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A. Introduction

Dental radiography is one of the most valuable tools used in modern dental health care. It makes possible the diagnosis of physical conditions that would otherwise be difficult to identify and its judicious use is of considerable benefit to the patient. However, the use of dental radiological procedures must be carefully managed, because ionizing radiation has the potential for damaging healthy cells and tissues. Although no known occurrence of cancer or genetic damage has been observed from radiation doses delivered in modern dentistry, until more evidence is available one should practice radiation protection with the same care as would be dictated if a hazard were known to exist.

It is generally accepted that there is no safe level of ionizing radiation dose and that no matter how low a dose is used, there is a mathematical probability of an effect. Since the projected effect of a low dose would increase the incidence of a deleterious effect only minimally above the naturally occurring level, it is impossible to prove by observation either the validity or falsity of this hypothesis. The linear extrapolation hypothesis has been widely adopted in radiological protection and has led to the formulation of the ALARA (As Low As Reasonably Achievable) principle. This states that exposure to radiation which can be decreased without loss of critical diagnostic information and without too much expense or inconvenience should be reduced. Furthermore, any exposure, no matter how low, which can be avoided altogether without unfavorable consequences, should be avoided.

In the Province of Alberta dental x-ray equipment and facilities, as well as dental lasers are governed by the Radiation Protection Act and Regulation. These documents specify that owners and staff have certain obligations to ensure the health and safety of themselves, their patients and the public.

The obligations include:

- registering the equipment,
- developing a code of practice,
- ensuring the installation and operation of equipment
- complying with particular standards,
- implementing quality assurance for x-ray emitting and film processing equipment, and
- preventative maintenance and dosimetry monitoring

This Guide has been developed to assist dental facilities with meeting these obligations. Failure to comply with the Radiation Protection Act and Regulation may constitute unprofessional conduct.

The term ‘dental facility’ rather than dental clinic is used throughout this Guide, as it is the terminology utilized within the standards.
B. Standards

Following is a list of standards which apply to dental facilities. This Guide consolidates the important information that is required by a dental facility on a regular basis. It is the owner’s responsibility to ensure the equipment and facility comply with the requirements.

Alberta Radiation Protection Act and Regulation
This is the provincial legislation which specifies the requirements to be met. The Act and Regulation are available on the Members website at www.abdentists.com and on the Alberta Queen’s Printer website http://www.qp.alberta.ca/

Health Canada Safety Code 30 - Radiation Protection in Dentistry Recommended Safety Procedures for the Use of Dental X-ray Equipment

This Safety Code is referenced in the Alberta Radiation Protection Regulation and sets out the requirements for the safe use of radiation emitting equipment in dental facilities. Authorized Radiation Protection Agencies use this Safety Code as a basis for their Compliance Verification Reports. (see Appendix 4, Appendix 5 and Appendix 6)

Health Canada Safety Code 35 - Safety Procedures for the Installation, Use and Control of X-ray Equipment in Large Medical Radiological Facilities

This Safety Code is referenced in the Alberta Radiation Protection Regulation and sets out the requirements for the safe use of radiation emitting equipment in dental facilities. Authorized Radiation Protection Agencies use this Safety Code as a basis for their Compliance Verification Reports. (see Appendix 6)

Government of Canada Radiation Emitting Devices Act and Regulations
These documents deal with the design, construction and function of radiation emitting equipment and are generally used by manufacturers and Authorized Radiation Protection Agencies when doing compliance verifications. The part of the regulations applicable to dental x-ray equipment is reprinted as Appendix VII in Safety Code 30 (available online)

Canadian Standards Association CAN/CSA-Z386-14 Safe Use of Lasers in Health Care Facilities
The Alberta Dental Association and College has adopted the use of this standard. Information is provided in Section E, Dental Lasers and Appendix 5.
C. Registration of Designated Radiation Equipment

Any regulated member of the Alberta Dental Association and College that owns designated radiation equipment must register with the Alberta Dental Association and College.

The owner is responsible for:

- proper installation of equipment
- registration and compliance verification/inspection
- operation and maintenance of the equipment
- education of the operators
- maintenance of accompanying software or film processing equipment
- storage of records
- development of a Code of Practice and a Quality Assurance Program
- dosimeter monitoring

1. When to Register

The Alberta Dental Association and College has been delegated the responsibility for registering dental x-ray and laser equipment.

Registration is required in the following situations:

- Installation of equipment or dental laser in a new or existing dental facility regardless of how the equipment or dental laser was obtained (purchased, leased, gifted) or how old the equipment is (new or resale).
- Relocation within the facility or to another facility.
- Modification of the characteristics of the radiation emitted from the equipment or dental laser, or the protective properties of the facility. Note that shielding calculations are based in part on the occupancy of adjacent rooms. If a facility is redesigned and the walls are not altered but the occupancy changes (i.e., storage room becomes waiting room), registration of the equipment is still required.

Cone beam CT equipment must have full manufacturers supported documentation. Equipment may be relocated to another facility only if there is evidence that the manufacturer continues to support the equipment. When installing 2D/cone beam CT (3D) dual-purpose unit, all requirements for shielding for the cone beam CT capability must be met. Significant upgrades and renovations may be required, if replacing an existing unit with a newer unit, or if installing a new cone beam CT unit.

2. How to Register

To register radiation equipment and dental lasers, submit a completed Application for Registration of Designated Radiation Equipment form. The application must be signed by the owner of the facility and a compliance verification report from an Authorized Radiation Protection Agency must be submitted prior to the clinical use of the radiation equipment or dental laser. See Appendix 1 for an Application to Registration form.
If the equipment is located in a large facility such as a university, technical school or hospital; consult with the Occupational Health and Safety staff responsible for designated radiation equipment. Dental x-ray equipment owned by Alberta Health Services are registered to College of Physicians and Surgeons of Alberta. See the registration flowcharts in Appendix 7.

3. Owner Update
The owner(s) of the facility is responsible for ensuring that all obligations under the Radiation Protection Act and Regulations are met. You must advise the Alberta Dental Association and College if the owner(s) of the facility changes.

4. Facility Fee
The facility fee will be assessed on a facility rather than on an equipment basis. A fee will be charged when opening a new facility. To ensure ongoing success of the program a $150.00 facility fee will be assessed every second year.

5. Compliance Verifications
Compliance verifications of x-ray equipment, dental lasers and facilities must be performed by an Authorized Radiation Protection Agency prior to registration.

Verifications ensure that:
- that the facility is in compliance with current legislation
- equipment has been installed correctly and is functioning properly
- shielding has been calculated and installed correctly
- the principle of ALARA has been utilized within the facility design
- patient surface doses are within the limits specified in Safety Code 30
- patients who undergo a particular radiographic procedure receive similar doses regardless of the equipment/operatory used
- evidence that the manufacturer continues to support the equipment and software

The Agencies will be assessing the parameters listed in the checklists. (Appendix 4, Appendix 5 and Appendix 6)

The owner of the equipment is responsible for arranging the compliance verification and forwarding the final report to the Alberta Dental Association and College along with a completed registration application.

To assist the owner with obtaining the services of an Authorized Radiation Protection Agency, a list of these agencies is provided in Appendix 2. Updates to the list may be obtained from the Alberta Dental Association and College website www.abdentists.com or from the Alberta Government website. http://work.alberta.ca/occupational-health-safety/292.html
6. Maintaining Registration
To maintain registration of the equipment, the owner is responsible for:
- A full compliance verification every 5 (five) years after the original registration of the equipment and facility, and
- An annual confirmation of facility registration, including evidence of dosimetry service and management of quality assurance and preventative maintenance.

7. Considerations
Some dental x-ray equipment is not registerable because it does not meet the standards for design, construction or function. Although this is more prevalent with older equipment, particularly 50 and 60 kVp units, it can occur with new equipment if the manufacturer has not ensured that the equipment complies with the federal Radiation Emitting Devices Act and Regulation. Dental radiography must not be performed at tube voltages below 50 kVp and should not be performed at voltages below 60 kVp. Due to their age most x-ray units that are rated at 50 or 60 kVp actually output at less than the specified voltage. It is recommended that x-ray equipment rated at a minimum of 70 kVp be used for dental radiography. Before purchasing equipment it is recommended that a dental supply representative be consulted to ensure that the equipment being purchased complies to all aspects of the Radiation Emitting Devices Act.

8. Personal Dosimetry
Safety Code 30 and the Radiation Protection Regulation of Alberta indicates that radiation workers must wear personal dosimeters. A facility policy on dosimetry must be incorporated into the Code of Practice. A list of currently approved personal dosimetry services is provided in Appendix 3.

Personal dosimetry monitoring:
- All operators of X-ray equipment, together with personnel who routinely participate in radiological procedures must wear personnel dosimeters.
- It is recommended that dentists also wear personnel dosimeters.

It is recommended that dental facilities also have a control badge issued by the Dosimetry Service, to differentiate elevated exposures that may have occurred at the facility from those that may have occurred during shipping of the dosimeter badge.

It is the Radiation Program policy that each dosimeter badge registered within a facility remains at that one facility and is not used or transferred by any means to another facility. If a dentist owns more than one facility, each facility must register, utilize and monitor its own dosimeter badges. A dentist and/or their staff cannot use the badge(s) for multiple facilities.
D. Dental Cone Beam CT

Dental cone beam CT scanners and computer software are capable of providing three-dimensional diagnostic images of hard tissues with lower radiation dose than medical multi-slice CT scanners, when a comparable anatomical volume is imaged. However, such doses may be higher when compared to conventional dental radiography, including panoramic radiography. Radiation doses are dependent on equipment type, exposure settings and especially the field of view selected.

Serious consideration should be given to modifying the field of view, or other exposure factors, such as scan time, so that a reduced and safe radiation dose is the priority while consideration is given to maximizing the diagnostic quality. The scanned volume should only be as large as is required to demonstrate the anatomical area required for diagnosis.

Pediatric size adjusted protocols must be considered. As there is higher risk associated with radiation exposure in children, cone beam CT examination for children should be considered only when the required information cannot be obtained by lower dose radiography. The justification for use of Cone Beam CT over lower dose radiography on patients under the age of 18 years must be fully documented. Wherever pediatric settings are available on the cone beam CT scanner, such as modifying the size of the field of view or scan time, they should be selected.

