

Lasers in Veterinary Practice:

Safe Use Guidelines



BC Centre for Disease Control
An agency of the Provincial Health Services Authority



**College of Veterinarians
of British Columbia**

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- Ian Salomon, Occupational Hygiene Officer, WorkSafeBC; and,
- Francine Anselmo, Head, Medical X-ray, Radiation Protection Services, BC Centre for Disease Control.

Forward

The use of lasers in veterinary medicine is expanding. Smaller reliable lasers are available for clinical use in veterinary medicine. Safety issues for the use of lasers in veterinary medicine are almost identical to those required for human surgical medicine. Education regarding their safe use is essential for surgical lasers to be integrated into a veterinary practice. A brief inadvertent exposure to high-power laser radiation can cause permanent eye injury and/or skin burns. This guideline is designed to give the Designated Member (DM) and operating staff of veterinary facilities essential information for laser safety. Following the guidelines listed in this document does not relieve the DM, who is at all times responsible to the CVBC for the management and practice of veterinary medicine at a facility, from their obligation to take any additional measures necessary to prevent health hazards from occurring in the veterinary facility. The DM and operator(s) should refer to the user information supplied by the manufacturer or distributor of their equipment, as well as their training resource materials and related guidance documents available.

The DM and operator(s) should be aware that use of these lasers is subject to provincial legislation, for purposes of worker health and safety. The DM must be aware of the *BC Workers' Compensation Board's Occupational Health & Safety Regulation (Part 7 Division 3 Radiation Exposure)* available at <http://www.worksafebc.com>, which states:

"Equipment producing ionizing or non-ionizing radiation must be installed, operated and maintained in accordance with the applicable standard, as listed in the regulation". A Workers' Compensation Board inspector may visit a site and inspect for compliance with the Occupational Health & Safety Regulation". (Note: In this Guideline the Workers' Compensation Board will also be referred to by their preferred operational name of 'WorkSafeBC' or 'WSBC'.)

CVBC Responsibility

CVBC members have previously been advised of their obligations respecting the safety of x-ray equipment. The CVBC will not directly enforce other agencies' legislation; however, the CVBC has a role to monitor evidence of member's compliance with facility requirements under other legislation. One such requirement is to ensure that laser devices meet certain standards. These obligations arise under the *Workers Compensation Act (WCA)*. These are worker safety provisions, but it should be noted that the *WCA* requirements also serve public and animal safety. The CVBC will not test and assess the machines but will monitor through the practice inspection process whether members have had their

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machines maintained, the facility has proper standards for use, and procedures are in-place for all workers to comply with occupational health and safety regulations under WorkSafeBC.

Introduction

Health Canada, Consumer and Clinical Radiation Protection, assesses, monitors and assists in the reduction of the health and safety risks associated with different types of radiation emitted from radiation emitting devices or other sources. Its mandate is to ensure that Canadians are protected by enforcing the provisions of the federal *Radiation Emitting Devices Act*. With regard to lasers Health Canada has developed regulations for design, construction and performance of only two types of laser devices; the laser scanner and the demonstration laser.

Canada has not adopted a laser hazard classification and labeling system. Consequently, reliance is placed on the laser device entering Canada being labeled in conformance with United States (US) requirements. Lasers, in general, fall into two categories (http://www.bccdc.ca/healthenv/Radiation/Lasers/Gnrl_Laser_Guide.htm):

- Lower power lasers (e.g. school lasers, laser pointers, supermarket checkout lasers, etc.)
- Higher power lasers (e.g. surgical lasers, entertainment lasers, industrial lasers, skin therapy i.e. removal of tattoos, hair, spider veins, age spots, warts, moles, etc.)

Commercially-produced lasers and laser devices in the US are designated using a numerical hazard classification system (Classes 1 to 4) and identified by attached warning labels. These labels also indicate the degree of hazard that is associated with the laser radiation to which human access is possible during laser operation.

Laser applications in veterinary medicine for small and large animals include declawing, surgery, dermatology, ophthalmology, upper respiratory tract, urinary and GI tracts, wound management, etc. These applications utilize high laser emission levels and the lasers used are therefore designated in the highest hazard classes (Class 3b & 4). These classifications indicate that the laser radiation emitted from these devices is a hazard to unprotected eyes or skin from exposure to the direct beam and that exposure to the reflected or **scattered beam** may also be hazardous under some conditions. The direct beam may also be a fire hazard if it strikes combustible materials. Safety features that are a part of these laser devices and operator training specific to the laser type are essential for their safe use.

