | | | |
| Detail type of barrier / shielding that ensure that beams, specular reflections and hazardous diffuse reflections cannot escape into other areas including non-controlled areas. Confirm that the barrier is appropriate to contain the beam in the event of direct strikes. | | | |  | | | | | |
| Confirm that walls/barriers are painted in bright matt colours with good lighting to minimise eye pupil size. If not, state justification. | | | |  |  | | | | |
| Confirm that walls/barriers are not adorned with reflecting surfaces, e.g., glass fronted cupboards | | | |  |  | | | | |
| Confirm interlocking on entry to Controlled Area and the nature of it. | | | |  |  | | | | |

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| --- | --- | --- | --- | --- |
| **Section 3: Hazard Identification and Risk Assessment** | | | | |
| **Please ensure you give an answer for each section of the risk assessment. If a section does not apply to you, please mark it clearly as such.**  For a more detailed description of the expectations of this section, and an explanation with some examples of the hazards expected under each heading, please see Section 3 of the guidance at the bottom of the document. | | | | |
| **Hazards** | **Describe the nature of the potential harm associated with the hazard** | **Risk Evaluation without controls in place**  Likelihood (1-5) X Consequences (1-5) = Risk Rating\* (1-25) | **What control measures are, or will be put, in place to control the risk?**  List all elimination, substitution, engineering and/or administrative controls | **Risk Evaluation with controls in place** Likelihood (1-5) X Consequences (1-5) = Risk Rating\* (1-25) |
| **The Laser (s):** | | | | |
| 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |
| **Beam Delivery:** | | | | |
| 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |
| **Laser Process:** | | | | |
| 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |
| **Environment & People:** | | | | |
| 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |

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| **Section 4: Open beam working and justification (compulsory for Class 3B / 4 laser products/systems)** | | | | | | |
| **For each laser task undertaken** within your lab (see table below), please indicate which statement, below, regarding the levels of engineering controls best fits your intentions:   1. Full enclosure of harmful beams (Remote operation/ CCTV / cameras / motorised mounts / top-mounted adjusters), with no access to the beam in any circumstances, **OR** laser beam **always below the MPE** with **no potential** for Human Factors (e.g. incorrect following of SOPs, forgetting to lower power, etc) to allow exposure above the MPE. 2. Any open beam working, compartmentalised or not, using a **laser that is 3B or 4, but with the power, or energy, below MPE** through use of power restriction e.g., via software / use of attenuating filters or similar. (No access to any beam **above the MPE**, but there may be reliance on administrative controls or Standard Operating Procedures to maintain the safe power level) 3. Compartmentalised open-beam alignment of harmful beams **with a mixture of safety controls** (Remote operation/ CCTV / cameras / motorised mounts / top-mounted adjusters) as well as some open-beam alignment using laser power, or energy, **not below MPE**. (This includes tweaking at powers not below the MPE.) 4. Compartmentalised open-beam alignment with laser power or energy **not below MPE** (this includes beam tweaking not below the MPE, and will involve exposure to the beam, but **not** across the full beam path). 5. Full open beam with no enclosure/compartmentalisation with laser power or energy **not below MPE**.   For any option selected below 1., please fully justify, **for each criterion above the option you have selected,** why you **cannot** use the combination of engineering controls given, e.g., if you have selected option 4, you must justify why you cannot select **any** of options 1-3. (You may group your responses to multiple criteria to avoid repetition.)  **Do not simply restate why you have selected the controls you have; you must indicate why you cannot select the higher levels of protection.**  **For further information on how to fill out this section, please see Section 4 of the guidance at the bottom of the document.** | | | | | | |
| **Operation / Task**  **(amend if appropriate)** | **Appli-cable?** | **Option no:**  **(1-5)** | **Typical Frequency**  **(Daily, fortnightly, monthly, etc.)** | | **Justification for not selecting higher-level of protection:** | |
| Initial setting up/ Significant modification of setup |  | Choose an item. |  | |  | |
| Standard operation (normal daily use)  (Tasks occurring **more** than once every 2 weeks) |  | Choose an item. |  | |  | |
| Non-standard operation (Tasks occurring **no more** than once every 2 weeks) |  | Choose an item. |  | |  | |
| Maintenance / servicing |  | Choose an item. |  | |  | |
| **Section 5: Personal Protective Equipment** | | | | | | |
| **State any Personal Protective Equipment requirements** | | | | **Protective eyewear specifications:**  **If multiple pairs of eyewear are required, such as for tuneable lasers, please provide a detailed list for each filter type required. You need only give a list of protective eyewear for wavelengths/ powers that you may potentially be exposed to.** | | |
| **For laser work, state, below, under which circumstances PPE is required:** | | | | **Manufacturer** | | 1.  2.  3. |
| **Emission type (D, I, R or M) and Scale Number (LB), and Wavelength(s) covered by eyewear (nm)** | | 1.  2.  3.  4.  5. |
|  | | | |
| **Have you confirmed, using LaserBee, that the LBs and emission types (D, I, R M) for your eyewear are correct?**  Note: This information should be available upon request from the LSO or H&S/LSA upon inspection.    (check if yes) | | | | **Location of PPE** | | 1.  2.  3. |
| **Other PPE requirements (i.e., for skin):** | | | |  | | |