Cone beam CT scans must not be used as a replacement or substitute for conventional dental radiographic imaging techniques nor used as a routine screening device. Consideration must be given to the use of alternative and conventional imaging techniques. The availability and thoughtful use of conventional imaging devices and techniques, including intra-oral and extra-oral and panoramic tomography, can frequently provide information sufficient to diagnose and guide treatment choices with reduced radiation dosage compared with cone beam CT.

Some cone beam CT units have dual capability as either a cone beam CT unit or as a conventional imaging device (for example: conventional panoramic imaging and cone beam CT imaging). Units with dual capability can be considered as two separate devices when both capabilities are able to function separately.

1. Roles and Responsibilities

It is the dentist’s professional responsibility to have an understanding of the technology including the benefits relative to possible risks of the technology, as well as the diagnostic limitations in scan interpretation. Any dentist acquiring a cone beam CT scan must have a thorough understanding and have completed training for safe working methods and appropriate techniques and procedures. Any dentist interpreting and reporting on a cone beam CT scan must have completed training of approved cone beam CT courses that will allow them to interpret and report on scans limited to the field of view size and level specified in the course. See section F. Educational Requirements.

An individual dentist or several dentists may fulfill one or more of the following roles and responsibilities.
2. Ordering
Any dentist or may order, request or prescribe a cone beam CT scan within their own dental facility, or by referring a patient of record, to another dentist who has a cone beam CT unit or to an Oral and Maxillofacial Radiology Center (as defined by the Alberta Dental Association and College). This request must be done in writing. See section F. Educational Requirements.

Prior to ordering a scan the dentist:
- must review and update the patient medical and surgical history, the clinical information and any supplemental images or previous cone beam scans to confirm that the scan is justified.
- must justify that the results of the scan could change their treatment decision to a degree that the benefits outweigh any risks.
- is responsible to have the education required to understand the limitations of the scan and subsequent report from a qualified individual when that report is used to make treatment decisions.
- is responsible to store the scan results and/or report of the scan in their patient’s record.

The dentist can only assume the responsibilities of Interpreting and Reporting if they meet the educational requirements as stated in section F. Educational Requirements. If the dentist has not completed the approved training for the interpreting and reporting responsibility must be delegated in advance by formal mutual agreement to a third party. (E.g. A Medical or Oral and Maxillofacial Radiologist or an individual appropriately trained and authorized by the Alberta Dental Association and College to fulfill this role.)

3. Acquiring
The dentist is ultimately responsible for the image quality and appropriateness of the scan and data volume. They must follow the accepted principles and are responsible for selecting imaging protocols, acquiring the scan and data volume and for providing hard and/or electronic copies of the scan and data volume in a format suitable for reviewing, interpreting, reporting and archiving. The dentist must ensure the retention of the records according to the Alberta Dental Association and College Standard of Practice. The dentist must maintain the original software for the equipment for at least 5 years.

The dentist can only assume the responsibilities of Interpreting and Reporting if they meet the educational requirements as stated in section F. Educational Requirements. If the dentist has not completed the approved training for interpreting and reporting responsibility must be delegated in advance by formal mutual agreement to a third party. (E.g. A Medical or Oral and Maxillofacial Radiologist or a dentist appropriately trained and authorized by the Alberta Dental Association and College to fulfill this role.)

Prior to acquiring a scan the dentist:
- If the patient was referred for a scan the dentist:
  - must review the referral form, the patient medical history, the clinical information and the supplied supplemental images or previous cone beam scans to confirm that the scan is justified.
  - must contact the Ordering Dentist for clarification if a patient arrives without appropriate
referral information.
  o If the dentist declines the acquisition of a cone beam CT scan, the dentist must communicate this decision and the reasons for declining the scan to the Ordering Dentist.
  
- Should inform the patient that a cone beam CT scan data could be potentially used for evaluating additional areas, by the same dentist or by other dentists, or medical professionals involved in the patient’s care.
- The patient should be made aware that the data is stored by the acquiring dentist and could be provided to other dentists or medical professionals involved in the patient’s care in the future, upon request.
- Obtain informed consent from the patient and note it in the chart.
- Ensure proper function of the cone beam CT equipment
- Have the education to understand the operational parameters of the equipment.
- Ensure the unit operator has the proper education to perform the scan.
- Be available for consultation while the scan is being acquired, either on site or by telephone.

**After acquiring the scan the dentist:**

- Must systematically review the cone beam CT scan and the entire data volume acquired to confirm that the entire image is of acceptable diagnostic quality and to confirm the acquired image’s appropriateness to the indication for the scan. This requirement is distinct and separate from the responsibilities related to the interpreting and reporting of the scan and data volume.
- The dentist should be willing to and able to provide the scan data to other dentists or medical professionals for potential evaluation of other areas of interest. The scan data should be provided in the requested format such as DICOM files, or a viewer.
- If the dentist has not completed the approved training to interpret and report on the scan they must send the scan and complete patient information to a third party for review. (E.g. A Medical or Oral and Maxillofacial Radiologist or a dentist appropriately trained and authorized by the Alberta Dental Association and College to fulfill this role.)

**Field of View and Collimation**

Field of views can vary from a few centimeters in height and diameter to a full head reconstruction. Some cone beam CT units offer the option to collimate the beam to the minimum size needed to image the area of interest. The size of the field of view is associated with radiation dose to the patient and the staff. The larger the field of view, the greater the amount of radiation exposed.

For the purposes of this document there are two classifications of field of view defined.

1. Small and medium field of view - 10 centimeters or less – Dentoalveolar cone beam CT scan a small field of view must only be used for imaging the teeth, their supporting structures, the mandible and the maxilla, excluding the temporomandibular joint and the base of the skull.

2. Large field of view – over 10 centimeters – Craniofacial cone beam CT scan. In addition to dento-alveolar structures, a large field of view may include intracranial structures, the base of the skull, the temporomandibular joint, the paranasal sinuses, the craniovertebral junction, the cervical spine, the neck and the airway spaces.
Some cone beam CT scanners offer a range of fields of view, while others may be limited to a fixed field of view. The appropriate field of view must be selected for the specific area of interest.

**Data Formatting**

Data should be exportable in a format compatible with the International Standards Organization (ISO) referenced Digital Imaging and Communications in Medicine (DICOM) Standard. 
http://dicom.nema.org/

Cone beam CT images should display:
- Patients name and ULI number
- Date of scan
- Location of scan
- Type of machine used
- mA’s used
- kVp used
- Slice thickness

**Data Storage and Retention of Records**

The data volumes that are generated must be kept for the period of time that is stipulated by the Alberta Dental Association and College Standard of Practice: Patient Records for record retention as this data is part of the patient record. Storage and transfer of this data is must comply with the Alberta Health Information Act.

**4. Interpreting and Reporting**

The dentist must have completed the approved training and be able to examine and systematically review the entire data volume generated by the cone beam CT scan and provide evidence of a review or a formal written report about the data volumes generated. Excluding the technical procedures required to acquire and store the scan and data and to transcribe a report, no part of this process may be delegated to staff.

The review and any findings (incidental or significant) determined from the review must be documented in the patient’s record and included in the formal report to the Ordering and Acquiring Dentists involved in the process. It is acceptable for the dentist undertaking the review to comment and record upon unusual, abnormal and positive findings.

If there is any uncertainty regarding the findings derived from the review and the interpretation of a scan further review and/or consultation with an Oral and Maxillofacial Radiologist, Medical Radiologist, or other experienced and qualified health professional, as approved by the Alberta Dental Association and College, should be obtained.

When there are urgent concerns about some of the findings in the clinical volume, these must be communicated immediately by telephone if possible to the ordering dentist. Direct or attempted direct communication with ordering dentist must be documented.
Any discrepancy between a preliminary report and the final written report must be directly communicated to the Ordering and/or the Acquiring Dentist.

The formal written report must include the following information:

- The Ordering Dentist’s name and contact information (Address, telephone number, fax number, email address, practitioner number);
- The Acquiring Dentist’s name and contact information (Address, telephone number, fax number, email address, practitioner number);
- Names and contact information of any other dentists, physicians or other third parties that, by patient consent, are to receive copies of the scan and data volume and/or the interpretation and report of the scan;
- Patient’s name and contact information (address, telephone numbers and other contact information as needed);
- Patient’s birth date, age and gender;
- Indications for the scan being requested;
- Brief medical and surgical history;
- Case history, provisional diagnosis and/or proposed treatment;
- A description of the anatomical area that was imaged by the scan;
- Any limitation or technical factors, such as patient movement or metallic artifacts;
- The reasons for taking additional radiographs if taken;
- The findings, using precise anatomical and radiological terminology;
- Any patient clinical issues raised in the request for the scan;
- Comparative information with previous radiographs and/or other images;
- A precise diagnosis whenever possible;
- A differential diagnosis when appropriate;
- Recommendations for any advised follow-up and/or any additional diagnostic imaging studies to clarify the findings of the original cone beam CT volume where indicated;
- Incidental findings and recommendations;
- A conclusion section, unless the cone beam CT scan is being compared with other recent radiographs and/or images and no changes have occurred during the intervals or the body of the report is brief; and
- The type of the cone beam CT machine used and its serial number.
E. Dental Lasers

Under the Alberta Radiation Protection Act, Class 3b or Class 4 lasers that are not enclosed within a laser system with a lower classification must be registered with the Alberta Dental Association and College and have compliance verification by Authorized Radiation Protection Agency for compliance with safety standards.

- Class 3b lasers are those that have a power output between 5mW and 500mW.
- Class 4 lasers are those that have the power output greater than 500mW.

Prior to the procedure, patients should be provided with brochures or other illustrative materials explaining the laser procedure to be performed, the steps involved during the procedure, and pre- and post-treatment instructions. Patients shall be provided with information describing the risks associated with the laser procedure and the patient protective measures that will be taken. This should be documented in the patient’s record.

The dentist shall ensure that a laser safety program is established and maintained in accordance with applicable standards, regulations, and professional guidelines. Policies and procedures shall be reviewed yearly and revised as necessary to follow recent standards.

The development and revision/updating of laser safety procedures shall be performed by personnel directly involved in laser use and operation, with final approval by the dentist.