These "Safe Use Guidelines" address: general laser safety; roles and responsibilities; the risks associated with the use of lasers; and, provide advice for laser personnel to help reduce health risks to themselves and to others in the veterinary workplace.

Laser Safety Responsibility

Overall safety associated with the installation and use of lasers in a veterinary facility remains the responsibility of the DM. For class 3b and 4 lasers, the DM shall designate a Laser Safety Officer (LSO), which may be the DM, to be responsible for implementing a laser safety program. It is the responsibility of the DM to ensure an operator in the veterinary facility is aware of the requirements for safe use. This means that:

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- a) Laser operators must be trained in laser safety and be knowledgeable of local regulations.
- b) Periodic laser safety audits of the facility and personnel safety features (e.g. eyewear, barriers, area controls, warning signs, etc.) and equipment safety features (interlocks, labels, etc) shall be conducted and documented, with any identified deficiencies being duly corrected in a timely manner.
- c) All laser safety audits shall be made readily available in a suitable format for an inspector with the CVBC, WorkSafeBC, or as otherwise required by legislation.

Introduction to Lasers

Laser is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. Most lasers used in veterinary medicine produce an intense beam of pulsed or continuous invisible infrared light (radiation), which is used for cutting and sealing tissue. The benefits of using laser radiation in surgery include decreased bleeding as smaller blood vessels are sealed, decreased pain in post operative recover and destruction of bacteria.

The more common lasers used in veterinary medicine are the carbon dioxide (10,600 nm), Nd:YAG (1064 nm), Ho:YAG (2100 nm) laser, diode laser (810, 980 nm) KTP (532nm) pulsed visible and occasionally the argon (488 - 514 nm) visible laser. All lasers are normally identified by their 'lasing' chemical element(s) and the wavelength of the laser radiation in meters (m) with the appropriate metric unit abbreviation (e.g. "μ" micro 10⁻⁶, or "n" nano 10⁻⁹, etc).

Laser light is coherent and monochromatic and unless caused to diverge by the use of optics i.e. lens, it is non-divergent. It travels in parallel waves of a single constant phase difference and is composed of only one wavelength and frequency. Increasing the amount of laser energy delivered to tissues will decrease the time needed for tissue vaporization. This can be accomplished by:

- (a) increasing beam power output measured in watts (W) or
- (b) decreasing beam diameter measured in watts per square centimeter (W/cm²)
- (c) and for pulsed lasers increasing the energy per pulse measured in joules (J)

In general, laser light focused onto tissues will be absorbed, transformed, reflected and/or scattered. The laser wavelength is chosen so that most of the light energy is absorbed and/or transformed. When absorbed or transformed within the target tissue the laser energy interactions are classified respectively as:

- i. **Photothermal**. Heat energy is conducted to the surrounding tissues resulting in hyperthermia and collateral tissue damage. The remaining carbon black char can act as a foreign substance creating an inflammatory response and thus impede wound healing.
- ii. **Photochemical**. Laser light is absorbed and converted into chemical energy, resulting in tissue destruction. Photodynamic therapy (PDT) utilizes a laser activated photosensitizer drug which is administered either intravenously, orally or topically that stimulates the destruction of a chemically-labeled tissue.

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- iii. **Mechanical-photodisruptive.** Pulsed laser light can be converted into acoustical energy upon impact creating a shock wave that disrupts the target tissue (e.g. laser intracorporeal shock wave lithotripsy).

When laser energy is applied to the target tissue it may be scattered forward in and through tissue causing heating and necrosis. Backscattering can also occur as the energy partially reflects on impact with tissue. This may have a damaging effect on staff and equipment if adequate safety precautions are not taken. The Nd:YAG and the Argon laser are known to produce significant backscatter which can be helpful in cauterizing bleeders below the tissue surface. The Nd:YAG laser penetrates 4-5 mm with large amounts of forward and backscatter making it good for cauterization. The visible Argon laser is highly absorbed by hemoglobin, has a 2-3 mm penetration and moderate forward and backscatter. The carbon dioxide (CO₂) laser's infrared radiation is highly absorbed by water and consequently is rapidly absorbed within the first 0.1 to 0.3 mm of tissue. This makes it a good 'cutter' but poor cauterizer. The carbon dioxide (CO₂) laser is one of the most widely used lasers.

