STANDARD OPERATING PROCEDURE:

Use of lasers in schools

Part 2: Bench lasers

Note: To be undertaken only by trained personnel in conjunction with a site-specific risk assessment. Contact your state or territory radiation regulatory authority for the interpretation of regulatory matters. For contact details see:
http://www.arpansa.gov.au/Regulation/Regulators/index.cfm

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1. Introduction

The word LASER is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation, which describes the process by which lasers generate light (electromagnetic radiation).

There are many applications of the use of lasers in schools, including as a white board pointer, a pointer for astronomy observations, the teaching of optics, ray paths, refraction and diffraction, the modulation of laser beams to carry signals, and the applications in fibre optic communications.

As laser technology is very widely used in industry, medicine and in everyday life, it is desirable that students learn to safely and responsibly use and manage lasers in a supervised school science environment.

Bench lasers used in school science are likely to be Helium- Neon gas lasers (Class 2 or Class 3R/ 3A), emitting red light (632.8 nm wavelength). It is recommended that the use of bench lasers **be restricted to Class 3R/3A or below, continuous wave (not pulsed), and emitting visible radiation. Lasers that emit wavelengths that are not in the visible spectrum are not recommended for use in schools.**

2. Context

- This document summarises the guidelines for the storage and use of bench lasers in Australian secondary schools and colleges.
- **This is Part 2 of a three part document addressing three separate applications:**
    - **Part 1**: **Laser pointers** (solid state diode lasers)
    - **Part 2: Bench lasers** (as used in Physics investigations, usually He-Ne gas lasers)
    - **Part 3: The construction of laser equipment**

3. Safety notes

- Bench lasers should be stored in a secure locked cupboard (e.g. in a storeroom) when not in use to prevent unsupervised student access.
- Do not leave a laser unattended.
- Avoid shining a laser beam at or near persons.
- Avoid student seating that could bring the laser beam to eye level.

- Remove from the area all exposed shiny objects such as rings, watches, metal bands, tools or glass.
- When a laser is in use, access and movement around the room should be controlled and nobody should stand between the laser beam and its target.
- Despite the low power rating i.e. Class 1 or 2 lasers, eye damage is possible if magnifying viewing instruments such as lenses, microscopes, binoculars or telescopes are used. Do not use these optical aids to view a laser beam.
- Laser light differs from light emitted from conventional sources. It is monochromatic, coherent and is collimated (refer to definitions below). This last feature is very important in considering the safety of lasers.

Definitions of properties of laser light:

Monochromatic	The emitted light is concentrated at a single wavelength
Coherent	The light waves remain in phase as they propagate
Collimated	The light rays are parallel, with very little divergence, the intensity is maintained over long distances.

- Conventional light sources emit light in all directions, and so the intensity of the light rapidly diminishes with distance from the source (the inverse square law). As laser light is collimated into a beam with very little divergence, the intensity is maintained over long distances. There is then a much greater capacity for laser beams to cause eye damage.
- The Class rating, the appropriate laser symbol and hazard warning statement are to be clearly marked on the instrument. A table of the laser classes is given in the Supplementary Information section at the end of this document. If the class of any laser is not clearly identified then it should not be used.
- **It is recommended that bench lasers used in schools should be rated no higher than Class 2 or Class 3R** (or 3A under the old pre-2001 classification), and with a power output not exceeding 5 milliWatts (mW). They should be **continuous wave (not pulsed), and emitting visible radiation. Lasers that emit wavelengths that are not in the visible spectrum should not be used in schools.** Note: the **Class 3B laser** has a significantly higher energy output than a Class 3R/3A laser.
- It is recommended that when purchasing **new** bench lasers, that they be rated no higher than a Class 2. Class 1 and Class 2 are generally considered to be sufficient for use in school science. As a guiding principle, always use the lowest power laser for any particular purpose.
- The decision to use a Class of 3R/3A lasers in a school should be made on a case by case assessment considering state/territory radiation regulations as well as educational jurisdictional policies. **A person knowledgeable in the potential hazards of laser radiation should conduct this.** Specific permission should be sought from the school to use this class of laser for teaching purposes.
- If a decision is made to use Class 3R/3A bench lasers, although they may be considered to present low risks when good safety practices are followed, additional safety procedures need to put into place such as: the use restricted to teacher demonstrations, keeping of log book records and using a laser controlled area with appropriate signage in place. Whilst special laser eye protection is not considered necessary for these laser classes, consideration could be given to the provision of appropriate laser eyewear that has been tested to Australian Standards.