General Safety and Responsibility

- assure that all lasers and laser systems have been labeled by the manufacturer to indicate the appropriate hazard classification
- ensure that the product is properly classified and that the correct classification label is affixed (if this classification or label is not available or the system has been modified)
- ensure that a hazard evaluation of the laser treatment controlled area has been performed prior to laser operation.
- immediately inform the user of imminent danger from a laser hazard
- ensure that control measures are in effect; and periodically evaluate the effectiveness of the selected controls.
- establish and enforce standard operating procedures
- ensure that protective equipment is available, in good working order and is used correctly.
- ensure that the wording on area signs and equipment labels are accurate and appropriate
- conduct hazard evaluations of modifications to existing facilities or laser equipment
- ensure that maintenance and service is carried out by qualified personnel
- ensure that appropriate safety education and training is provided to all personnel associated with lasers
- provide safety instructions, which shall be incorporated into the standard operating procedure for the laser (if manufacturer’s labeling safety information does not exist and cannot be obtained from the manufacturer or the distributor of the laser system)
- maintain necessary records
Warning signs posted in the vicinity of the laser-controlled area shall:

- identify the laser-controlled area;
- establish the nature of the hazard by specifying the wavelength and class of laser being used;
- be posted on all means of access to the area;
- only be posted or illuminated when the system is powered on or in standby; and
- indicate that protective eyewear shall be worn.

The dentist shall ensure that a maintenance program for health care lasers is in place and that personnel are appropriately qualified, whether in-house services or contracted services are used.

Training programs shall be evaluated by the dentist for applicability to the facility’s practice. Successful completion of the program for all personnel responsible for working with lasers shall be documented.

**Non-Hospital Environment**

Section 1.4 of Z-386-08 “Laser Safety in Health Care Facilities” published by the Canadian Standards Association

Health Care Laser Systems (HCLs) may be used in a variety of non-hospital environments. The requirements and principles of the safe use of HCLs in these settings are no less stringent than when the same systems are used in large institutional settings such as hospitals.

It is the responsibility of the user in the non-hospital environment to be aware of the requirements for safe use. The individual user shall be responsible for all the requirements of safe use contained in this document. Therefore, this professional user assumes the administrative responsibilities of the Laser Safety Officer (LSO) and ensures that all regulations are met and that non-governmental controls are in place. This means that he or she should be trained in laser safety and be knowledgeable about applicable regulations, advisory standards, and professional recommended practices. The user is responsible for, among others, the physical facility and its signs, proper use of protective eyewear and other safety measures, both for protection of the patient, or others who may be potentially exposed to hazards associated with the laser use. This individual is also responsible for overseeing maintenance and other practices required for safe operation of the health care laser system or systems that the user employs. If needed, the user should consult a safety expert, a consultant, or other sources regarding safety related issues such as site assessment, hazard evaluation, problem solving, or compliance enforcement.

**Definitions:**

**Health Care Laser System (HCLS):** A laser system used in health care applications. The HCLS includes the laser or lasers, a delivery system to direct the output of the laser, a power supply with control and calibration functions, mechanical housing with interlocks, and associated liquids and gases required for the operation of the laser.

**Laser User:** A person who is using the laser for its intended purpose within the user’s scope of practice, training and experience. Also termed laser surgeon when appropriate.
Laser Safety Officer (LSO): The laser safety officer (LSO) is the person responsible for the laser safety program in the facility. This individual has the training and experience to administer a laser safety program. The LSO is authorized by the administration and is responsible for monitoring and overseeing the control of laser hazards.

Maintenance: Performance of those adjustments or procedures specified in user information provided by the manufacturer with the laser or laser system, which is to be performed by the user to ensure the intended performance of the product.

In accordance with CAN/CSA-Z386-14 “Safe Use of Lasers in Health Care Facilities” Published by the Canadian Standards Association. CSA-Z-386-14 “Safe Use of Lasers in Health Care Facilities” is available from:

Canadian Standards Association
5060 Spectrum Way, Suite 100
Mississauga, Ontario L4W 5N6
Tel: 1-800-463-6727
E-mail: sales@csa.ca
Website: www.csa.ca

For more information about laser safety in health care facilities.
www.ccohs.ca/oshanswers/phys_agents/lasers.html
F. Educational Requirements

All dentists, dental hygienists and dental assistants operating ionizing radiation equipment shall be knowledgeable about the operational parameters of the equipment and their influence on radiation dose and image quality.

1. Dental X-ray Equipment
The equipment operator must have a thorough understanding and have completed training for safe working methods and appropriate techniques and procedures. It is also acceptable to send staff to training facilities that offer training for the equipment that has been installed or modified. This training must be documented.

2. Dental Lasers
Dental laser operators must complete training in the safe operation of the equipment at the time of purchase/installation. New dentists and staff, who join the facility after the installation and initial training, must receive similar training. It is also acceptable to send this staff to training facilities that offer dental laser training for the equipment that has been purchase/installed. This training must be documented.

3. Cone Beam CT Equipment
Any dentist registered with the Alberta Dental Association and College may order a cone beam CT scan. It is their professional responsibility to have an understanding of the technology that includes: the benefits relative to possible risks of the technology as well as the diagnostic limitations in scan interpretation. It is recommended that cone beam CT continuing education in this area be documented when an ordered scan is to be used for treatment decisions.

Dentists registered in Alberta may submit, to the Alberta Dental Association and College, prior education for consideration of equivalency and qualification for any of the categories listed below.

a) Dentist Education - Acquiring, Interpreting and Reporting
   i. Cone Beam CT Unit Specific Education
      Any dentist acquiring a cone beam CT scan must have a thorough understanding and have completed training for safe working methods and appropriate techniques and procedures at the time of installation of the specific cone beam CT unit. New dentists who join the facility and who will be ordering and acquiring images after the installation and initial training, must receive similar on site training. It is also acceptable to attend training facilities that offer cone beam CT training for the equipment that has been installed. This training must be documented.
ii. Acquiring, Interpreting and Reporting Education

In addition to the cone beam CT unit specific education the acquiring, interpreting or reporting dentist also requires the following education.

Small and medium field of view: 10 centimeters or less Dentoalveolar cone beam CT
A small field of view used for imaging the teeth, their supporting structures, the mandible and the maxilla. Successful completion of an approved course of instruction, with examination, will allow the dentist to acquire, interpret, and report on scans limited to this size.

Alberta Dental Association and College approved qualification programs and continuing education specific to this category are:
- University of Alberta small field of View 3-day course with examination.
- University of Toronto small field of view course with examination.
- Appropriate and Alberta Dental Association and College approved University didactic program for undergraduate or post graduate dental students.

Large field of view – over 10 centimeters - Craniofacial cone beam CT scan
LEVEL 1, Acquiring images only for Large Field of View Craniofacial
In addition to dentoalveolar structures, a large field of view may include intracranial structures, the base of the skull, the temporomandibular joint, the paranasal sinuses, the craniovertebral junction, the cervical spine, the neck and the airway spaces.

Successful completion of an approved course of instruction at this level only allows the acquisition of scans of this size. All images must be interpreted and reported on by a more qualified dentist (see LEVEL 2).

Alberta Dental Association and College approved qualification programs and continuing education specific to this category are listed below.
- University of Alberta course under development
- Appropriate and Alberta Dental Association and College approved University didactic programs for undergraduate or post graduate dental students.

Large field of view – over 10 centimeters - Craniofacial cone beam CT scan
LEVEL 2, Reviewing, interpreting and reporting Large Field of View Craniofacial
In addition to the requirements of Level 1 Large field of view over 10 centimeters, additional craniofacial course(s) of instruction which cover interpretation of craniofacial cone beam CT curriculum. Successful completion of an approved course of instruction, with examination, will allow the dentist to acquire, interpret, and report on scans of this size.

Alberta Dental Association and College approved qualification programs and continuing education specific to this category are listed below.
- University of Alberta program under development
- Appropriate and Alberta Dental Association and College approved University didactic programs for undergraduate or post graduate dental students.
b) **Qualifications of Staff**

The dentist must ensure that any staff member operating a cone beam CT unit is appropriately trained. The staff member must be adequately qualified by registration or licensure, have a thorough understanding and completed training for safe working methods and appropriate techniques and procedures with minimal supervision. Supervision is defined as having the ability to consult with the dentist either onsite or by phone.

The Alberta Dental Association and College recommend the following minimum staff educational requirements in addition to the on site training specific to the cone beam CT unit to be used:

Successful completion of a course, at least 1 day’s duration, in the operation of a cone beam CT scanner. The curriculum should include theoretical, practical and practice components, radiation physics and protection, patient positioning, selection of parameters based on established protocols and image processing. A certificate or other evidence of satisfactory completion of the course, as well as a description of the program, signed by the course director should be available for review. An appropriate cone beam CT training facility program, university program or the training provided by the equipment manufacturer is sufficient.

c) **Continuing Education**

All dentists and staff members that operate cone beam CT equipment shall include courses and/or other educational programs related to the ordering, acquiring, interpreting and reporting of cone beam CT scans in their personal continuing education. Continuing education should be documented.
G. Code of Practice

The owner or employer is responsible for having available a code of practice to provide information to workers and other persons concerning the safe operation of radiation facilities and radiation equipment. The written code of practice addresses the following:

1. Management Responsibilities
   - General obligation
   - Informing staff
   - Radiation worker competency
   - Maintenance of radiation equipment
   - Radiation exposure limits*
   - Notice of incidents and overexposures

2. Radiation Worker Responsibilities
   - General obligation
   - Protective clothing and devices
   - Holding of patients and film
   - Pregnant radiation workers
   - Operation of non-compliant equipment

3. Protection of the Patient
   - Surface dose
   - Gonadal shielding
   - Radiography below 50/60 kVp
   - Collimation
   - Repeat exposures
   - Radiography of women of reproductive capacity
   - Radiography of pregnant patients
4. Suggested Code of Practice for Dental X-Ray Facilities
This section can be used as is or modified to suit the needs of the dental facility.

a) Management Responsibilities

i. General Obligation
The dental facility is committed to a radiation health and safety program that protects staff, patients, public and property. Management takes all reasonable precautions to protect persons from radiation injury and provides leadership in the radiation health and safety program.

All Facility owners, dentists or non dentists, all support staff, all managerial staff and anyone involved in the procurement, installation, maintenance, and operation of radiation equipment must be knowledgeable in issues relating to the operation the unit, must be aware of the Alberta Radiation Protection Act and Regulation and the Alberta Health Information Act governing the transferring of patient health information.

