LASER SAFETY

POLICY©

DOCUMENT SUMMARY/KEY POINTS

At SCH, refer to and adhere to the following POW policies:

Laser Safety Policy:
http://www.seslhd.health.nsw.gov.au/Policies_Procedures_Guidelines/Clinical/Radiation_Safety/Documents/SESLHDPD161-LaserSafetyPolicy.pdf

Laser Safety – managing the hazards procedure:
http://www.seslhd.health.nsw.gov.au/Policies_Procedures_Guidelines/Clinical/Radiation_Safety/Documents/SESLHDPD162-LaserSafetyProcedure.pdf

At CHW - this Policy provides a framework towards the safe management of Lasers utilised within The Children's Hospital at Westmead (CHW).

- **Mandatory compliance** applies to CHW staff who:
  - Controls the delivery of the laser radiation to the working area[3].
  - Operates laser controls (e.g. parameter settings, actuation switch)[3].
  - Deliver Laser energy to the intended target.
  - Work in an environment where lasers are utilised.
  - Supervise or manage a department where Lasers are utilised.

CHANGE SUMMARY

- New Network policy – SCH staff are to adhere to PoW Laser Safety policies and CHW staff are to adhere to this policy.
- Changes to CHW information:
  - Recommendations of an external Laser Safety Expert,
  - Changes in Laser Classifications from AS/NZ IEC 60825.1:2014

READ ACKNOWLEDGEMENT

- CHW Training/Assessment Required – Laser Operators, Laser Users, Laser Safety Officers, Laser Site Supervisors, Laser Safety Nurses, and Biomedical Engineering staff.
- All CHW staff who work in an environment where Lasers are used are to read and acknowledge they understand the contents of this policy.

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Introduction

The word “LASER” is an acronym for “Light Amplification by Stimulated Emission of Radiation”. Laser devices emit an intense, coherent and highly directional beam of light which may or may not be visible, depending on the type of laser.

Laser devices are sources of non-ionising radiation (NIR). This form of radiation is distinguished from ionising radiation by a different mechanism of interaction with matter. Non-ionising radiation is so called because it does not carry enough energy to ionise atoms. Instead, it interacts with matter by, for example, generating heat.

Many different materials may be used as the laser medium and the laser type is commonly known by the particular medium used. Each medium produces light of an individual wavelength.

The table below lists the medical lasers used in this hospital, including their wavelengths and the region of the electromagnetic (EM) spectrum they represent.

Table 1. Laser emitted light spectrum

LASERTYPE	WAVELENGTH	Region of EM spectrum	CLASS	APPLICATION
KTP ‘Nuvolas’	532nm	Visible (Green)	Class 4	ENT
Co_2 ‘Lumenis’	10600nm	Far infrared	Class 4	ENT, Plastics
Co_2 ‘Ultrapulse’	10600nm	Far infrared	Class 4	Burns
Nd Yag ‘Slit Lamp’	1064nm / 532nm	Near infrared/visible	Class 4	Ophthalmology
Nd:Yag “YC-1800”	1064nm / 532nm	Near infrared/visible	Class 3B	Ophthalmology (Eye Clinic)
Nd Yag ‘Xeo’	1064nm	Near infrared	Class 4	Plastics
Pulse Dye ‘Candela’	595nm	Visible (Yellow)	Class 4	Dermatology, Burns
Laser Diode ‘Red’	810 nm	Near Infrared	Class 4	Ophthalmology
Laser Diode ‘Green’	532nm	Visible (Green)	Class 4	Ophthalmology
Laser Diode ‘Doppler’	780nm	Near infrared	Class 3R	Burns
Laser Diode “Doppler LDLS”	785 nm	Near infrared	Class 3R	Burns (Clubbe Ward)

Properties of Lasers

Laser light has three unique characteristics that make it different to ordinary light:

1. **Monochromatic**

   Each laser produces light of one (or more) pure wavelength or colour. Sunlight, by contrast, is made up of multiple colours, or wavelengths of light.

2. **Low divergence**

   A laser emits its light in **one direction only in a nearly parallel beam**. It travels over very long distances with very little spread. In other words it has very low divergence.

3. **Coherent**

   All individual waves of laser light are moving precisely together through time and space i.e. is in phase.

Together these properties allow power to be concentrated in a tiny area, yielding a very high power density.

This gives laser radiation a far greater potential to cause injury than light from any other source e.g. a light bulb.

Modes of Operation

Most lasers used in medicine operate in one of two modes:

- **Continuous wave**

  This is where the beam is present continuously while in operation.

- **Pulsed mode**

  This is where laser output is not continuous, but is confined to a very short period. This process can be repeated to produce a sequence of pulses.

  High-energy pulsed lasers can produce extremely high peak power output over very small time scales, and can cause tissue damage in less than a nanosecond.