|  |  |
| --- | --- |
| **Section 6: Additional Requirements** (if recorded elsewhere, state where) | |
| **First Aid** |  |
| **Waste handling** |  |
| **Emergency Actions**  (consider laser incidents involving damage to eyes or skin and other emergency scenarios) | **To protect people**: |
| **To render location safe**: |
| **Emergency contact** (name and mobile): |
| **Training, supervision and competency** (Amend to suit) | . |
| **(Maintenance / Servicing) by third parties** |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Section 7: Training and Competency Record** (if recorded elsewhere, state where): | | | | | | |  | | |
| **Name of worker** | **Activity** | **Measure of competency** | **Assessor comments** | **Competent to perform activity Y/N?** | **Signature (Worker)** | **Name (Assessor)** | | **Signature (Assessor)** | **Date** |
|  |  |  |  |  |  |  | |  |  |
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| **Section 8: Modification and Review** | | | |
| **Modification and Review** - where new lasers or components are introduced then such changes need to be assessed and protocols may need to be modified. Record the review of changes below. | | | |
| **Date of Review** | **Name and role of person carrying out review** | **Summarise changes** | **Confirm RA remains suitable or has been updated in the light of the review** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Guidance on completing Laser Risk Assessment form (and associated Open Beam Working Justification)**

In order to comply with the Artificial Optical Radiation Regulations 2010, it is necessary for the University to ensure that suitable and sufficient risk assessment of laser work is carried out and that the risk of exposure to optical radiation is eliminated or minimised as far as reasonably practicable.

A specific Laser Risk Assessment Form is available for recording the risk assessment. This can be used for all laser work. Acceptable exceptions would be use of bought-in, CE marked, totally enclosed & interlocked, Class 1 laser **products**. Please seek advice from your LSO if you are uncertain whether a laser product must undergo a formal Laser Risk Assessment.

**One risk assessment per set up / experiment is required.**

The **Principal Investigator** or owner of the laser product is responsible for ensuring a risk assessment has been carried out. Approval of the risk assessment (‘Responsible person’ field), whether authored by the PI or a member of the research group, must be the Principal Investigator unless they have appointed a suitable competent staff deputy such as a competent Post-Doctoral researcher or Research Assistant.

**Section 1 Lasers in Use**

This allows for recording the details of the lasers involved in the experiment.

**Section 2 Laser Controlled Area**

This must be completed where the laser work takes place in a laser-controlled area, i.e., restricted access (via entry door interlocking) areas. Enter full details as relevant.

**Section 3 Hazard Identification and Risk Assessment**

The definition of a Hazard is the potential for something to cause harm, e.g. chemicals, radiation, lasers, fire.

To minimise the number of documents, it is recommended that the laser risk assessment incorporates all hazards rather than referring to other risk assessment documents.