All staff must undergo initial training. An ongoing training schedule must also be developed to accommodate changes in the units operation and maintain consistency of the operators over time.

ii. Informing Staff
The owner informs staff, who is likely to be exposed to radiation, of the potential hazards of the radiation and the precautions to be taken to protect themselves and other persons from the hazards.

Information includes:
- the worker’s responsibilities and duties under the Radiation Protection Act and the regulations;
- the type of radiation source the worker will be working with;
- radiation protection principles and maximum exposure limits appropriate to the type of radiation;
- the uses and limitations of the radiation facility, equipment, and source; and
- known or suspected health hazards associated with the form of radiation emitted by the radiation source.

iii. Radiation Worker Competency
All tasks which involve the use or operation of radiation equipment must be performed by competent radiation workers.

A competent radiation worker is an individual who is adequately qualified by registration or licensure, suitably trained and sufficiently experienced to perform safely the assigned task without supervision, or with minimal supervision.
iv. Maintenance of Radiation Equipment
The owner maintains all radiation equipment in a condition that will not endanger the health or safety of persons operating or affected by the operation of the equipment, and a preventive maintenance program is required.

v. Radiation Exposure Limits
The owner takes all reasonable precautions to ensure the radiation exposure of persons is kept as low as reasonably achievable and the maximum exposure limits described in Tables 4A and Table 4B are not exceeded. Reasonable precautions would include Sections 8 and 9 of Safety Code 30. www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm177/index-eng.php

vi. Notice of Incidents and Overexposures
The Alberta Dental Association and College must be notified of any overexposures or incidents that have the potential of causing an overexposure. Therefore, it is important that staff inform the owner immediately of any such incidents and that the incidents be recorded including resolutions in the facility radiation manual.

b) Radiation Worker Responsibilities

i. General Obligation
Radiation workers are responsible for following all procedures, working with an awareness of radiation health and safety and cooperating in working towards improved radiation health and safety conditions at work. Radiation workers will take all reasonable precautions to ensure their own safety and the safety of their colleagues and maintain their knowledge by appropriate continuing education.

ii. Protective Clothing and Devices
Operators should remain in the control booth area or behind a shielded wall, however, if this is impractical, protective lead aprons, gloves, eye protection and personal dosimeters must be worn.

iii. Holding of Patients
It is generally not necessary to hold patients for radiographic examinations, however, should the need arise, the following guidelines should be used.

- Holding devices should be used to support children or weak patients.
- Parents or escorts who assist with supporting patients must be provided with lead aprons and be positioned so they are not in the primary beam. It is essential to check with females of childbearing age regarding the likelihood of pregnancy. If they suspect that they may be pregnant, they must not assist with the exam. If follow-up visits are necessary, the same person should not assist each time.
iv. **Holding of Film**
Intraoral films should be held in place by film holding devices. If this is not possible, the patient should be instructed as to how to hold the film in place.

Cassettes for extraoral radiography should be placed in a cassette holding device. If the cassette must be hand held to obtain specific views, the patient must hold it in place.

The x-ray tube housing should not, under any circumstances, be held by the operator to prevent it from moving during the x-ray exposure.

v. **Pregnant Radiation Workers**
Pregnant radiation workers must inform the owner as soon as they are aware of the pregnancy. This will assist the owner in ensuring that radiation exposure to the fetus does not exceed the limit specified in Table 4A.

vi. **Operation of Non-Compliant Equipment**
A radiation worker must not operate equipment which is in a condition that will endanger the health or safety of themselves or others. If such equipment is under her control she must notify the owner immediately.

c) **Protection of the Patient**

i. **Surface Exposure**
Upper and lower surface exposure limits are provided in Table 4B.

ii. **Gonadal Shielding**
All patients are to be provided with a lead apron for the purpose of gonadal shielding.

Thyroid shielding is provided where practical.

In the case of Panoramic Radiography, where the source of radiation is behind the patient, dual (front and back) aprons or a wrap-around style apron is to be used.

iii. **Radiography Below 50/60 kVp**
Dental radiography must not be performed at tube voltages below 50 kVp and should not be performed at voltages below 60 kVp.

iv. **Under no circumstances should the patient hold the x-ray tube housing to prevent it from moving**

v. **Collimation Limits for Equipment with Adjustable Collimation**
The film size used should be as small as possible to adequately visualize the area of interest and the maximum size of the beam limited to the film size.
It is desirable to see unexposed areas along the edge of the finished radiograph (i.e., cone marks) to indicate that collimation of the beam has been accomplished. Caution must be taken so that areas of diagnostic information are not obliterated through the practice of excessive collimation.

vi. Repeat Exposures
Patient exposure and the need for repeat exposures can be minimized by observing the following factors.

- Use the fastest film speed and the lowest exposures practical for examination requirements and to obtain maximum diagnostic information.
- Exposure charts are posted by each piece of equipment to ensure consistency of exposure factors. It is recognized that these exposure factors may be varied according to patient condition and the presence of pathological entities.
- Regular maintenance checks are conducted to make certain that equipment is correctly calibrated and output is within acceptable limits.
- Ensure that optimal film processing conditions exist by performing daily sensitometric analysis and by conducting regular cleaning and maintenance checks on automatic processors.
- Determine when the last radiographic examination took place. Further examinations may be unnecessary or an abbreviated examination to provide supplementary radiographs may be adequate.
- The lowest number of radiographs that will provide the required diagnostic information are taken.
- In cases where patients are referred to or choose to be seen by a different dentist, previous radiographs should be sent to this dentist to avoid duplicate examinations.
- A Repeat-Reject Analysis is conducted monthly on all discarded films to monitor problem areas. (5% limit, see page 29.)
- Radiographs are not repeated because they are not of the “best diagnostic quality.” If these radiographs contain the required diagnostic information; they will not be repeated.

vii. Radiography of Women of Reproductive Capacity
Operators of x-ray equipment should be aware of the effects of fetal exposure especially in the early stages of pregnancy when the patient may not be aware that she is pregnant.

If the patient believes that she may be pregnant, and the radiograph is elective, it should be possible to defer the examination until the patient can confirm whether she is pregnant or not.

Lead shielding should be provided for the patients in all instances.
viii. Radiography of Pregnant Patients
   Efforts should be made to avoid unnecessary irradiation of women who are or suspect that they may be pregnant. This is of particular importance during the earliest stages of pregnancy when the potential for damage is the greatest.

   If radiological assessment is necessary for diagnosis of an urgent condition, it is performed even though the patient is pregnant.

   Correct practice of radiation protection techniques such as providing lead apron shielding, as well as precise alignment of the x-ray beam with the patient’s head will reduce the fetal dose to an accepted minimum level that will not be a significant hazard. Correct alignment of the x-ray beam should ensure that the beam is not directed at the patient’s abdomen.

d) Table 4A - Annual Exposure Limits of Ionizing Radiation to Radiation Workers and the Public

Alberta Radiation Protection Regulation Schedule 1, Table 1.

MAXIMUM EFFECTIVE DOSE LIMITS FOR IONIZING RADIATION

<table>
<thead>
<tr>
<th>Person</th>
<th>Exposure Period</th>
<th>Effective Dose Limit (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation Worker</td>
<td>One year</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Rolling 5 calendar year</td>
<td>100</td>
</tr>
<tr>
<td>Pregnant radiation worker</td>
<td>Balance of pregnancy after informing employer in accordance with section 5(1)</td>
<td>4</td>
</tr>
<tr>
<td>Student undergoing course of instruction involving the use of ionizing designated radiation equipment</td>
<td>One year</td>
<td>1</td>
</tr>
<tr>
<td>Person who is not a radiation worker</td>
<td>One year</td>
<td>1</td>
</tr>
</tbody>
</table>

The millisievert (mSv) is the International System (metric) version for dose equivalent. Companies who provide dosimetry services should provide results in mSv.
e) Table 4B – Acceptable Surface Exposure Ranges for D and E Speed Film per Bitewing or Periapical Examination

A patient surface exposure greater than the upper limit specified for the film and kilovoltage is an indication of poor film processing techniques or sub-standard equipment performance. The lower limits indicate the point where any gain in exposure reduction may be reflected by a loss of diagnostic quality of the film. This table is provided for guidance and are not regulatory limits. This table is found in Safety Code 30, page 41, table 4.

<table>
<thead>
<tr>
<th>Operating Kilovoltage</th>
<th>D Speed Dose Range (milligray)</th>
<th>E Speed Dose Range (milligray)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>2.79 to 4.15</td>
<td>1.48 to 1.92</td>
</tr>
<tr>
<td>65</td>
<td>2.36 to 3.62</td>
<td>1.27 to 1.66</td>
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<tr>
<td>70</td>
<td>2.01 to 3.14</td>
<td>1.09 to 1.44</td>
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<tr>
<td>75</td>
<td>1.57 to 2.66</td>
<td>0.87 to 1.18</td>
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<tr>
<td>80</td>
<td>1.40 to 2.27</td>
<td>0.74 to 1.00</td>
</tr>
<tr>
<td>85</td>
<td>1.22 to 2.01</td>
<td>0.70 to 0.92</td>
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<tr>
<td>90</td>
<td>1.05 to 1.83</td>
<td>0.61 to 0.83</td>
</tr>
<tr>
<td>95</td>
<td>0.87 to 1.70</td>
<td>0.52 to 0.74</td>
</tr>
<tr>
<td>100</td>
<td>0.79 to 1.57</td>
<td>0.44 to 0.61</td>
</tr>
</tbody>
</table>

The milligray (mGy) is the International System (metric) version of the milliroentgen (mR).

\[ 1 \text{ mGy} = 100 \text{mR} = 1 \text{mSv} \]
H. Quality Assurance Program

The Radiation Protection Act RSA 2000 requires that an owner of a diagnostic facility establish and implement a Quality Assurance Program.

Quality Assurance is defined as the planned and organized actions necessary to provide adequate confidence that dental x-ray equipment will produce quality radiographs reliably with minimal radiation to patients and staff. Quality Assurance includes quality control procedures for the monitoring and testing of x-ray emitting and film processing equipment, regular preventative maintenance and calibration, and administrative methodology to ensure that monitoring, evaluation and corrective actions are properly performed.

The goals of Quality Assurance Program are to provide accurate and timely diagnosis while minimizing radiation exposure to the patient, staff and public.