The heat diffusion into the tissue surrounding the target results in collateral tissue damage. Lowering the laser setting does not necessarily improve things as less power requires longer contact times to produce the desired effect which in turn results in increased heat diffusion into surrounding tissue. Alternatively, "superpulsing" of laser energy by a surgeon can allow tissue recovery between micropulses, which is shorter in duration than the time required for diffusion of heat through tissue. This allows the thermal energy time to escapes primarily through vaporization resulting in minimal collateral heat diffusion.

Laser Hazards to Occupationally-Exposed Humans

Eye and Skin Exposures

The primary hazard associated with lasers stems from inadvertent exposure to laser emissions. Exposure to an individual may occur directly from the laser beam, or when the beam is reflected from a shiny surface such as a mirror, ring, glass picture frame, etc. or in the case of the CO₂ laser from metal instruments and other common operative items. The parts of the body at greatest risk are a person's eyes and skin. Persons at risk are principally the staff carrying out laser procedures.

When visible and near infrared laser light passes through the cornea, pupil and the lens of the eye and is focused onto a small area of the retina it results in an increase in the amount of energy/power that is absorbed by the retina. The energy or power per unit of area on the retina can be increased by 10,000 to 100,000 times! Consequently even brief or partial exposures can instantaneously damage the retina and other tissues around the impact area. Because the eye cannot see infrared radiation it will not respond to protect itself by blinking or by looking away from the laser radiation. It is even possible for eye damage to occur to a person without them being aware that an exposure has taken place.

All persons within the operating area are at risk of eye injury when they are not using eye protection. Laser induced eye injury may interfere with vision either temporarily or permanently, in one or both eyes. It is extremely important that all authorized personnel entering the area of the laser be provided with and WEAR protective eyewear.

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To Avoid Eye Damage

An analysis of 417 laser accidents/events, voluntarily reported to Rockwell Laser Industries, from 1964 to 2001 revealed that seventy percent (70%) of all laser accidents have been related to not wearing protective eyewear, wearing inappropriate eyewear or wearing damaged protective eyewear while using the laser! Protective eyewear is the single most important piece of protective equipment needed by persons within the treatment area.

Eyewear **must** be labeled with the same wavelength of laser radiation as is emitted by the laser that you are using! e.g. 10,600 nm or 10.6 μm for CO₂, 1064 nm for the Nd:YAG, etc. In addition, it **must** be labeled with an optical density (OD) number. The optical density of the eyewear is unique to both the output power/energy used by the laser and the laser's wavelength. Consequently, protective eyewear must have an OD that is recommended by the laser equipment manufacturer. This would likely be at least an OD of 5 or greater. Always confirm the wavelength number and an OD number before using protective eyewear. Ensure the wavelength matches that emitted by the laser being used and the OD number is not lower than that recommended by the laser manufacturer. The optical density (OD) is simply the logarithm of the potential eye exposure, divided by the maximum permissible exposure (MPE). Eye wear protection requirements include:

- Eye protection must be available and worn in the laser treatment area (sunglasses and/or contact lenses do not provide adequate protection during laser procedures).
- Eye protection must be labeled with the optical density for the laser wavelength in use.
- Eyewear must have adequate side protection. This means that the eyewear must have side and top guards and fit snugly around the nose.
- Eyewear must be regularly inspected for cracks and discoloration and replaced as required.
- Eyewear should not move between laser treatment rooms, nor should they be carried in the pockets between use.
- Eyewear must be inspected regularly since small cracks, discoloration, or loose fitting filters may permit the laser beam to reach the eye directly.
- All staff, who periodically will be working with the laser, should have their eyes checked prior to their first occupational exposure with the laser and as further recommended by an optometrist.
- Never permit a laser beam to be pointed directly at a person's eye, even if protective eyewear is worn.

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To Avoid Skin Damage

- Damage from direct and reflected laser light, which may appear as an erythematous reaction or maybe severe sunburn, can be avoided by wearing gloves and gowns. The use of moistened drapes and sponges with sterile saline will afford some protection to the worker from reflected laser energy.