Each hazard should be broadly grouped into one of the 4 given groups (detailed further below), and a description should be given regarding what the control measures have been put in place to lower the risks associated with each hazard. Note that the assessments do not need to be broken down into individual tasks **for individual lasers**, rather the hazards should be evaluated for the set-up as a whole. Different methods of laser exposure should be considered e.g., specular reflections from optics, and exposure from beams escaping fibre optics would both be considered and suitably assessed, but you do not need to give a list of how a user can be exposed from each and every optic on a table.

In terms of control measures, these must be the actual measures that are in place to control the hazard and thereby reduce the risk. With optical hazards relating to Class 3B and 4 work, the default control measure must be total enclosure of the beam. Other acceptable control measures that eliminate the risk of exposure are operating at a power equivalent to Class 2/2M (which must be evidences with calculations if the laser is normally >Class 3R), remote operation or local compartmentation to shield the beam. Any control measure that is less robust must be justified.

**The four hazard groups and a basic description of each is given below (examples below descriptions):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group** | **Description** | | | |
| The Laser(s) | The hazards associated with the laser unit itself i.e., from the aperture of the laser system, all the way back to the plug. Note that any laser radiation through the aperture should not be included in this section, but laser radiation within the unit should be risk assessed. | | | |
| Beam Delivery | The hazards associated with the laser radiation interacting with anything between the aperture of the laser until the point just before the final intended laser process.  e.g., The path the laser takes after exiting the laser and anything it could interact with before it performs its intended function. This may include laser interactions with shielding, optics, beams dumps, laser dyes, etc. | | | |
| Laser Process | The hazards associated with the laser radiation performing its intended process, e.g., when it interacts with plastics/metals in laser cutting, excitation of gases/ liquids, liquid interaction e.g., fluorometry, power meter measurements, etc. **This section may be brief if there are no hazardous laser processes.** | | | |
| Environment and People | How the experimental environment, and its state and suitability – including equipment related to the experiment - affects the safety posed to workers and others.  How workers/ visitors directly impact the safety of the environment through their proceedings. | | | |
| **Examples of hazards within each group – not exhaustive:** | | | | |
| **The Laser(s)** | | **Beam Delivery** | **Laser Process** | **Environment and People** | |
| Electricity (high-voltage power supplies/ capacitors) | | Direct/ indirect strikes via Laser alignment/ Open beam use | Laser radiation scattered during end process e.g., from a power meter or solid sample | Cryogens | |
| Chemicals/ substances (excimer gases, laser dyes) | | Specular/ Diffuse reflections from optics | Fumes/ dusts created when sample exposed to laser (e.g., in laser cutting) | Compressed/ toxic gases | |
| Falling objects | | Diffraction/ Refraction via optics | Beam path changing due to poor target stability, e.g., inadequately mounted sample | Non-laser related chemicals | |
| Movable parts (Trapping/Crushing) | | Absorption by laser shielding/ poorly selected beam dumps – fire | Heat generated from laser interaction with sample | Poor Lighting/Housekeeping (Slips, trips and fall hazards) | |
| Manual Handling | | Beam escaping from damaged fibre-optics | Biological/Chemical creation upon laser interaction e.g., biological aerosols | Unauthorised use of equipment | |
| Noise | | Ablation or Fresnel absorption of optics causing changing optical path. (Optical component failure) | Plasma emissions, UV, X-ray (Bremsstrahlung), other ionising radiation. | Lone/Isolated working | |
| Spillages (water cooled lasers) | | Wavelength changing or multiple wavelengths along beam path |  | Other non-beam hazards related to experiment but not the laser e.g. mechanical, electrical, water, flammables, etc. | |
| Hot objects/ Fire | | Beam leaving plane of optical table |  | Confined spaces | |
|  | |  |  | Ergonomics | |