1. Summary of Quality Control Procedures

The types of quality control procedures summarized in this document are minimum standards. Owners who are performing additional tests are encouraged to continue to do so. The frequency of the procedures may vary depending on manufacturer’ recommendations, problems encountered etc.

Procedures and sample forms are included in this section, however, the dental facility may prefer to develop its own or use other available forms. Some dental service companies sell Quality Assurance Manuals which contain such items as a thermometer, a monitoring device, forms, information booklet and videos.

2. Preventative Maintenance

The Alberta Radiation Protection Act Section 14.2(b) requires that an owner establish regular preventative maintenance for the equipment.

This consists of regularly scheduled procedures to assess radiation and processing equipment and correct faults where necessary. Some of the procedures may be performed by dental facility staff whereas others may need to be completed by qualified service personnel. It is of utmost importance that the individual responsible for completing these procedures notifies the dentist (s) and operators immediately if problems exist.
3. Quality Assurance Tests-FILM

Daily Procedures
- Measure developer temperature
- Evaluate image quality
- Replenish chemicals as required

Weekly Procedures
- Clean cross over racks (automatic processors)
- Change processing solutions and clean processor solution tanks. This may be performed at time intervals specified by the manufacturer or as the dental monitoring device results indicate.
- Inspect intensifying screens and cassettes for artifacts and/or defects
- Exposure normalization

Monthly Procedures
- Check processing solution replenishment rates (for processors with automatic replenisher)
- Repeat/reject analysis

Annual Procedures
- Perform safelight tests and check for light leaks where applicable. These checks should also be carried out immediately when a safelight problem is suspected as causing film fogging.
- Check film screen contact where applicable
- Clean intensifying screens and cassettes with manufacturer recommended screen cleaner where applicable. This cleaning may be required every four to six weeks depending on artifacts seen and workload.
- Check cassettes, including the hinges and locking mechanisms for signs of wear, damage or misalignment of the front and back halves of the cassette.

Quality Control Equipment Needed
- A non-mercury thermometer
- An alarmed timer if using a manual film processor
- A Dental Radiographic Normalizing and Monitoring Device available from dental suppliers or the manufacturer – Xray Quality Control. P.O. Box 5216, Vail, CO, USA 81658, (970) 470-0859, www.xrayqc.com
- Manufacturer recommended screen cleaner for those using film screen cassettes
- Film/screen contact mesh for those using flat cassettes and performing their own film screen contact test
4. Preventative Maintenance
The following procedures should be considered for all radiation equipment.

Daily Procedures
Assess the functioning of:
- kVp meter for equipment with adjustable kV
- mA meter for equipment with adjustable mA
- mAs meter for equipment with adjustable mAs
- exposure indicators
- deadman timer
- tube movement and stability

Annual Procedures
- Clean interior of view boxes
- Check mechanical operation of all moving parts
- Examine integrity of all electrical cables
- Check operation of interlocks where applicable
- Check condition of protective clothing and thyroid shields

Considerations:
If the owner has the equipment calibrated it is important to ensure quality service.
- Ask the service company about its training programs for service personnel. Most manufacturers of equipment offer factory training courses.
- Ensure the service personnel are qualified to work on the type of units installed in the facility
- Ensure the reports state numerical results not just check marks
- Discuss the results and control limits with the service personnel
5. Image Quality Evaluation

What it means
This test utilizes a Dental Radiographic Normalizing and Monitoring Device to compare the density of a test film to a standard density strip. This is generally considered a test of the processor and darkroom conditions since only one film from one unit is being tested. It does not assess the image quality of all units nor will it indicate a problem with any of the units not tested. Providing the unit is functioning properly and remains stable, any change in the density on a given day is probably due to problems with the processing conditions. If the test film is outside the limits, review processing conditions first, then consider the possibility of a problem with the unit used to expose the test film.

Why is it done
To ensure on a day-to-day basis that optimum processing conditions exist.

How to implement it
As with all quality control procedures, standardization is extremely important. Staff responsible for performing this and other quality control tests should standardize the procedures and eliminate as many variables as possible. The more variables introduced into the procedure the more difficult it is to establish whether a problem really exists and if it does exist what is causing it.

The recommended frequency of performing this test is daily. If results demonstrate the processing conditions are continually within the limits the frequency might be changed to weekly. However, if problems are identified or the processor or x-ray equipment has been recently serviced it is recommended the frequency revert back to daily to once again establish consistency.

The test should be performed before the first patient radiograph is taken for the day or at the very least before the first radiograph is processed (for those doing batch processing). If the test film density is outside the limits corrective action can be taken.

Procedure:
1. Replenish processing solutions following manufacturer’s recommendations.
2. Measure and record the developer temperature.
3. Expose an intraoral film in the monitoring device using the facility’s most reliable intraoral x-ray unit (generally the newest unit). If the units are equally reliable choose one to use on a regular basis. Rotating the test through all the units adds a variable - is the change in density due to the processor or due to differences in the units?
4. Process the film and insert it into the film slot on the monitoring device.
5. Place the device on a view box and slide the film strip along until one of the density steps matches the density of the test film. Do not eye-ball it by holding the monitoring device up to the room light.

6. If the density of the test film is comparable to the mid-range step of the density strip in the monitoring device or one density step above or below, the processing conditions are acceptable.

7. If the density of the test film is outside the limits corrective action is needed. Some dental monitoring devices come with a troubleshooting guide which can assist with determining the corrective action needed.

8. Repeat steps 3-7 to ensure the corrective action brought the density into mid-range.

9. Record density steps and corrective actions.

**Considerations:**
Normally the developer is rapidly oxidized, resulting in a continual decline of chemical activity with subsequent drops in the density levels, as well as changes in contrast. Poor processing conditions will increase patient and staff radiation exposure. The chemicals need to be replenished and changed regularly to avoid this (see Sample Image Quality Record).
SAMPLE DEVELOPER TEMPERATURE RECORD

MONTH: __________

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DATE | CORRECTIVE ACTION TAKEN
-----|----------------------------------------------------


SAMPLE DAILY/WEEKLY IMAGE QUALITY RECORD

MONTH: ________________

Unit: ________________

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<th>MONTH</th>
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<th>Limit</th>
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DAYS

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Alberta Dental Association and College
Guide for Radiation Health and Safety Program
SAMPLE DAILY/WEEKLY IMAGE QUALITY RECORD

MONTH: ____________
Unit: ______________

Note: Deterioration of developer activity is apparent when chemicals are not changed.

SAMPLE DAILY/WEEKLY IMAGE QUALITY RECORD

MONTH: ____________
Unit: ______________

Chemicals changed
Excessive variability eliminated
**SAMPLE DARKROOM PROCESSING RECORD CHART**

*Date and Initial When Completed*

<table>
<thead>
<tr>
<th>Developer Change</th>
<th>Fixer Changed</th>
<th>Processor Tank Cleaned</th>
<th>Screens/Cassettes Tested</th>
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</thead>
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</table>
6. Exposure Normalization

What it means
This test utilizes the same device described under Image Quality Evaluation. However, it provides a comparison of the image qualities of all x-ray units of a similar type (ie. intraoral). Optimally when the results are recorded the outcome should be a straight horizontal line indicating that all units deliver comparable radiation (see Sample Exposure Normalization Record).

Why is it done
To ensure that each x-ray unit is delivering comparable radiation exposures for common examinations.

How to implement it
Exposure normalization of x-ray equipment is recommended weekly, when problems arise associated with the output from a particular unit or after the x-ray equipment has been calibrated. If results demonstrate the units are continually delivering comparable radiation the frequency might be changed to monthly.

Procedure:
1. Start with fresh chemicals in a clean processor.
2. Measure the temperature of the processing chemicals and adjust the processing time and/or temperature as necessary.
3. Expose an intraoral film in the monitoring device as per instructions.
4. Repeat #3 for each piece of x-ray equipment. Ensure that each film is identified by the x-ray tube with which it was exposed.
5. Develop the films at same time using optimized developing technique.
6. Compare each test film using the monitoring device. Each film should have a density comparable to the mid-range.
7. If the density of a test film is outside the limits corrective action is needed.
8. Repeat steps 3-7 to ensure the corrective action brought the density into mid-range.
9. Ensure all densities are comparable. Record density steps and corrective action. The enclosed sample charts can be used for up to ten units each.
SAMPLE EXPOSURE NORMALIZATION RECORDS

DATE: ____________________

Note: All units deliver comparable radiation exposure.

CORRECTIVE ACTION


SAMPLE EXPOSURE NORMALIZATION RECORDS

DATE: ____________________

Note: Patients exposed with Unit 2 are receiving higher radiation exposure.

CORRECTIVE ACTION


Alberta Dental Association and College
Guide for Radiation Health and Safety Program
7. Repeat/Reject Analysis

What it means
Repeat/reject analysis provides an evaluation of rejected and repeated films to determine why they were unacceptable. Rejects include fogged film, clean-up film and unacceptable patient film where no second exposure was required. Repeats are limited to those films which were unacceptable and an additional exposure of the patient was required.

Why is it done
One of the main goals of quality assurance is to reduce the number of films that are rejected and repeated. This cuts down on waste and patient exposure. By analyzing the repeats and rejects staff will obtain valuable information to indicate where quality assurance efforts should be focused.

How to implement it
Establish a method to determine the number of total films used during the month. A tally sheet or the film box labels may be useful. The total films row can be used or film can be further sub-divided as shown on the form.

Procedure:
1. Retain the repeat and reject films in a small container. Once a month categorize and record the totals in the log. Enter the totals of all film used during the month.

2. Calculate the percentage of wasted film

\[
\text{% wasted film} = \frac{\text{repeats} + \text{rejects}}{\text{total films used}} \times 100
\]

3. The percentage of wasted film should not be higher than 5%. If the percentage of wasted film is higher than 5% corrective action should be taken. Examination of the reasons for repeats and rejects will identify the problem area.
## SAMPLE REPEAT/REJECT FILM ANALYSIS

### MONTH OF

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<th>Jan</th>
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<tbody>
<tr>
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### Repeats/Rejects

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<td>Total Repeats</td>
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</tbody>
</table>

% wasted film = repeats + rejects X 100 total films used

### DATE

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<thead>
<tr>
<th></th>
<th>CORRECTIVE ACTION TAKEN</th>
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</tbody>
</table>
8. Safelight and Light Leak Test

What it means
This test checks for sources of light leaks or “unsafe” light as well as the appropriateness of the safelight bulb and integrity of the filter which ensures that the safelight and other sources of unsafe light will not fog film being handled in the darkroom. Fogging can occur as films are packed into cassettes prior to exposure or during processing.