To Avoid Exposure from Reflections and Transmissions

Collimated laser energy has a higher potential of reflection than focused laser energy due to the slower loss of power density over distance. However, it is recommended that backstops, which protect underlying tissue, and instruments that have a non-reflective finish are employed within the vicinity of a laser beam to prevent laser reflection.

Windows in the laser treatment area may need to be covered if they are within the nominal hazard zone (defined below) for the laser in use. Covers need to be non flammable opaque material labeled with their optical density OD number. Window glass has an optical density of 5.0 for short wave ultraviolet and long wave infrared without being covered. It provides adequate protection against transmission of the laser energy in the wavelength range from 180 nm to 300 nm e.g. excimer argon fluoride at 193 nm and excimer krypton fluoride at 248 nm and greater than 4,000 nm e.g. the CO₂ at 10,600 nm

Education, Training and Standards

A thorough understanding of laser wavelength and tissue penetration, potential hazards with laser use, and the utilization of the recommended standards for safe operation is an essential requirement for the surgeon and operating staff to provide a laser-safe environment. **The Occupational Health & Safety (OHS) Regulations** for British Columbia that pertain to the use of lasers in a health care is Section 7.19(4)(b) of the OHS Regulation, which states (Ian – you commented last week there is confusion here between the Guidelines and Regulations. How should this be worded?):

(4) The employer must ensure that a worker's exposure to non-ionizing radiation does not exceed the exposure limits specified in (b) for lasers:

(i) ANSI Standard Z136.1-2000, Safe Use of Lasers, as amended from time to time;

(iii) ANSI Standard Z136.3-1996, Safe Use of Lasers in Health Care Facilities, as amended from time to time; and,

(iv) CSA Standard Z386-01, Laser Safety in Health Care Facilities, as amended from time to time, except as otherwise determined by the Board.

**WCB will enforce the most up to date standards which are currently (a) ANSI Z136.1 – 2000, Safe Use of Lasers and (c) ANSI Z136.3 – 2005, Safe Use in Health Care Facilities.*

On its website, www.worksafebc.com, WorkSafe BC also provides detailed explanatory material - Guidelines. The following guideline has been reproduced from several that include information that applies to Lasers.

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* "G7.19(4)-2 Exposure to non-ionizing radiation – Lasers Issued August 1999; Revised January 1, 2005.

Section 7.19(4) of the regulation refers to applicable ANSI and CSA standards. CSA Standard Z386-01 is a reproduction of ANSI Standard Z136.3 but with a few pages of "Canadian Deviations, "which make the standard more applicable to the health care environment in Canada. The determination of worker exposure to non-ionizing radiation from lasers is very complex. Calculation of the exposure limit is dependent on the type of laser being assessed; there is no generic calculation covering all laser sources. Neither a WCB officer nor an employer would normally be expected to measure the radiation being emitted by a laser. Rather, compliance with this section will normally be determined by an evaluation of the laser safety program, as required by the applicable standard - such as the program outlined in Table 1 of ANSI Standard Z136.1-2000. In this instance, an effective laser safety program is equivalent to an effective exposure control plan, and both are equivalent to actually measuring exposures. In other words, workers cannot be overexposed to laser radiation if there is an effective laser safety program in place. The employer should establish and maintain an adequate program for the control of laser hazards to the eyes and skin. For class 2 and 3a lasers and laser systems, a laser safety program meeting the requirements of ANSI Standard Z136.1-2000, or a program providing an equivalent level of worker protection, constitutes an effective exposure control plan. For class 3b and 4 lasers and laser systems, a laser safety program meeting the requirements of ANSI Standard Z136.1-2000 constitutes an effective exposure control plan. The requirements of a laser safety program are summarized in Table 10 of ANSI Standard Z136.1-2000"

Laser Safety Program

ANSI standards require laser facilities regardless of their size to establish and maintain an adequate safety program for the control of laser hazards. The employer has the fundamental responsibility for assurance of the safe use of lasers owned and/or operated by the employer or employee. The DM for a facility must designate a **Laser Safety Officer** (LSO) for the facility, to be responsible for implementing a laser safety program for all circumstances where there is human access to Class 3b and/or class 4 levels of laser radiation. The laser safety officer is responsible for:

- Establishing the laser treatment controlled area and ensuring only authorized personnel occupy the operating area.
- Evaluate hazards of laser treatment area (i.e. floor is uncluttered, there is clear access to footswitch, cables are secure, cords are not crimped, etc.).
- Approving installation and equipment prior to use, and modifications to existing equipment and facilities.
- Approving standard operating procedures (SOPs), administrative and procedural controls (i.e., checklists).
- Recommending or approving protective equipment (i.e. eyewear, clothing, barriers, etc) as required assuring personnel safety.
- Auditing the functionality of control measures periodically to ensure proper operation.
- Approving the wording on area signs and equipment labels.
- Keeping a laser 'use log' that records laser procedure and time, power settings, accessories used, and problems encountered and their resolution.

