Lasers – Health Care Fact Sheets

WHAT IS A LASER?

The term “laser” is an acronym that stands for “Light Amplification by Stimulated Emission of Radiation”. Laser light is a form of non-ionizing radiation. Laser equipment produces and amplifies light that has unique properties that cannot be produced any other way. The light that it produces is monochromatic – it is composed of one single colour at a specific wavelength. Laser radiation can be generated in different parts of the spectrum – ultraviolet (UV), visible light, and infrared (IR).

The color of laser light is usually described in terms of the wavelength of the laser radiation. The most common unit used for the wavelength of laser is a nanometer (nm – one billionth of a metre). Light from other sources is made up of combination of colours at various wavelengths.

Another property of lasers is they are coherent light sources. This feature means that lasers produce monochromatic light (i.e., with a single or selected wavelength) in which the light “particles” or photons all travel in the same direction. This directionality allows laser beams to be very focused (collimated) so they do not fan out like the light beam of a flashlight. Since the light beam can be contained in a very narrow beam, it has a high radiant power per unit area. These properties enable laser devices to produce powerful laser beams that can cut metal. In health care, lasers are used for cutting, sealing and surgical procedures.

What are examples of lasers that are used in health care facilities?

A wide variety of lasers are used in health care facilities. The type of laser depends on the purpose of use. Lasers can be used as knives or probes and for imaging techniques. For example, laser knives can make cuts that do not bleed. They can be used to smooth skin wrinkles or remove skin moles, cysts, tattoos, spider veins, and so forth. Some commonly used lasers are given in the following table.

Table 1: Commonly Used Lasers in Health Care

Commonly Used Lasers in Health Care

Type	Radiation Type/Wavelength in Nanometres (nm)	Examples of Application
Carbon dioxide (gas laser)	Infrared/ 10,600	Surgery: Incision and excision by vaporization
Argon (gas laser)	Visible, blue/ 488	Sealing blood vessels in retina, plastic surgery
Argon (gas laser)	Visible, green/ 514	Sealing blood vessels in retina, plastic surgery
Krypton KPT 532 (gas laser)	Visible, green/ 532	Surgery: Cutting, coagulation, and vaporization of tissues
Nd:YAG* (continuous wave – solid state laser)	Infrared/ 1,064	General surgery
Nd:YAG* (Q-switched – solid state laser)	Visible, red/ 632	Ophthalmology: cutting tissues
Helium-Neon (gas laser)	Visible, red/ 632	Alignment: for aiming invisible beams
Ruby (solid state laser)	Visible, red/ 694	Plastic surgery, Dermatology: Destroying tissues
Rhodamine 6G Dye (Tunable – dye laser)	Visible/ 570-650	Treatment of malignant tissues; red (630 nm) commonly used

What are the types of hazards found when using lasers?

There are two types of laser hazards: the laser beam hazards and the non-beam hazards. Laser beam hazards include eye and skin burns which are due to laser beam shining on a person’s body. Non-beam hazards are associated with the laser equipment or the hazardous substances released from the laser equipment, and fumes emitted from materials exposed to laser beams, including laser-plumes produced during surgical procedures.

Sources of laser hazards include:

- Unintentional eye exposure during alignment
- Misaligned laser beam
- Lack of eye protection
- Equipment malfunction
- Improper handling of high voltage systems
- Use of unfamiliar equipment
- Improper restoration of equipment following service

What safe work practices should be used?

There should be a laser safety program in place and all staff who must work with or near the laser unit should receive:

- Training on proper procedures for the safe use of equipment.
- Instructions about how to keep equipment in good working order.
- Instruction and training to protect patients and clients from exposure.
- Education about possible health and safety hazards to all workers.

For example, the CSA Standard Z386-20 “Safe Use of Lasers in Health Care” specifies that facilities using lasers shall have a laser safety officer (LSO) and a laser safety committee (LSC) to perform risk assessments, and to ensure that laser safety policies and procedures are developed, implemented and maintained.