Procedure:
1. Turn off the safelight and other lights in the darkroom.

2. After your eyes have become accustomed to the darkness look for any source of light. Pay particular attention to seals around processors and doors, and suspended ceilings.

3. Expose a sensitized film using a technique that will result in a density comparable to the mid-range step of the monitoring device.

4. Remove the film from the holder and cover half of it with cardboard.

5. Place the partly covered film in the normal position that films are unwrapped and turn on the safelight for two minutes. Process this film in total darkness.

6. When viewing this processed film it is recommended that you place a thin strip of cardboard or opaque tape over the joint between the safelight exposed side and the unexposed side. Eliminating the sharp border significantly changes the perception of the density difference between the two sides.

7. View the film on a viewbox to determine whether or not there is a density difference between the two sides. If there is a noticeable difference corrective action must be taken.
   - Check the film manufacturer’s recommendations for the appropriate safelight and distance of the safelight.
   - Ensure the proper filter is installed correctly in the safelight. Some filters must be placed so that the lettering can be read from the outside.
   - Check the filter for fading, aging, cracking and replace if necessary.
   - Ensure the proper wattage of bulb is being used and that there is no light “leakage” at the edges of the filter and housing.
9. Film Screen Contact

What it means
This test identifies cassettes that have poor film screen contact.

Why is it done
To ensure maximum definition of patient radiographs is obtained.

How to implement it
This test may be performed annually by dental facility staff, although it may be more cost effective for a dental service company to complete the test due to the cost of the film/screen contact mesh.

Procedure:

1. Place the film/screen contact mesh on top of the cassette.

2. Collimate the beam to the cassette size.

3. Radiograph the contact mesh using a technique that will result in a density comparable to step 5 or 6 of the monitoring device. Grossly under- or overexposed radiographs cannot be readily interpreted.

4. View the film on a viewbox at a distance of approximately 2 meters. Areas of poor contact will appear darker than areas of good contact. Large central areas of poor contact indicate the need for corrective action. Areas of poor contact at the periphery of the image may still be within acceptable limits as long as they do not constitute a major part of the diagnostic image in the center of the film. Freshly loaded cassettes may exhibit poor contact because of entrapped air. Wait 10 to 15 minutes after cassette loading before doing a screen contact test.

5. Artifacts from improper film handling during cassette loading may be seen. These may be ignored for the interpretation of contact radiographs but indicate a need to improve film loading techniques.
10. Quality Assurance of Dental and Maxillofacial CBCT Image Quality

The radiation dose from dental and Maxillofacial CBCT investigations is generally higher than from conventional dental radiography. In addition, the digital capture of images is more reliable than using conventional film. For these reasons the performance targets should be set higher.

Subjective image quality ratings and minimum targets for CBCT

<table>
<thead>
<tr>
<th>Quality rating</th>
<th>Basis</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostically acceptable</td>
<td>No errors, or minimal errors in either patient preparation, exposure, positioning or image reconstruction and sufficient image quality to answer the clinical question</td>
<td>Not less than 95%</td>
</tr>
<tr>
<td>Diagnostically Unacceptable</td>
<td>Errors in either patient preparation, exposure, positioning or image reconstruction which render the image diagnostically unacceptable</td>
<td>Not greater than 5%</td>
</tr>
</tbody>
</table>

The quality assurance program would include an image quality analysis to allow comparison of the image quality against these targets. Image quality should be monitored at regular intervals and may be carried out prospectively (as the images are being produced) or retrospectively (as an audit). If the latter is undertaken the interval between audits should not exceed 6 months.

As well as grading each image as either ‘acceptable’ or ‘unacceptable’ it is important that the underlying cause of each unacceptable image is identified and recorded. This allows the operator to initiate appropriate corrective action. Common errors that are seen with CBCT are shown below.

<table>
<thead>
<tr>
<th>Category of error</th>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient preparation with radiographic guides</td>
<td>Failure of radiographic guide to be seated or use of an unstable guide when scanning to assess the alveolus prior to implant placement using a ‘guided’ surgical technique</td>
<td>Radiographic markers are not accurately related to the alveolus leading to errors in planning</td>
</tr>
<tr>
<td>Exposure</td>
<td>Exposure factors used too low</td>
<td>Image may be noisy, pale and lack contrast</td>
</tr>
<tr>
<td>Positioning</td>
<td>Inadequate immobilization used leading to patient movement Patient incorrectly positioned within the machine</td>
<td>Blurred image</td>
</tr>
<tr>
<td>Image Reconstruction</td>
<td>Inappropriate positioning/thickness of ‘panoramic curve’ Inappropriate adjustments to brightness/contrast/thresholds</td>
<td>Failure to detect and fully visualize the complete area under investigation Failure to identify relevant anatomy and disease, particularly small low density structures</td>
</tr>
</tbody>
</table>
11. Quality Assurance Tests (Digital and Conventional)

The following pages are example only. You may chose to use some or all of the quality control procedures listed below. The manufacturers of your specific equipment should be contacted and the routine tests, as suggested by the manufacturers, should be followed.

<table>
<thead>
<tr>
<th>Area</th>
<th>Quality Assurance Procedure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Receptors</td>
<td>Artifact Evaluation (pg 35 + 38)</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Cleaning</td>
<td>AR</td>
</tr>
<tr>
<td>Repeat Analysis</td>
<td>(pg 29 + 54)</td>
<td>AR</td>
</tr>
<tr>
<td>X-Ray Equipment</td>
<td>Visual Inspection (pg 39)</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Safety &amp; Preventive Maintenance (SPM) Test</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Panoramic slit alignment (pg 46)</td>
<td>AR</td>
</tr>
<tr>
<td>Scanner</td>
<td>Cleaning (pg 40)</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Abnormal occurrences, maintenance and repairs</td>
<td>AR</td>
</tr>
<tr>
<td>Screens &amp; Cassettes</td>
<td>Cleaning</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Light leakage (pg 47)</td>
<td>AR</td>
</tr>
<tr>
<td></td>
<td>Check for wear (pg 47)</td>
<td>AR</td>
</tr>
<tr>
<td>Protective Equipment</td>
<td>Integrity check (pg 40)</td>
<td>A</td>
</tr>
<tr>
<td>Video Monitor QA</td>
<td>Various tests (pg 46 + 41-45)</td>
<td>Q</td>
</tr>
<tr>
<td>Technique chart</td>
<td>Review and update (pg 39)</td>
<td>A</td>
</tr>
</tbody>
</table>

Frequency:  A – annually,  S – semi-annually,  Q – quarterly,  M – monthly,  R – required every 5 yrs,  AR – as required
MONTHLY TO DO LIST

Year ____________

<table>
<thead>
<tr>
<th>Quality Assurance Procedure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection of x-ray equipment</td>
<td>M</td>
</tr>
<tr>
<td>Scanner cleaning</td>
<td>M</td>
</tr>
<tr>
<td>Image receptor artifact evaluation</td>
<td>M</td>
</tr>
<tr>
<td>Video monitor QA</td>
<td>Q</td>
</tr>
<tr>
<td>Arrange for SMP test</td>
<td>R</td>
</tr>
<tr>
<td>Screen cleaning</td>
<td>S</td>
</tr>
<tr>
<td>Protective equipment check</td>
<td>A</td>
</tr>
<tr>
<td>Technique chart – review and update</td>
<td>A</td>
</tr>
<tr>
<td>Repeat analysis</td>
<td>AR</td>
</tr>
<tr>
<td>Panoramic slit alignment</td>
<td>AR</td>
</tr>
<tr>
<td>Screens &amp; cassettes – light leakage</td>
<td>AR</td>
</tr>
<tr>
<td>Screens &amp; cassettes – wear check</td>
<td>AR</td>
</tr>
</tbody>
</table>

*at installation for video monitors, you may follow this modified schedule for quality assurance testing frequency:
- New to 2 years of service: check annually
- 3 to 5 years of service: check semi-annually
- >5 years of service: check quarterly

<table>
<thead>
<tr>
<th>Date</th>
<th>Test</th>
<th>Comments</th>
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# IMAGE RECEPTOR ARTIFACT EVALUATION

Year  
Imaging System  

Initial each month to indicate that a successful evaluation was done for each image receptor in the facility. Make a note of unusual occurrences, artifacts or maintenance required in the Comment section below.

<table>
<thead>
<tr>
<th>Image Receptor Identification</th>
<th>January</th>
<th>February</th>
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VIDEO MONITOR QA CHART

Month/Year __________ Imaging System__________________
Application for viewing______________________________

Initial each month to indicate that a successful evaluation was done for each video monitor in the facility. If a monitor fails the test, contact your service company for appropriate corrective action. Make a note of unusual occurrences, artifacts or maintenance required in the Comment section below.

Indicate whether you are using either the SMPTE test pattern or the TG18-QC test pattern for the majority of the tests.