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- Keeping a 'laser maintenance log'.
- Assuring adequate safety education and training are provided to laser area personnel.

In veterinary facilities, the DM may also be the laser safety officer. In all cases a laser safety officer (LSO) must be designated and must have authority to carry out a laser safety program in the facility. The LSO must have the necessary training and experience to administer a laser safety program. The LSO must be authorized by the employer and be responsible for monitoring and overseeing the control of laser hazards.

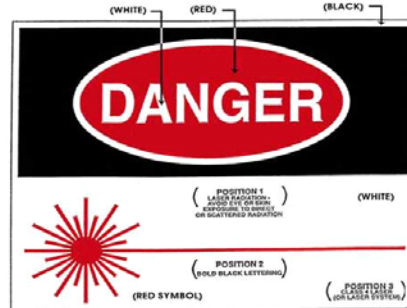
Safety Zones

Laser safety standards make use of the concept of a **maximum permissible exposure** (MPE), which is a number representing the amount of energy (joules) or power (watts) in the cross section of area (cm²) of a laser beam to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin. Laser radiation exposure may be unsafe within a specific distance, beyond which it is not harmful as a result of the laser beam spreading out (divergence) and being attenuated or scattered by air. Consequently knowledge of this distance can be used to protect oneself and others from laser exposure injury. The distance beyond which it is safe to view or be exposed to a laser beam is unique for each type of laser and would depend upon many factors. Laser standards define the area **inside** this distance as the "**Nominal Hazard Zone**" (NHZ). Some lasers are provided a different measure of laser safety called the "**Nominal Ocular Hazard Distance**" (NOHD). This is "*the distance along the axis of the unobstructed beam from a laser ... to the human eye beyond which the irradiance or radiant exposure, during installation or service, is not expected to exceed the appropriate MPE*".

It is much simpler to define an area or zone where the laser is used and where it is probable that any exposure in this area exceeds this maximum permissible exposure and require that safety precautions be used in this zone. It is best to designate the laser operating and/or treatment room as the NHZ and to prevent any inadvertent scattered beam from exiting the room through open doors, windows or other breaks in the treatment room enclosure. Access into the treatment enclosure must be restricted to essential personnel during treatments.

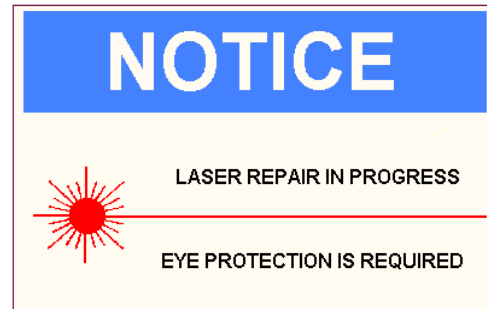
The occupancy and activity of those within the laser treatment controlled area are subject to supervision for the purpose of protection against all hazards associated with the use of the laser(s). This laser treatment area is usually a separate room with a closeable door and covered windows. Appropriate warning signs such as those shown **MUST** be identified at all entrances to the area. The entry warning sign(s) can be a large version of the laser warning sign that is attached to the laser (i.e. as shown). Note that the sign with the exclamation mark in the triangle is the newer ANSI standard recommended sign and is the style required when interpreting the requirement of the WorkSafeBC, Occupational Health & Safety Regulation. The older style however is still acceptable.