- The CSA Standard Z305.13-13 (R2020) “Plume scavenging in surgical, diagnostic, therapeutic, and aesthetic settings” also requires that:
- The facility has procedures and policies that are created and kept up-to-date that address the various hazards that may be present.
- Procedures should also address purchasing, installation, testing, use, servicing, and maintenance.
- All disposable plume scavenging system (PSS) equipment including filters, capture devices, and hoses be considered biohazardous, and that these items should be handled according to the manufacturer’s instructions or the facility’s policy.

Are there standards that can be used to develop a safe work practice program?

Yes, standards such as the following are available to develop a safe work practice program:

- The CSA Standard CSA-Z94.3.1-16: Guideline for selection, use, and care of eye and face protectors
- CSA-Z386:20: Safe Use of Lasers in Health Care
- CSA Standard Z305.13-13 (R2020) Plume scavenging in surgical, diagnostic, therapeutic, and aesthetic settings
- The American National Standards Institute (ANSI) Standard Z136.1-2014: Safe Use of Lasers
- ANSI Z136.3-2018: Safe Use of Lasers in Health Care
- ANSI Z136.7-2020: Testing and Labeling of Laser Protective Equipment

Note: Always check with your local jurisdiction to determine if your workplace must follow a specific standard.

What are the eye hazards when using lasers?

The eye is the most vulnerable to injury from a laser beam. The potential for injury depends on the power and wavelength of the laser beam (light). Intense bright visible

light makes us blink as a reflex reaction. This closing of the eye provides some degree of protection. However, visible laser light can be so intense that it can do damage faster than a blink of an eye. The invisible infrared laser beam, such as carbon dioxide (CO_2) laser beam, does not produce a bright light that would cause the blinking reflex or the pupil to constrict and, therefore, chances of injury are greater compared to visible light beam of equal intensity.

The location of the damage depends on the optical nature of the laser beam. Lasers in the visible light and near infrared range focus on retina. Therefore the injuries produced are retinal burns. The infrared radiation is absorbed in the cornea and may cause corneal damage and loss of vision.

What kind of eye protection should be used?

Every piece of laser equipment has built-in engineering controls such as protective housing, fail-safe interlocks, master switches, beam stops and attenuators (e.g., light absorbers) to prevent

accidental exposure. However, eye protection is needed while using Class 3B or Class 4 type lasers to prevent harmful exposure from reflected and scattered laser beams.

The ability of eye wear to filter the laser beam is expressed in terms of optical density. Optical density, type of laser, and visibility required are all important factors in the selection of protective eye wear. Protective eye wear may not provide the same degree of protection for infrared as for visible light and ultraviolet laser beams. Goggles with side shields are preferred because they provide protection against back reflection and side entrance of stray laser beams.

Selection of Protective Eye Wear

Consult appropriate standards such as CSA Standard Z94.3.1-16: Guideline for selection, use, and care of eye and face protectors or American National Standards Institute / International Safety Equipment Association (ANSI/ISEA) Standard Z87.1-2020 for guidance on selecting protective eye wear for your specific application.

Plastic versus glass lenses: Protective eye glasses typically are available with plastic lenses. Plastic lenses are light weight and can be molded into comfortable shapes. However, care is needed because they can be affected by heat, and/or UV radiation which can darken the lens or decrease its ability to absorb laser energy.

Alignment eye wear: This type of eye wear is used for low power visible laser beams. Alignment eye wear should not be worn during the operation of high power or invisible laser beams. Instead, safety eye wear that provides adequate protection should be worn.

What are skin hazards and what protective clothing is needed?

The potential for skin damage depends on the type of laser, power of the laser beam, and the duration of exposure. The type of damage may range from localized reddening to charring and deep incision.

Protective clothing (gown, cap, mask), gloves, and safety eye wear may be required for working near a laser. Consult manufacturer’s operating procedures and check with the laser safety officer to determine the specific needs for personal protective equipment and clothing.

What are the sources of fire hazard from lasers?

A fire can be started when laser beam or reflection of the beam strikes a combustible material such as rubber, plastic, human tissues, paper products, skin treated with acetone and alcohol-based preparations, human hair, and intestinal gases. Fire hazards are of particular concern in oxygen-rich atmospheres when oxygen or when nitrous oxide is being used.

What are preventative measures for the fire hazard?