<table>
<thead>
<tr>
<th>Video Monitor Identification</th>
<th>Video Monitor Setting &amp; Test Pattern</th>
<th>0% - 5% contrast</th>
<th>95%-100% contrast</th>
<th>Grey steps</th>
<th>Alphanumerics</th>
<th>Resolution (centre)</th>
<th>Resolution (corners)</th>
<th>Distortion</th>
<th>BWH Grey Scale</th>
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</table>
**REPEAT ANALYSIS**

Period of Repeat Analysis: From:_______ To: ____________

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<th>REASON</th>
<th>Size 0</th>
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<th>Size 2</th>
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<td>Too light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient movement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artifact in Image</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Image transfer error</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other reasons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of repeated images</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total number of Images in this period: ________________

% Repeated = \[
\frac{\text{Total number of Repeated Images}}{\text{Total number of Images}} \times 100\]

If the % Repeated exceeds 5%, a review should be conducted to determine the reason or reasons that may be causing it.
<table>
<thead>
<tr>
<th>QA Test</th>
<th>Image Receptor artifact evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Needed</td>
<td>2-step Aluminum wedge</td>
</tr>
<tr>
<td>Limit of Acceptability</td>
<td>Minimal image artifacts that do not interfere with diagnosis</td>
</tr>
<tr>
<td>Procedure:</td>
<td>Note: The first time this test is performed, save the images for each image receptor to be used for comparison in subsequent tests</td>
</tr>
<tr>
<td></td>
<td>• If you suspect that an image receptor has become damaged or introduces artifacts in the image, immediately remove the image receptor from service until this test can be performed</td>
</tr>
<tr>
<td></td>
<td>• Choose a flat surface. The same surface should be used each time the test is performed. Avoid metal surfaces, and ensure that the site below can be exposed to radiation (i.e. do not perform test above the drawer where you store extra image receptors)</td>
</tr>
<tr>
<td></td>
<td>• Place the unexposed image receptor on the flat surface with the sensitive area facing up</td>
</tr>
<tr>
<td></td>
<td>• Carefully position the 2-step wedge on the image receptor, ensuring that you do not scratch the sensitive surface (you may use a barrier if you are careful to ensure that it does not affect the test results)</td>
</tr>
<tr>
<td></td>
<td>• The wedge should be positioned so that both steps of the wedge will be imaged</td>
</tr>
<tr>
<td></td>
<td>• Position the cone, centered on the wedge and touching the surface</td>
</tr>
<tr>
<td></td>
<td>• Expose the image receptor using typical posterior bitewing technique</td>
</tr>
<tr>
<td></td>
<td>• Process the image using the normal techniques</td>
</tr>
<tr>
<td></td>
<td>• Inspect the image for light or dark spots, scratches or bands that indicate damage on the image receptor</td>
</tr>
<tr>
<td></td>
<td>• If you encounter suspect areas, compare the image with its initial reference image to assess the extent of the damage.</td>
</tr>
<tr>
<td></td>
<td>• Remove damaged image receptors from service immediately</td>
</tr>
<tr>
<td></td>
<td>• If no damage is reported, initial the appropriate box on the Image Receptor Artifact Evaluation Chart to indicate that the test was performed</td>
</tr>
<tr>
<td></td>
<td>• At the end of the year, file the completed Image Receptor Artifact Evaluation chart in the QA Procedures Manual and maintain a new copy of the form.</td>
</tr>
</tbody>
</table>
### Visual X-Ray Equipment Inspection

**Procedure:**

Note: If anything that may pose an imminent danger is discovered (e.g., loose electrical cable), discontinue the use of the x-ray equipment and call for service.

- A visual inspection of the x-ray equipment and associated apparatus should be conducted monthly
- The date of the inspection should be documented on the Monthly To Do List
- Anything out of the ordinary (e.g., loose screws, frayed cables, sharp edges, etc.) should also be recorded in the comments on the Monthly To Do List
- Determine that all motions of the x-ray equipment are smooth and stable. The dental tube head should remain where you position it, without drifting. The panoramic tube and film holder (or image receptor) should move freely without catches or interruptions
- Prior to calling the service company to schedule a Safety and Preventive Maintenance (SPM) Inspection, review the comments on the Monthly To Do List
- Discuss the items that you have logged with the service company so that they can bring the necessary parts when they come to do the SPM Inspection

### Technique chart – review and update

**Procedure:**

Consult with x-ray operators in the office and dentist(s) to determine if any of the techniques or views for the procedures that you are currently doing require modification. Is everyone using the same settings for each of the x-ray units? Are all of the images produced of similar quality? What settings do you use for small patients and children?

### Scanner cleaning

**Equipment needed:** Protective clothing/eyewear

**Limit of Acceptability**

Consult the scanner’s operating manual for the manufacture’s recommendations regarding cleaning solutions and care instructions

**Procedure:**

- Consult the manufacturer’s recommended procedure and solutions for cleaning the image receptor scanner
- If a separate system (i.e. UV light box) is used to erase the image receptors, follow the instructions for the care of the additional equipment.
- Record this activity and data on the Monthly To Do List

### Protective equipment integrity check

**Equipment needed:** Lead aprons & thyroid collars

**Limit of Acceptability**

Varies according to usage and site of defect. Medical x-ray facilities will reject an apron or collar if a single defect in the vicinity of the thyroid or of reproductive organs exceeds the equivalence of a 5 mm diameter circle.

**Procedure:**

Note: if you have access to medical radiographic equipment, arrangements may be
made to have the protective equipment inspected there. This is the preferred way to inspect the lead lining

- The expected lifetime of a properly cared for lead apron is 10 – 15 years. Hang the protective equipment when not in use. Avoid creasing or sitting on the apron.
- Closely inspect each item for wear and irregularities
- Lay out the item to be checked on a table
- Run your hands over both sides to find breaks in the lead lining
- Take an image of suspect areas or hold the item up to a bright light source to see if the lining is broken through entirely
- Check the image for dark exposure areas that show breaks in the lead lining
- Record this activity on the Monthly To Do List

<table>
<thead>
<tr>
<th>QA Test:</th>
<th>Video Monitor QA with SMPTE1 Test Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment needed:</td>
<td>Digital image file of the SMPTE1 Test Pattern</td>
</tr>
<tr>
<td>1 Test Pattern R.P-133, The Society of Motion Pictures and Television Engineers, 595 West Hartsdale Ave., White Plains, NY</td>
<td></td>
</tr>
<tr>
<td>Limit of Acceptability:</td>
<td>No areas of distortion or damage. Track degradation of resolution, contrast and brightness</td>
</tr>
<tr>
<td>Procedure:</td>
<td>Each video monitor in the facility should be tested</td>
</tr>
<tr>
<td></td>
<td>It is preferable to load the test pattern using the x-ray imaging software. If this is not feasible, load the test pattern onto the screen by using an available application (for Microsoft Windows systems: Paint or Microsoft Picture and Imaging, or Adobe Photoshop, etc)</td>
</tr>
<tr>
<td></td>
<td>If you are not able to load/import the .gif file, try another file format</td>
</tr>
<tr>
<td></td>
<td>Before you start the assessment:</td>
</tr>
<tr>
<td></td>
<td>Position the monitor to minimize reflections on the screen from ceiling lights, lamps or other illuminators</td>
</tr>
<tr>
<td></td>
<td>Set the room (ambient) light low</td>
</tr>
<tr>
<td></td>
<td>Warm up the monitor for 30 minutes prior to testing</td>
</tr>
<tr>
<td></td>
<td>Load the test pattern with the software application as specified on the Video Monitor QA Chart</td>
</tr>
<tr>
<td></td>
<td>Adjust the monitor settings, if required, as specified on the Video Monitor QA Chart. This may include: (a) window level and width, (b) contrast, (c) brightness, (d) vertical or horizontal size</td>
</tr>
<tr>
<td></td>
<td>Centre the test pattern in the active area of the monitor. Ensure all borders of the test pattern are visible</td>
</tr>
</tbody>
</table>

The following tests have been adapted from the tutorials developed by the Department
Perform the following tests:

1. **Resolution**
   - The high contrast bar patterns in the test image should be distinct as a pattern of black and white pairs.
   - In each corner of the image, as well as in the centre, inspect the 6 squares filled with varying widths of alternating black and white horizontal and vertical lines (these are referred to as high contrast line-pair images). Refer to the diagram with arrows to indicate the regions of interest.
   - Verify that the high contrast line-pair images at the centre and corners of the SMPTE pattern are distinguishable. You should be able to differentiate all the lines, from wide to narrow, both horizontal and vertical.
   - Record the results on the Video Monitor QA Chart.

2. **Contrast & Brightness**
   - The contrast and brightness of the monitor is adequately set if the 5% squares at both ends of the grey scale are visible.
   - The grey scale is shown as a series of squares in the centre of the image that range from black (0%) to white (100%) in a semi-rectangle.
   - The 0% and 100% squares (see arrows on image at left) each contain smaller squares within them that represent signal level steps of 5% and 95% respectively.
   - You should be able to visually differentiate the inner square from the larger square that contains it.
   - Verify that the 0%-5% contrast is visible.
   - Verify that the 95%-100% contrast is visible.
   - Record the results on the Video Monitor QA Chart.

3. **Grey Steps & Alphanumerics**
   - The grey scale is shown as a series of squares in the centre of the image that range from black (0%) to white (100%) in a semi-rectangle.
### QA Test: Video Monitor QA with TG18-QC Test Pattern

<table>
<thead>
<tr>
<th>Equipment Needed:</th>
<th>Digital Image file of the TG18-QC(^3) Test Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit of Acceptability:</td>
<td>No areas of distortion or damage. Track degradation of resolution, contrast and brightness</td>
</tr>
</tbody>
</table>
| Procedure: | - Each video monitor in the facility should be tested  
- It is preferable to load the test pattern using the x-ray imaging software. If this is not feasible, load the test pattern onto the screen by using an available application (for Microsoft Windows systems: Paint or Microsoft Picture and Imaging, or Adobe Photoshop, etc)  
- If you are not able to load/import the .gif file, try another file format  
  
Before you start the assessment:  
- Position the monitor to minimize reflections on the screen from ceiling lights, lamps or other illuminators  
- Set the room (ambient) light low  
- Warm up the monitor for 30 minutes prior to testing  
- Load the test pattern with the software application as specified on the Video Monitor QA Chart |
Monitor QA Chart

- Adjust the monitor settings, if required, as specified on the Video Monitor QA Chart. This may include: (a) window level and width, (b) contrast, (c) brightness, (d) vertical or horizontal size
- Centre the test pattern in the active area of the monitor. Ensure all borders of the test pattern are visible

The following tests have been adapted from the American Association of Physicists in Medicine, On-line Report No. 033. Perform the following tests:

1. Resolution
   - The high contrast bar patterns in the test image should be distinct as a pattern of black and white pairs
   - In each corner of the image, as well as in the centre, inspect the 4 squares filled with varying widths of alternating black and white horizontal and vertical lines (these are referred to as high contrast line-pair images). Refer to the diagram with arrows to indicate the regions of interest
   - Verify that the high contrast line-pair images at the centre and corners of the TG18-QC pattern are distinguishable. You should be able to differentiate all the lines, from wide to narrow, both horizontal and vertical
   - Record the results on the Video Monitor QA Chart

2. Contrast & Brightness
   - The contrast and brightness of the monitor is adequately set if the 5% squares at both ends of the grey scale are visible
   - The grey scale is shown as a series of 16 squares around the centre of the image that range from black (0%) to white (100%) in a semi-rectangle

---

1 Test Pattern TG18-QC, American Association of Physicists in Medicine, AAPM On-line Report No. 3
continued from previous page….