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Other additional wording and style recommended in the ANSI standard for entrance signs are:

- "Eye Protection is Required"
- "Laser Protective Eyewear Required"
- "Invisible Laser Radiation"
- "Knock Before Entering"
- "Restricted Area"



Some infrared radiation can travel through window glass and other openings, and can be reflected off mirrors and other shiny surfaces. Windows can be covered with a non flammable opaque material, labeled with the optical density OD number or otherwise restricted to prevent the radiation leaving the treatment room. Fire proof light weight laser blocking covers are available with magnetic sides allowing them to be put on and taken off easily if necessary. It follows that only trained and/or authorized persons with protective equipment are allowed to enter or be in the treatment room. Similarly, reflective items must not be used or worn by persons in this area. Although access to the laser treatment area must be restricted, it must not prohibit rapid entry and exit to deal with any emergency situations.

Standard Operating Procedures

Safety policies and procedures need to be established and copies kept posted. They should include authorizations for laser use, operating instructions, prior-to-use checklists, and maintenance/service instructions. Newer lasers often come with sophisticated built-in safety features such as protective housings around the laser, interlocks on the protective housings, a key control and warning systems. To prevent unauthorized operations your laser needs to be either securely stored when not in use or require a key or coded access to enable the laser.

Other safety features include:

- The switch, which controls client exposure, must be guarded to prevent inadvertent activation. Another way to accomplish this is to require two simultaneous actions, such as foot pedal depression and hand trigger, in order to operate.
- An emergency shutoff switch must be available to the operator or assistant to enable the rapid shutdown of equipment.

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- Equipment must be serviced and maintained as recommended by manufacturer to ensure safeguards remain functional.
- The laser operator should periodically check electrical cords for damage.
- Check any skin coolant hoses supplied, for wear and any damage.
- All testing of the laser should be done by staff that are adequately protected.

Non-beam Hazards

Airborne contaminants - Laser-tissue interactions produce a plume of smoke that may contain bacterial and viral particles (0.1 to 0.3 μm) and hazardous chemicals (e.g. benzene, formaldehyde, phenol and toluene); some of which are carcinogens. To avoid the inhalation of these aerosols, appropriate air evacuation systems must be used. The required system is determined by the laser beam power (i.e. irradiance – W/cm^2)

The following recommendations are made to protect the operator and surgical staff in the laser treatment area:

1. Control the dispersion of laser generated exhaust - hazardous materials, potentially toxic gases and airborne contaminants - by capturing exhaust as near as practical to the point of production (e.g. within 2- 5 cm of treatment area on patient). They should be either completely trapped or vented out of the area in an environmentally sound manner. Portable smoke extractors using charcoal and/or HEPA type filters are satisfactory (see [Control of Smoke From Laser/Electric Surgical Procedures](#)) at the National Institute for Occupational Safety and Health (NIOSH) at www.cdc.gov/niosh/hc.html. Filters and absorbers used in portable smoke evacuators require replacing on a regular basis.
2. Local exhaust ventilation techniques should serve as the first line of protection from occupational exposure. According to ANSI Z136.3-2005, section 7.4.2.2. - Respiratory Protection: "At present there is no suitable half-mask respirator (fitting over nose and mouth) used for the specific purpose of excluding all laser generated plume particulates, bacteria, viruses, gases, vapors, or other irritants. Surgical mask are intended to protect the patient from the contaminated nasal or oral droplets of anyone with access to the surgical field." Standard surgical masks do not offer protection against particles of 0.2 μm or smaller. Filter masks that do filter > 0.2 μm particles and rated for laser use are available, such as the half face mask with an organic cartridge and hepa filter pad (P100).

Fire safety - Lasers should not, whenever possible, be used in the presence of flammable anaesthetics, prep solutions containing alcohol, drying agents, petroleum ointments or flammable plastics. Other recommendations include:

1. Surgical drapes should, wherever possible, be made from flame-retardant material and be protected with moistened towels and sponges near the primary laser beam.
2. Water and a fire extinguisher should be readily available.
3. Adequate prep towels and the insertion of a moistened sponge in the anal opening to reduce the release of methane gas when performing surgery in the perineal area.
4. In the presence of an oxygen rich environment - which may increase the risk of a fire hazard - use "laser safe" endotracheal tubes that may include nonflammable metal tubes, specially wrapped red rubber tubes, or 100% silicone tubes. The cuff of the endotracheal tube should be filled with saline. Protect the endotracheal tube with moistened sponges.

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5. Use intravenous anaesthetic technique instead of a volatile gas anaesthetic whenever practicable.

