



Laser Safety Protocol

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Purpose

To provide safety procedures for working with lasers of all risk levels and to offer guidelines regarding the design of laboratories and experimental systems that use dangerous lasers.

Nature of Risks and Definitions

Classification of Lasers and Laser Systems:

- **Class 1:** A laser that cannot cause damage to the eye even with direct exposure of 8 hours during a workday. **Class 1M** refers to a Class 1 laser that can cause damage if viewed through magnifying (concentrating) optics.
- **Class 2:** A visible, CW (continuous wave) light laser that cannot cause eye damage unless the viewer overcomes the blink reflex and continues to look into the beam. **Class 2M** refers to a Class 2 laser as described that can cause damage if viewed through magnifying optics.
- **Class 3R:** A laser with a power level up to 5 times higher than that of a Class 2 laser for visible light, and up to 5 times higher than a Class 1 laser for all other lasers.
- **Class 3B:** A laser capable of causing eye damage via direct viewing in **less than ¼ second** (the blink reflex time). It cannot cause damage from viewing light reflected from a diffuse surface and generally does not cause damage to the skin.
- **Class 4:** A laser with high potential for injury. It can cause **irreversible eye damage** from direct viewing and also from reflections off a diffuse surface; it can cause skin damage from direct exposure and diffuse reflections and may **ignite flammable materials**.

Key Definitions

- **Permissible Exposure Level (PEL):** The level of laser radiation to which nearly all workers can be exposed during a work shift, over time, without health effects. The level/calculation method for each type of laser is detailed in the **IEC-60825 Part 1 standard**, which is available at the university's safety unit offices.
- **Dangerous Laser:** Includes Class 3R in invisible light, and all lasers in Class 3B and Class 4.

- **Laser Hazard Area:** Any area where there is a risk of exposure to laser radiation exceeding the PEL.
- **Laser Hazard Worker:** Any worker who is routinely located in a laser hazard area for the purpose of their work.

Laser Safety Goggles

Goggles specifically adapted to a laser because the lenses absorb the specific wavelength(s) of the laser with an **optical density (OD)** that reduces beam intensity to at least the PEL. The lenses must be durable against the maximum energy the laser can emit routinely or in case of malfunction. They must be marked according to their protective properties and possess a standard mark according to **EN207/EN208**. **Using laser safety goggles without a standard mark is prohibited.** For use of goggles with a different standard mark than mentioned above, approval must be obtained from the Laser Safety Officer or a labor inspector.

Work Methods

General:

- Only individuals who have completed laser safety training and received training confirmation are authorized to work with dangerous laser systems.
- Training will be provided to every new employee starting work with a dangerous laser in person or via interactive modules. Refresher training will be given via the module or in person as needed. The safety department / Laser Safety Officer is responsible for organizing these trainings.
- All lasers of **Class 2 and above must be marked** with a standard warning label according to the risk presented by the system.
- In any case of malfunction or irregularity, the system must be shut down immediately and not operated until repaired.

Protection from the Laser Radiation Beam:

- **Never look directly into the radiation beam** or its path, and never aim a laser at a person's eyes, regardless of its risk level. Direct or reflected viewing can cause irreversible eye damage, depending on the laser's risk class.
- In any work with a dangerous laser where there is a possibility of exposure exceeding the PEL, goggles must be worn that are suitable for the wavelength and intensity of the laser and marked according to standards.

Selection of appropriate goggles will take the following parameters into account:

- Wavelength.
- Radiation intensity the worker might be exposed to routinely or during malfunction.
- The PEL for that specific laser.
- Absorbance / Optical Density of the goggles at that wavelength.

- Visible light transmission (VLT) of the safety glasses.
- Radiation intensity that might damage the goggles.
- Need for prescription goggles.
- Comfort, ventilation, and lens possible degradation.
- Lens resistance to shock or impact.
- Peripheral vision requirements.
- Compliance with standards and regulations.

Despite the above, in rare cases where it is practically impossible to use appropriate goggles for a visible light laser, requirements may be reduced only if the work method is defined in a protocol and approved by the Laser Safety Officer.