Laser Delivery Systems

All lasers require a means of transmitting the radiation to the treatment site – this is known as a *delivery system*.

The laser wavelength determines the type of delivery system. Four types are in common use:

1. Direct delivery
2. Articulated arm
3. Hollow flexible waveguide
4. Optical fibres

Tissue Effects of Laser Radiation

The interaction of light with human tissue is complex. The potential for injury depends upon the laser wavelength, the exposure time, the size of the laser beam at the point of incidence and power density.

Optical Interactions

When tissue is exposed to laser radiation, the laser radiation may undergo one or more of the following processes:

1. Reflection, either specular or diffuse
2. Scatter
3. Absorption, where the energy is transferred to the tissue
4. Transmission, where no energy is lost during passage through tissue.

The retina of the eye is particularly susceptible to injury from laser radiation at wavelengths in the visible and near infra-red regions. This is because these wavelengths are readily transmitted through the ocular media and focussed onto the retina. As the eye focuses visible light (increasing its power density) serious damage to the interior tissues of the eyes can occur. It can result from the viewing of even quite low power lasers within the visible and near-infrared band. This can occur with exposure levels that, at the front of the eyes and at the skin, are completely harmless.

Photothermal Interaction

The most common result of exposure to laser radiation is the production of heat. Because of the highly intense nature of the laser beam and its ability to be finely focused, heat can be generated in very large quantities, easily sufficient to coagulate or evaporate small volumes of tissue.

Photochemical Interaction

This is a chemical process that is dose related and initiated by the absorption of visible ultraviolet or infrared radiation. This principle has been utilised in the treatment of malignant tumours in which light absorbing chemicals are taken up predominantly by the rapidly dividing malignant cells. Exposure to laser energy at the appropriate wavelength causes the chemical molecules to undergo a series of reactions which result in the destruction of the target tissue.

Photoablation

This involves direct breaking of molecular bonds and subsequent release of biological material. Ultraviolet radiation is very strongly absorbed by biomolecules so penetration depths are small, of the order of a few micrometres.

Electromechanical Interaction

This interaction requires an extremely high power density delivered in an extremely short pulse, with a very short duration i.e. microseconds. Very high temperatures, lasting only the length of the pulse, are created, resulting in an explosive shockwave. A localised mechanical rupture of tissues usually occurs.

Hazard Classification of Lasers

Lasers are grouped into hazard classes under AS/NZS IEC 60825.1:2014 as:

Table 2. Laser Classifications

Classification	Associated hazards
Class 1	Inherently safe
Class 1C	Ocular hazard prevented by engineering means. Designed for contact application to the skin or non-ocular tissue.
Class 1M	As Class 1, but beam not to be viewed with optical magnifiers
Class 2	Low hazard – aversion response sufficient protection
Class 2M	As Class 2, but beam not to be viewed with optical magnifiers
Class 3R	Visible radiation, direct viewing hazardous, blink reflex protection
Class 3B	Higher risk than Class 3R – direct viewing hazardous
Class 4	Direct and indirect viewing hazardous

Hazards of Lasers

Eye exposure

The principal hazard is damage to the eye. Laser radiation in the visible and near infrared wavelength regions can penetrate the eye and damage the retina, usually permanently, while ultraviolet laser radiation and far infrared radiation can damage the surface of the eye. Damage from Class 4 lasers can occur in a fraction of a second, far quicker than the eye can blink to shut off the beam. The hazard can arise from direct exposure to the laser beam or accidental reflections of the beam from shiny objects.