Electrical hazards - Ensure there is adequate amperage, voltage and avoid fluids, which may result in a short circuit, to the laser system. Proper grounding and insulation is imperative. Internal maintenance must only be performed by a qualified biomedical technician for the specific type of laser.

Documentation and Records

The DM must keep records and have them available on site. Required records include:

- Laser operator qualifications i.e. laser educational and safety training
- Standard Operating Procedures (SOP) for laser use.
- Safety Checklist (see Appendix 1)
- Previous safety inspections
- Reports of accidents or incidents
- All records must be typed or legibly written in ink and retained.

Conclusion

Surgical lasers are powerful and potentially dangerous instruments. Misuse can result in severe injury to the animal and to the occupationally exposed veterinarian and staff. Protection however is relatively easy. With safety and training on their use, the potentially exposed veterinarian and staff can ensure their protection and that of the animal.

Reference

“Lasers – Have You Seen The Light?” by Timothy Holt, DVM. Proceedings & Note Book, CANWEST Veterinary Conference, 2005.

Further information on laser safety may be obtained from:

- The Laser Institute of America, 12424 Research Parkway, Suite 125, Orlando Florida 32826; Phone: 407.380.1553
- Rockwell Laser Industries Inc, PO Box 43010, Cincinnati OH 43010; Phone: 513.271.1568, toll free 513.271.1598
- The Radiation Protection Services, BC Centre for Disease Control, 655 12th Ave W, Vancouver BC V5Z 4R4; Phone: 604.707.2442
- American National Standards Institute (ANSI), 1819 L Street, NW, 6th Floor, Washington DC 20036; Phone: 202.293.8020 (www.ansi.org/contact_us)

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Glossary of Terms

ANSI: the American National Standards Institute - a private, non-profit organization that administers the US voluntary standardization and conformity assessment system.

Incidental personnel: those whose work makes it possible, but unlikely, that they will be exposed to laser energy sufficient to damage their skin or eyes.

Infrared: invisible radiation with wavelengths from approximately 700 nanometers (nm) to 1 millimeter.

Irradiance: the power per unit area, usually expressed in watts per square meter, used to measure or quantify the intensity of laser radiation.

Joule: the unit of energy used to measure the energy of a laser pulse.

Laser controlled area: an area that is appropriately enclosed so that no laser radiation above the maximum permissible exposure inadvertently escapes to injure unsuspecting persons.

Laser personnel: those who work routinely in the laser environment and must be fully protected.

Laser safety officer: the person with training and experience who is authorized by the Designated Member to be responsible for the laser safety program in the facility.

MPE: abbreviation for the **M**aximum **P**ermissible **E**xposure allowed by the laser standard before injury occurs to the skin or eyes.

Nd:YAG: notation for the component in a laser which produces the infrared radiation i.e. neodymium:yttrium-aluminum-garnet.

NHZ: abbreviation for Nominal Hazard Zone, which is the space within which the level of the direct, reflected, or scattered radiation during normal operation exceeds the applicable maximum permissible exposure. This zone may be smaller than and contained within the laser controlled area.

NOHD: abbreviation for Nominal Ocular Hazard Distance which is the distance along the axis of the unobstructed beam from a laser to a human eye, beyond which the irradiance or radiant exposure, during installation or service, is not expected to exceed the appropriate maximum permissible exposure.

Optical Density [OD]: a material's ability to absorb laser radiation, as used in protective eyewear i.e. $OD = \log_{10}(\text{potential eye exposure}/\text{MPE})$.

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Appendix 1: Laser Safety Checklist

✓	PROCEDURE	NOTES (MUST BE INITIALED BY OPERATOR)
	Record laser type to be used?	
	Who is the laser operator?	
	Laser Safety goggles – available and 'OK' for use?	
	OD label on goggles adequate?	
	Correct wavelength on goggles?	
	Have 'Warning" notices been posted?	
	Laser area secure?	
	Permanent location of 'safety key'?	
	Name person holding 'safety key'?	
	Patient protection performed?	
	Emergency contact?	
	Anaesthetic machine has been inspected?	
	Fire Extinguisher, water available if fire?	
	Operator's Manual available?	
	Contact information of manufacturer?	
	Preventative maintenance current?	
	Smoke evacuation working?	
	Masks available?	
	Emergency shutdown procedure posted?	
	Laser treatment area clear of unauthorized personnel?	