- Where a school uses a number of lasers, particularly including the Class 3R/3A, consideration should be given to appointing a **Laser Safety Officer (LSO)** to support these activities. The LSO would normally be a staff member who is familiar with the ARPANSA Safety Guide, understands the laser classification system and has a good working knowledge in the use of lasers. The LSO would be available to assist other staff with performing risk assessments and may assume the role of ensuring all staff complies with the safe storage requirements that are part of the school's safety policies.

4. Regulations, licences and permits

- The use of lasers in schools is informed by the *Safety Guide: Use of Radiation in Schools (2012), Part 2: Lasers* http://www.arpansa.gov.au/pubs/rps/RPS18.pdf.

  It is recommended that persons handling lasers be familiar with this document and a **printed hard copy of this resource is recommended for reference.**

- It is important to check if permission is required to use Class 3R/3A bench lasers in your state or territory with the relevant radiation regulatory body. In addition, you will need to check if your educational governing body allows their use.
  For details of your state/territory regulator see:
  http://www.arpansa.gov.au/Regulation/regulators/index.cfm

5. Equipment

- Bench Laser Class 1 or Class 2 (or class 3R/3A with school permissions in place)

6. Operating procedure

1. **Storage:**

   Lasers should be stored in a secure locked cupboard (e.g. in a storeroom) when not in use to prevent unsupervised student access.

2. **Steps before use:**

   2.1 Check that the bench laser is rated at no higher than Class 2, or Class 3R (or 3A), and with a power output not exceeding 5 milliWatts (mW).

   2.2 Check that the bench laser is appropriately labelled as below:

   Class 1 laser

   

   Class 2 laser

   

   

   Class 3R laser

   

   

   2.3 For the use of Class 3R or 3A lasers, check that the planned activity is conducted by a person knowledgeable in the potential hazards of laser radiation, and who has been given specific permission by the school to use the laser for teaching purposes.

   2.4 Check that a Risk Assessment has been carried out for the planned activities. (Examples of Risk Assessments for laser use are given in the ARPANSA Safety Guide - Use of Radiation in Schools Part 2: Lasers, Section 10: http://www.arpansa.gov.au/pubs/rps/RPS18.pdf .)

   2.5 Check that the following items are available, particularly for the use of Class 3R/ 3A lasers:

   - Copy of the ARPANSA Safety Guide
   - Manufacturer's instructions for assembly and safe use
   - Information on emitted wavelengths and maximum power output
   - A log book recording the use of the laser

   2.6 For the use of Class 3R or 3A lasers, establish a laser controlled area, with access limited to persons granted permission by the school to use lasers, and persons under their control. Warning signs are to be displayed on the outside of the laser controlled area.

3. **Use:**

   The specific procedures to be applied will partly depend on the particular laser activity being undertaken. These may include the following.

   1. Operate the laser at bench or waist height. Avoid student seating that could bring the laser beam to eye level. Avoid uncontrolled beam movement of the laser.
   2. Ensure that students are aware of the laser beam hazard.
   3. Begin with a diagram of the planned laser system before introducing and aligning the optical components. Fix optical components securely to the optical bench.
   4. Evaluate the need for screens and baffles to eliminate possible hazardous reflections. Baffles should use a minimal aperture.
   5. Fix and align the optical components at the minimum power needed to see the beam. Check for stray beams at low power. Advice, including procedural flow charts, is given in the ARPANSA Safety Guide (see Annex A, p.90).
   6. Turn off the laser or block the beam with the shutter when not in use.
   7. Eye damage is possible if magnifying viewing instruments such as lenses, microscopes, binoculars or telescopes are used. Do not use these to view a laser beam.