The mechanisms of laser-induced damage are illustrated in Figure 1

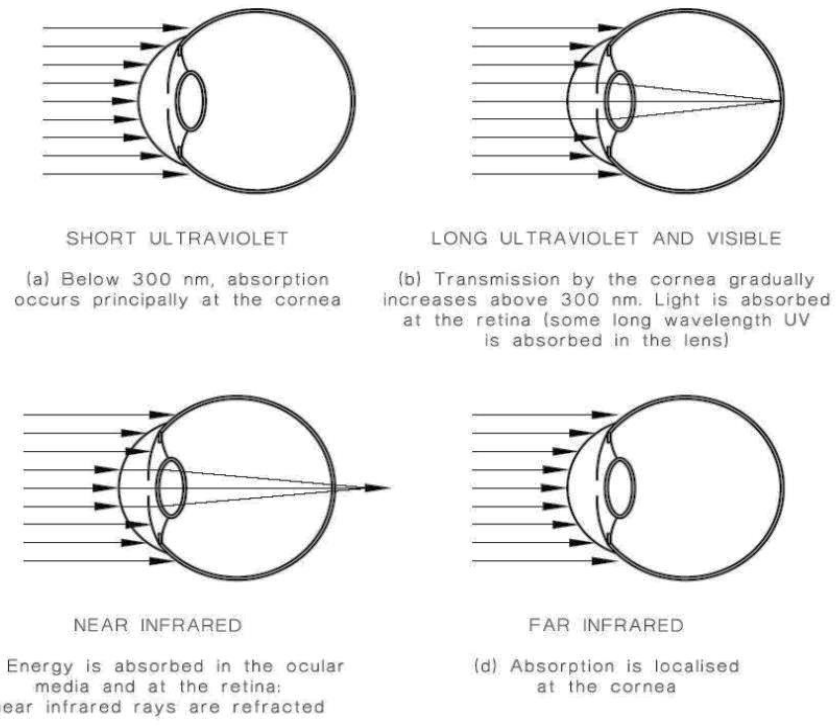

Figure 1. Mechanisms of Laser-induced damage[1]

For staff using lasers it must be stressed that eye damage is most likely immediate and often permanent - thus the local safety rules must be understood and adhered to by all staff involved. The risks of a laser accident occurring may be very small, but the consequences are often serious.

Skin exposure

The penetration of optical radiation into the skin is dependent on its wavelength and is generally greater in the visible and near infra-red regions of the spectrum. As the penetration depth increases, so does the volume of tissue exposed and the amount of radiation required to cause injury is consequently higher. Ultraviolet and mid to far infra-red radiations do not penetrate the skin significantly and thus a very brief exposure can cause serious harm. For most acute laser injuries to the skin a localised laser burn will be the result.

Repeated or extended exposure to low intensity ultraviolet radiation can induce erythema, a photochemical reaction resulting in reddening of the skin (>sun burn). Prolonged exposure over time can initiate long term degenerative processes including premature ageing of the skin and skin cancers.

Other hazards

Other hazards are fire (lasers can ignite flammable materials), skin burns, electrical hazard due to high power and potential hazards from plume generated by lasers used for tissue ablation (due to the possible presence of live viral material in the smoke plume).

Responsibilities

Chief Executive

The Chief Executive is responsible for the health, safety and welfare of persons within all facilities of the SCHN. AS/NZS IEC 60825.1:2012 recommends the appointment of a Laser Safety Officer (LSO) to advise and assist an employer in fulfilling their responsibilities for laser safety. Although the Chief Executive may delegate responsibility for laser safety within the LHD to the LSO, ultimate responsibility for implementation of the laser safety program and compliance with the legislation and standards rests with the Chief Executive.

CHW Laser Safety Committee

A Laser Safety Committee is recommended by AS/NZS IEC 60825.1:2012 for assisting the Chief Executive in fulfilling the legislative responsibilities for Laser safety within the Hospital.

Laser Safety Officer

A Laser Safety Officer (LSO) is appointed by the Laser Safety Committee to advise and assist the Laser Safety Committee in fulfilling the legislative responsibilities for laser safety.

Laser Safety Officers have the authority to:

- Stop any unsafe operations or proposed actions involving laser radiation that come to his or her attention, and
- Implement any necessary urgent actions following the occurrence of a laser accident.
- Lead any investigation into Laser incidents, near misses or accidents.
- Undertake audits of compliance with this Laser Safety Policy and present reports of these audits to the Laser Safety Committee.

Department Heads and Managers

Department Managers are responsible for the management of laser safety within their department.

For departments in which lasers are used, the specific responsibilities include:

- Ensure that all employees, doctors, contractors and/or visitors in their department comply with this Policy, by completing in-services and/or approved training courses, and that Laser Users and Laser Operators hold valid facility accreditation.
- Ensure that all employees in their department receive appropriate induction and continuing laser safety training, and that records of this training are maintained.
- Providing all staff, who may be exposed to laser radiation, the appropriate personal protective equipment.
- Actively participates in the investigation of Laser near misses, incidents or accidents, under the supervision of the LSO.

Laser Site Supervisor

To provide local supervision to laser utilising environments, a Laser Site Supervisor will be designated to ensure that the policy and procedures are implemented.

- The laser supervisor is responsible for: Liaison with the Laser Safety Officer on such matters as hazard identification and evaluation.
- Reporting of known or suspected near misses, incidents or accidents and ensuring that medical examinations of staff involved are arranged, if required.
- Escalating any incidents to the Department Head or Manager.
- Ensuring that all new employees required to work with the laser are adequately instructed on safety measures.
- Ensures identification and allocation of a Laser Safety Nurse for cases involving the use of lasers.
- Completes regular spot checks to ensure that an adequate supply of protective eyewear for all lasers in use are available to staff.
- Completes regular spot checks of all documentation relating to the use of the laser, to ensure they are complete.

Laser Safety Nurse

To assist with local supervision in a particular treatment area, a Laser Safety Nurse will be designated to ensure compliance with local procedures.