Engineering and Mechanical Controls

- **Shields/guards** should be placed around the radiation path whenever possible to protect workers from accidental exposure.
- The end of the useful beam must be blocked by a **shutter, filter, or absorbing body**, or a suitable shield mounted on the laser or optical table.
- Shields must not be removed, and the laser must not be operated without them or with damaged shields. Where removal is necessary for research, appropriate measures to prevent exposure must be taken, and goggles must be worn at all times in the lab.
- In case of doubt, contact the Laser Safety Officer/Safety Department for instructions.

Safety Measures by Risk Class

- **Class 3R (Visible, CW):** No special measures beyond those mentioned above.
- **Class 3R (Invisible) or Pulsed (< ¼ second):** Appropriate goggles are required.
- **Class 3B:**
 - Define the hazard area boundary.
 - Access is restricted to authorized personnel only via badge readers or similar.
 - A red warning lamp with "Visible/Invisible Laser" signage must be installed outside the door and activated during operation.
 - Signs mandating goggles must be posted inside/outside the lab.
 - A specific storage place (shelf/drawers) for goggles must be installed and labeled.
 - The laser must be installed so the beam path is **below the eye level** of a standing or sitting person and never at eye height.
 - The beam must not be directed toward the door.
 - Systems must undergo **annual inspection** by an authorized/ certified laser safety auditor / inspector.
- **Class 4:**
 - A red warning lamp above the door must **automatically activate/deactivate** with the laser.

- Warning signs must include risk symbols, visible/invisible hazard warnings, and "authorized entry only" with goggles.
- Specific goggle storage must be provided in the entryway or an accessible location.
- The beam must be below eye level and directed toward an opaque wall rather than the door.
- Windows must be coated with laser-absorbing material to reach non-hazardous levels.
- The system must have **visual/audio indicators** for when it is active and a Class 4 warning label.
- Contain the beam path as much as possible to prevent entry of heads, hands, or reflective objects. Do not use shiny or reflective components in the laser path.
- An **emergency stop button** must be present on the system or at the room entrance.
- Fire extinguishers must be placed in or near the lab.
- Non-flammable, non-reflective beam absorbers must be at the end of the useful beam.
- Avoid shiny walls or reflective elements.
- A **door interlock (micro-switch)** must stop the laser if the door is opened. If this hinders operations, alternative measures (coordinated with the Safety Department) may be used, such as:
 1. Installing a black or specific wavelength curtain after the door; entering past the curtain requires goggles.
 2. Installing absorbing curtains around each laser system (including the optical path) with signs prohibiting entry to that area without goggles. This is required if separation is needed from other lab activities where workers wish to work without goggles.
 3. Curtains/partitions must automatically return to position (e.g., secured at the top) so they cannot be left open. If possible, an interlock should be installed on the curtain.

Experimental System Design Considerations

- The emission direction should not be toward room openings or at the eye level of workers.
- On open optical tables, components (mirrors, lenses) must be fixed so they **cannot be tilted upward**, allowing only horizontal rotation.
- If possible, a cover should be installed over the optical path to prevent head entry. For Class 4, the cover should also prevent entry of hands or other body parts.
- **Permanent beam blocks** must be at the end of the useful path, even if a mirror currently blocks it, in case the mirror is accidentally moved / removed.
- **Alignments** should be done at the lowest possible power while wearing goggles and other PPE.

- **UV Protection:** UV radiation causes cumulative skin damage. Long sleeves and protective gloves (latex or nitrile) are mandatory.
- Avoid shiny objects near the path for Class 3B or 4; use light-diffusing, blackened, and rough components instead.

Incident Procedures

In any case of exposure or suspected exposure from laser radiation, **report immediately** to the lab manager and Laser Safety Officer. The individual must be referred to an **ophthalmology clinic** for examination. The accident must be investigated, and lessons must be implemented to prevent recurrence. All safety events must be reported to the lab manager and the laser safety officer.

Additional Information

- **IEC-60825-1 (2014) standard** (copy available with the LSO).
- **2005 Safety at Work Regulations** (Occupational Hygiene and Safety for Laser Radiation Workers), available on the Ministry of Industry, Trade, and Labor website.