The risk evaluation columns (with and without controls) are based on a 5 x 5 matrix (likelihood x consequences = risk evaluation). This kind of quantitative evaluation is useful as an indicator. The explanation for the matrix is given in the table below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table: Risk Evaluation Definitions** | | | | | |
| **Likeli-hood** | **Definition** | **Con-sequences** | **Definition** | **Risk Evaluation / Rating** | **Actions** |
| 1 | Hazard is unlikely to occur | 1 | No injury/ill-health | 1-8 Low or Acceptable Risk | Progress actions that are straightforward and cost effective |
| 2 | Hazard will occur occasionally | 2 | Minor injury/ill-health | 9-12 Moderate Risk | Effort required to reduce risk. Moderate resource may be required |
| 3 | Hazard will occur sometimes | 3 | Injury/Ill-health required first aid | 15-25 High/ Substantial/ Intolerable Risk | Work should stop until control measures have been implemented. Considerable resource might be required to achieve this |
| 4 | Hazard will occur regularly | 4 | Injury/Ill-health requiring medical treatment outside the University |  |  |
| 5 | Hazard will occur frequently | 5 | Severe – Death or major injury/ significant ill health |  |  |

**Section 4 Recording Justification for Open Beam Working**

The aim is to explain why it is not possible to totally enclose/interlock the harmful laser beam and what measures have been implemented to reduce the risk as far as reasonably practicable. Use of laser goggles must be the absolute last resort.

Measures higher up the hierarchy of control must be considered first as they are less reliant on human behaviour.

The justification does not need to be long but should consider the obstacles preventing you from fully enclosing and automating the system. For example, if the experiment has many optics, all of which need tweaking as part of an alignment process, it would not be practicable to automate each and every optic, but you would be expected to enclose the experiment as much as possible, and control as many of the optics as is feasible.

When writing the justification, you should consider:

* Physically, what are the obstacles to fully enclosing the beam?
* What are the limitations on achieving this that cannot be readily or easily addressed?
* Is the equipment you require available, and can it be obtained in a timely manner?
* Would available equipment be able to do what you need it to sufficiently well or would outcomes be compromised?
* If you could make modifications, how long would it take, and would there be a notable reduction in risk?
* What are the costs of doing so?
* Can your budget accommodate the extra costs?
* Would these costs be prohibitively expensive?

**Additional options that could be considered over and above laser goggles (non-exhaustive list):**

* Enclosure where possible and creating distinct sections if that helps to reduce the risk.
* Securing enclosures by interlocks/tamper-proof fixings to prevent removal.
* Coupling the laser to fibres.
* Reducing the power to Class 2(M) levels or below.
* Using low power alignment lasers.
* Attenuating filters, similar to goggle specification but can be fixed over the beam.
* Using CCTV cameras.
* Using remote means of operation – computer control.
* Motorised mounts.
* Secure flight tubes on laser beams between sections/tables.
* Using secondary guarding (transparent if suitable) to cover parts of a system which do not need to be exposed.
* Using optics with top-positioned adjustment knobs to keep hands out of the beam path.
* Modularising to bring sets of optics together.

**Hierarchy of control:**



**Section 5 Personal Protective Equipment**

Use of laser goggles must be exception and only in fully justified circumstances, where this is the case, state the details of the goggles to be used as per the question set.

Use of other PPE should be included in the relevant section. Be specific on the type, it is not sufficient to state “wear PPE as appropriate” or “wear suitable PPE.”

**Section 6 Additional Requirements**

Complete these fields as relevant to the work. Ensure sufficient detail is given on Emergency Actions.

In terms of maintenance/servicing, consider who will be carrying this out. If it is a third party, state that this would be the case and that a specific risk assessment would be carried out if UoN members would be present and at risk of harmful exposure. If it is carried out by University members, include it in the risk assessment and associated procedures.

**Section 7 Training and Competency**

Training and the attainment of competence can be recorded in this section or if maintained elsewhere, state where the records are stored.

Ensure that if using individual training record forms that copies are kept by the worker. The University must maintain an up-to-date version.

**Section 8 Modification and Review**

This section is for recording changes to the setup such as the introduction of new components or lasers.