- Train personnel to develop awareness about fire hazards and response procedures in case of laser fires.
- Make sure that hot tip of the laser does not touch combustible items.
- Maintain precise control of laser beam.
- Eliminate surfaces which can reflect laser beam.
- During surgery the laser beam should be in the stand-by position at all times except when the handpiece is in the hand of the surgeon.
- Make sure that skin preparation solutions are fully vaporised before covering the area with surgical drapes.
- Follow standard procedures in the event of fire or explosion.

What are some non-beam hazards associated with lasers?

Electrical hazards

Many lasers use high voltage and high current electrical power. The danger of electrical shock or electrocution arises when an untrained or unauthorized person tries to perform maintenance work without following the proper safety procedures. ANSI Standard Z136.3-2018 outlines

electrical safety procedures applicable to laser equipment. Electrical safety requirements include the following:

- Use proper grounding for metal parts of the laser equipment.
- Label laser equipment with electrical rating, frequency and watts.
- Prevent explosions in high pressure arc lamps and filament lamps.
- Avoid contact with electrical components, including capacitors which can contain an electrical charge even after the power is turned off.
- Ensure that combustible components of electrical circuit are short circuit tested.
- Make sure that there is no electromagnetic interference between the laser equipment and other electrical equipment.

What are some elements of a laser safety program?

The ANSI Standard Z136.1 recommends a laser safety program for workplaces using class 3B or class 4 lasers. Following are the essential components of a laser safety program:

Administrative

- A written laser safety policy.
- Posting of warning signs.
- Designation of the authority and responsibility for the evaluation and control of laser hazards to a laser safety officer.
- Management of incidents including reporting, investigation, analysis and remedial action.
- Training and education of personnel involved in the use and maintenance of lasers.
- Formation of laser safety committee.

- Establishment of a quality assurance program including regular inspection of the laser equipment.
- Presence of another person (buddy system) during maintenance work to provide first aid and to call for assistance in case of an incident.
- Periodic eye examinations (consult ANSI Standard Z136.3).

Engineering Controls

- Local exhaust ventilation.
- Fail safe methods (e.g., automatic shutters to protect the user’s eyes from reflected laser beam).
- Lock and key to prevent unauthorized activation of laser.
- Elimination of reflective surfaces from the room.
- Window covers (if necessary) to absorb scattered laser beam.
- Built-in access panel interlocks and automatic shutting to protect maintenance personnel.
- Safety latches or interlocks to prevent unauthorized access to controlled laser area.

Personal Protection

- Appropriate eye protection.
- Adequate respirators.
- Protective clothing and gloves.
- Personal protection program including training in the maintenance and use of personal protective equipment.

What are some of the duties of a laser safety officer?

In workplaces where a class 3B or Class 4 laser is used, a laser safety officer (LSO) must be on staff. The laser safety officer must do the following to ensure safe use of lasers.

- Confirm classification of laser.
- Read manufacturers’ instructions for installation and maintenance of the laser equipment.
- Make sure that laser equipment is properly installed.
- Train workers in safe use of lasers.
- Limit access to laser areas.
- Maintain laser equipment properly.
- Post appropriate warning signs.
- Recommend appropriate personal protective equipment such as eye wear and protective clothing.

What are some elements in a laser safety training program?

- Explain what lasers are and how they work.
- Laser hazard classification and its relation to potential hazards and need for control measures.
- Laser beam hazards (eye and skin hazards).
- Potential hazards arising as a result of the use of laser beam.
- Non-beam hazards from laser equipment.

What is an example of a laser safety checklist?

Room

- Warning signs.

- Window and door covers (non-transparent, non-reflecting material).
- Fire extinguishers.
- Storage for gas tanks.
- Secure locked designated place for the laser key.
- Designated place for accessories.

Personal Protection

- Documented personal protection program.
- Training for use and maintenance of personal protective equipment.

Laser Equipment

- Electrical outlets.
- Electrical power cords.
- Cooling water pressure.
- Cooling water temperature.
- Maintenance up-to-date.
- Laser log up-to-date.

Smoke Evacuator

- Filter change date record.
- Responsibility for filter change assigned.
- Valid safety sticker.
- Laser operation.
- Documented authorization procedure.
- Written operating procedures.
- Emergency contact telephone numbers of persons responsible for laser safety.