The laser safety nurse is responsible for:

- Identifying themselves to the Laser User/Operator
- Set up the Laser equipment, ensuring correct Laser, signage, eye protection and Laser curtains are in place.
- Liaison with the Laser Site Supervisor on any matters related to Laser hazard and safety identification and evaluation.
- Reporting of known or suspected near misses, accidents or incidents through IIMS.
- Verify that all documentation relating to the use of the laser is completed by the Operator.

Laser Operator and Laser User

Laser Operators and Laser Users are clinical staff trained and hold local facility accreditation in the use of a particular type of laser for surgical / medical procedures.

The laser operator/user is responsible for:

- Identification of the LSN in the room and ensuring their presence throughout the time the laser is in use.
- Only permitting operation of the laser when the LSN is present and there is adequate control of laser hazards.
- Confirming the correct laser and that the test fire of the laser is completed to their satisfaction prior to the anaesthetising of the patient. For the Eye Clinic laser only, the laser must be test fired prior to the patient entering the room.
- Informing all staff in the procedure area when the laser is in operation.
- Reporting of known or suspected near misses, accidents or incidents through IIMS.
- Provide direct supervision to non-accredited medical staff in the treatment area, including supervision during training in laser operation.
- Ensuring that all documentation relating to the use of the laser is completed.

CHW Registered Nurses

Registered nurses are clinical staff that have received in-service training only, and do not hold local facility accreditation. They can be present for a laser procedure under the direct supervision of a LSN.

Completion of in-service will be recorded within the *In-service Laser Training* spread sheet.

Biomedical Engineering

Biomedical Engineering is responsible for supporting the safe clinical operation of Lasers.

The Biomedical Engineering is responsible for:

- Manage the performance testing of all Laser devices, to ensure that all Laser devices are electrically safe for operation.
- Maintaining service records for all Laser devices in operation.
- Actively participates in the investigation of Laser near misses, incidents or accidents, under the supervision of the LSO.

Visitors (including Medical Students)

Visiting medical professionals must receive in-service training prior to being present at any laser procedure at CHW. They can be present for a laser procedure under the direct supervision of a CHW LSN, Laser User or Laser Operator.

Visitors will comply with all *Laser Safety* policy and associated procedures, the *Third Party Access to SCHN Hospitals and Code of Conduct* policy and procedure, and the *Company Representatives visiting CHW* policy and procedure.

Completion of in-service will be recorded within the *In-service Laser Training* spread sheet.

Contractors

Contractors must receive in-service training prior to being present at any laser procedure at CHW. They can be present for a laser procedure under the direct supervision of a CHW LSN, Laser User or Laser Operator. Contractors will comply with all *Laser Safety* policy and associated procedures, the *Third Party Access to SCHN Hospitals and Code of Conduct* policy and procedure, and the *Company Representatives visiting CHW* policy and procedure.

Completion of in-service will be recorded within the *In-service Laser Training* spread sheet.

Staff Responsibilities

Staff working in areas where lasers are utilised will:

- Comply with the requirements of this Laser Safety Policy
- Wear any protective equipment provided by the facility
- Promptly report any incident involving a laser, or a potential laser hazard, to their direct supervisor and enter into IIMS within 24 hours. Refer to the Incident Management policy.
- Attend the recommended Laser Safety training required by the organisation

Laser Credentialing and Accreditation

The Laser Safety accreditation of all staff, visitors and contractors within The Children's Hospital at Westmead (CHW) is outlined in the *Laser Safety Accreditation – CHW Policy (2015)*.

Definition

- **Ionising radiation:** radiation capable of producing ions in its passage through matter (eg x-rays)
- **Non-Ionising Radiation**: radiation not generally capable of imparting enough energy to atoms or molecules to disrupt their structure, i.e. to break their chemical bonds[3].
- **LASER**: The word "LASER" is an acronym for "Light Amplification by Stimulated Emission of Radiation" – a form of non-ionising radiation.

References

1. Online Laser Safety Training – Oregon State University
   (Definition and Properties of Laser Light | Environmental Health and Safety | Oregon State University)
2. AS/NZ IEC 60825.1:2014 Safety of Laser Products
3. AS/NZ 4173:2004 Guide to the Safe Use of Lasers in Healthcare
4. AS/NZ 1336:2014 Recommended practices for occupational eye protection
5. ACORN Standards for Perioperative Nursing 2014
6. Work Health and Safety Act 2011 No 10
7. Work Health and Safety Regulation 2011
8. NSW PD2009_039 Risk Management – Enterprise-wide Policy and Framework – NSW Health
9. SCHN PD 0/A/12:9016-01:01 Third party access to SCHN Hospitals and code of conduct
10. CHW PD 0/A/11:8010-01:01 Laser Safety Accreditation – CHW
11. Work Health and Safety - Controlling Exposure to Surgical Plume
    (http://www0.health.nsw.gov.au/policies/gl/2015/GL2015_002.html)