STANDARD OPERATING PROCEDURE:

Use of lasers in schools

Part 3: The construction of laser equipment

Note: To be undertaken only by trained personnel in conjunction with a site-specific risk assessment. ***No dismantling or modification of laser equipment should be undertaken in schools.*** *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.

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. Therefore the **dismantling or modification of laser equipment should not be undertaken in schools**

2. Context

- This document notes some of the risks that may be associated with either constructing laser equipment, or with dismantling equipment that contains lasers. It recommends conditions for the safe construction of laser equipment in Australian schools, and that the dismantling or modification of laser equipment is not undertaken in schools.
- **This is Part 3 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

- All 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 the 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.
- Lasers constructed in schools should be restricted to Class 1 or Class 2 and should use commercially available low powered laser diodes or Helium-Neon gas tubes. Lasers should not be constructed where the power is unknown, or where it may exceed Class 2. For further information see section 9.10 'Lasers constructed at school' in the *Safety Guide: Use of Radiation in Schools (2012), Part 2: Lasers.*
- Equipment containing lasers must not be dismantled or modified in schools. Some equipment rated as Class 1 or Class 2 (and particularly 1M or 2M) contain lasers of higher power, and achieve a lower Class rating because of shielded enclosures or special optical systems that prevent human exposure to higher emissions during normal operation. Dismantling or modifying such equipment could result in these producing unsafe levels of emission. For further information see section 9.9 'General Warnings relating to construction or modifying laser products' in the *Safety Guide: Use of Radiation in Schools (2012), Part 2: Lasers.*
- Where a school uses a number of lasers, 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 this 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.**

  For details of your state/territory regulator see:
  http://www.arpansa.gov.au/Regulation/regulators/index.cfm

5. Equipment

- Lasers of Class 1 or Class 2

6. Operating Procedure

1. **Steps before use**

   1.1 Ensure that the laser component being used:

   - produces non-pulsed radiation in the visible spectrum
   - has a maximum output not exceeding 1mW
   - is classified as either Class 1 or Class 2

   These components will typically be commercially available low powered laser diodes or He-Ne gas tubes. If the laser power is unknown, or may exceed 1mW, then do not proceed.

   1.2 Ensure that a Risk Assessment is conducted for both the construction phase and for any activities to be undertaken using the laser.

2. **Use**

   2.1 Ensure that the constructed instrument is properly labelled with laser class, hazard symbol and hazard warning

Class 1 Laser		
Class 2 Laser		

   2.2 Ensure that the constructed instrument is stored in a secure locked cupboard to prevent unsupervised student access.

6. Trouble shooting/emergencies

- Not applicable

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).
- 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.

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.