7. Trouble shooting/emergencies

- Note: The risk of burns to the eye or skin is very low when using bench lasers of Class 2 or less.
- Burns to eye: Cover damaged closed eye with a clean eye patch, instruct the casualty to keep eye still, summon ambulance.
- Burns to skin: Cool area under cold running water. Cover damaged area with clean bandage; seek urgent medical advice.

8. Waste disposal

- Not applicable

9. Related material

- Australian Radiation Protection and Nuclear Safety Agency 'Safety Guide: Use of radiation in schools Part 2: Lasers. Radiation protection series no. 18', ARPANSA website, June 2012 http://www.arpansa.gov.au/pubs/rps/RPS18.pdf. This includes guidance on developing a Risk Assessment for the use of lasers in schools (see Section 10).
- Manufacturer's instructions
- Risk Assessment
- Useful links:
  - Macquarie University 'Faculty of Science Occupational Health and Safety – Lasers' Macquarie University website. (Accessed January 2015). http://web.science.mq.edu.au/intranet/ohs/lasers/. This page contains much useful information including information on laser classifications and laser induction.

    Overview of IEC laser classes.
    http://web.science.mq.edu.au/intranet/ohs/lasers/documents/classoverview.pdf

    Typical accessible emission limits (AEL) for visible CW lasers.
    http://web.science.mq.edu.au/intranet/ohs/lasers/documents/classifications.pdf

    Laser Induction: with links to watch the MPG free Faculty Laser Induction Module (PPT, 3.3 MB) plus the Eye Effects Video (46 MB, 5 minutes) and the Laser Safety Video (231 MB, 30 minutes)

References:

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) 2012. *Safety Guide for the Use of Radiation in Schools (2012)* http://www.arpansa.gov.au/pubs/rps/RPS18.pdf CC BY NC 3.0 AU http://creativecommons.org/licenses/by-nc/3.0/au/

Australian/New Zealand Standard AS/NZS IEC 60825.1:2014. Safety of laser products Part 1: Equipment classification and requirements.

St John Ambulance. 2010. *First Aid Manual*.

SUPPLEMENTARY INFORMATION:

Classification of lasers

Lasers are classified according to their potential degree of hazard, with the higher numbers indicating higher hazard levels. Older units may be classified under a similar early system, with the comparisons set out in the table below. It is important to remember that laser classification is made on the basis of the *entire* laser product. This means it is possible that a laser product could contain a high power laser internally with the engineering design allowing a lower classification for the unit.

Current classification	Former classification	Notes	Labelling and signage
Class 1	Class 1	Considered safe under foreseeable conditions because of low emission levels or through engineering design. Not harmful to eyes or skin.	
Class 1M		Higher emissions than Class 1, but because of the spread of rays, not capable of causing eye damage. This means the beam can be magnified with the help of optics.	
Class 2	Class 2	Low powered visible lasers (to 1mW power). Not harmful to skin. Eye damage avoided through natural aversion responses (blinking, turning away)	 
Class 2M		Higher emissions than Class 2, but because of the spread of rays, normally safe for viewing with unaided eye. This means the beam can be magnified with the help of optics.	 
Class 3R	Class 3A	For visible wavelengths, up to 5 times the emissions of Class 2 (i.e. up to 5 mW power). Risk of injury from accidental exposure is low.	 
Class 3B	Class 3B	Visible or invisible wavelengths where direct viewing is hazardous to eyes. (i.e. between 5mW and 500mW for visible wavelengths)	 
Class 4	Class 4	High powered lasers capable of causing damage to skin and eyes. (i.e. > 500mW)	 

Lasers in schools

It is expected that in almost all cases, lasers used in schools should be restricted to Class 1 and Class 2 (common outputs of 0.5 to 1 mW). At this level, eye damage from accidental exposure is very unlikely due to the human 'aversion responses' such as blinking and turning away. Lasers classified as Class 3R/ 3A, with power outputs in the 1–5 mW range, may be used subject to gaining school permission and following good safety practices as detailed in Part 2 of this SOP. Lasers of Class 3B and above, and any that emit wavelengths not in the visible spectrum, should not be used in schools. If the class of any laser is not clearly identified then it should not be used.