- The 0% and 100% squares (see arrows on image at left) each contain smaller squares within them that represent signal level steps of 5% and 95% respectively
- You should be able to visually differentiate the inner square from the larger square that contains it
- Verify that the 0%-5% contrast is visible
- Verify that the 95%-100% contrast is visible
- Verify that the contrast detail “QUALITY CONTROL” letters are visible and distinct in the three boxes below the grey scale squares
- Record the results on the Video Monitor QA Chart

3. Grey Steps & Alphanumerics

- The grey scale is shown as a series of 16 squares in the centre of the image that range from black (0%) to white (100%) in a semi-rectangle
- Verify that each step is distinguishable from the adjacent ones
- Verify that the alphanumeric characters that appear on the pattern are sharp and in focus
- Record the results on the Video Monitor QA Chart

4. Geometric Distortion

- Assess the general appearance of the test pattern
- Verify that all lines appear straight and continuous without curvature or waviness
- Verify that the ramp bars appear continuous without any contour lines
- Verify that the pattern is square
- Verify that there are no blurred areas or regions that flicker
- Record the results on the Video Monitor QA Chart

QA Test: Video Monitor QA with BWH Test Pattern
**Equipment Needed:**
Digital image file of the BWH\(^4\) Test Pattern

**Limit of Acceptability:**
Assess the range of grey levels available on your workstation

**Procedure:**
- Each video monitor in the facility should be tested
- It is preferable to load the test pattern using the x-ray imaging software. If this is not feasible, load the test pattern onto the screen by using an available application (for Microsoft Windows systems: Paint or Microsoft Picture and Imaging, or Adobe Photoshop, etc)
- If you are not able to load/import the .gif file, try another file format

Before you start the assessment:
- Position the monitor to minimize reflections on the screen from ceiling lights, lamps or other illuminators
- Set the room (ambient) light low
- Warm up the monitor for 30 minutes prior to testing
- Load the test pattern with the software application as specified on the Video Monitor QA Chart
- Adjust the monitor settings, if required, as specified on the Video Monitor QA Chart. This may include: (a) window level and width, (b) contrast, (c) brightness, (d) vertical or horizontal size
- Centre the test pattern in the active area of the monitor. Ensure all borders of the test pattern are visible

The following test has been adapted from the image and tutorial developed by the Department of Radiology, Brigham and Women's Hospital, Harvard Medical School\(^4\).

- The test pattern should appear as a continuous grey scale image from the center of the pattern
- No concentric ring-like features should be present. If such features are present, your system is displaying at less than optimal quality
- Record the results on the Video Monitor QA Chart

---

\(^4\) Visual Perception Laboratory, Video Monitor Test Pattern Tutorials, Brigham and Woman’s Hospital Department of Radiology, Harvard Medical School, Bringham RAD at [http://brighamrad.harvard.edu/research/topics/vispercept/tutorial.html](http://brighamrad.harvard.edu/research/topics/vispercept/tutorial.html), 1997

<table>
<thead>
<tr>
<th>QA Test</th>
<th>Repeat Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>Calculator</td>
</tr>
</tbody>
</table>
**Needed:**

<table>
<thead>
<tr>
<th>Limit of Acceptability:</th>
<th>If the % Repeated rate is greater than 5%, investigate.</th>
</tr>
</thead>
</table>
| Procedure:             | • Note: this test is recommended if you feel that you are taking an excessive amount of repeat radiographic images  
                          • Establish a monitoring period. For an average facility, six months may be appropriate while for a large facility, monthly analysis may be sufficient  
                          • You will need to determine the total number of images for diagnosis (excluding QA images and test images)  
                          • Keep the Repeat Analysis form available near the imaging workstation  
                          • When an x-ray image must be repeated, document the deficiency of the original image on the Repeat Analysis form  
                          At the end of the specified monitoring period, enter the total number of diagnostic images processed during the monitoring period on the Repeat Analysis form (do not include quality assurance images that were taken during the monitoring period)  
                          • Calculate the % Repeated rate at the bottom of the form  
                          • File the completed Repeat Analysis form in the QA Procedures Manual  
                          • Record this activity and data on the Monthly To Do List |

<table>
<thead>
<tr>
<th>QA Test:</th>
<th>Panoramic slit alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Needed:</td>
<td>Two intraoral size image receptors</td>
</tr>
<tr>
<td>Limit of Acceptability:</td>
<td>Opening on the x-ray tube of the Panoramic unit is aligned with the opening of its image receptor</td>
</tr>
</tbody>
</table>
| Procedure: | • Note: If you are suspicious that your pan images have degraded, you may wish to perform this test  
                          • If you are using image receptors that attach through wires, you may not have enough cable to reach the Pan unit.  
                          • Afix image receptors to the top and bottom of the slit on the Pan image plate  
                          • Mark the position of the slit on the image receptors by taping a small lead marker on the image receptor (a piece of paper clip will work)  
                          • Take an exposure of the Pan  
                          • The metal taped to the image receptors will look like bright (white) marks on the image. The radiation field on the Pan slit will be a dark area on the image.  
                          • If the metal markers are not centered on the dark area of the radiation field, the pan x-ray tube may not be aligned with the slit. Call your service person to arrange for servicing  
                          • Record this activity and data on the Monthly To Do List |

<table>
<thead>
<tr>
<th>QA Test:</th>
<th>Screens – cassette light leakage (Pan or Ceph units only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>Bright light source, stop watch (or equivalent)</td>
</tr>
</tbody>
</table>
**Needed:**

**Procedure:**
- Note: If you are suspicious that a cassette is not closing properly and light is causing latent images with the cassette, you should perform this test
- Set up the ceph or pan unit to take an image
- Ensure the cassette has been erased
- Place the cassette under a bright light with the hinged side of the cassette facing the light for 3 minutes
- Load the image from the cassette into the computer
- Review the image and determine if it is darker along any of the edges
- If an edge is darker, the cassette may not be closing properly
- Discuss the problem of the cassette with your vendor and replace it if necessary
- Record this activity and observations on the Monthly To Do List

**QA Test:**

<table>
<thead>
<tr>
<th>Equipment Needed:</th>
<th>Bright light source (or ultraviolet lamp)</th>
</tr>
</thead>
</table>

**Procedure:**
- If you are suspicious that a screen may be worn and is not functioning efficiently you may consider doing this test
  - If you have a UV lamp (black light), shine it on the screen and look for bright specks (caused by dust)
  - If you see bright specks, clean the screen
  - If you see dark patches, these are areas of excessive wear
  - Without the UV lamp, you may still inspect the screen for wear patterns or cracks by using a bright light source or sunlight
  - Tilt the screen to inspect the surface by the reflection of the bright light or sunlight
  - If there is evidence of wear, discuss the problem with your cassette vendor
  - Record this activity and observations on the Monthly To Do List
Appendix 1 – Application for Registration

In the province of Alberta, dental x-ray equipment and facilities as well as lasers, are governed by the Alberta Radiation Protection Act and Regulation. This Act and Regulation specify that owners of dental x-ray equipment and lasers must arrange the compliance verification/inspection and must ensure the final report is received by the Alberta Dental Association and College along with the completed registration application. Failure to comply with the Act, the Regulation and the Radiation Health and Safety Policy can result in additional fees associated with late registration or non-disclosed equipment.

Owner Information
☐ No Change ☐ New Owner ☐ Change of Address

Owner Name: ________________________________
Effective Date: ______/____/____
Address: ____________________________________
City: ________________________________
Postal Code: ____________ Telephone: (_____) ____________ Fax: (_____) ____________
Email: ________________________________

Name of Previous Owner (applies only if Owner is changed):

Facility Information
☐ New ☐ Relocation ☐ Change of Name ☐ No Change

Facility Name: ________________________________
Date Facility Opened: ______/____/____
Contact Name: ________________________________
Email: ________________________________
Address: ____________________________________
City: ________________________________
Postal Code: ____________ Telephone: (_____) ____________ Fax: (_____) ____________

Name of Previous Facility (applies only if Facility name is changed):

Equipment Information
☐ New ☐ 5-Year Renewal ☐ Relocation ☐ Replacement

Complete page 2 for each piece of equipment being registered; including Class 3b and Class 4 lasers.

Name of Authorized Radiation Protection Agency that performed Compliance Inspection:

Date of Inspection: ______/____/____

The installation of the above equipment complies with all aspects of the Radiation Protection Act and Regulations and the Radiation Health and Safety Program. I certify that the above information is complete and accurate. (the owner must sign).

__________________________________________
Date: ______/____/____

(Signature of Owner)
Facility/Owner Name: ________________________________

**Equipment Information**  
- [ ] New  
- [ ] 5-Year Renewal  
- [ ] Relocation  
- [ ] Replacement

- [ ] Intraoral  
- [ ] Panoramic  
- [ ] Pan/Ceph  
- [ ] Cephalometric  
- [ ] Tomographic (cone beam CT)

- [ ] Laser Class 3B  
- [ ] Laser Class 4

Location in Facility (Room Name): ________________________________  
Installation Date: _____ / ____ / ______

Manufacturer Name: ________________________________  
Model Name: ________________________________

**Equipment Information**  
- [ ] New  
- [ ] 5-Year Renewal  
- [ ] Relocation  
- [ ] Replacement

- [ ] Intraoral  
- [ ] Panoramic  
- [ ] Pan/Ceph  
- [ ] Cephalometric  
- [ ] Tomographic (cone beam CT)

- [ ] Laser Class 3B  
- [ ] Laser Class 4

Location in Facility (Room Name): ________________________________  
Installation Date: _____ / ____ / ______

Manufacturer Name: ________________________________  
Model Name: ________________________________

**Equipment Information**  
- [ ] New  
- [ ] 5-Year Renewal  
- [ ] Relocation  
- [ ] Replacement

- [ ] Intraoral  
- [ ] Panoramic  
- [ ] Pan/Ceph  
- [ ] Cephalometric  
- [ ] Tomographic (cone beam CT)

- [ ] Laser Class 3B  
- [ ] Laser Class 4

Location in Facility (Room Name): ________________________________  
Installation Date: _____ / ____ / ______

Manufacturer Name: ________________________________  
Model Name: ________________________________

**Equipment Information**  
- [ ] New  
- [ ] 5-Year Renewal  
- [ ] Relocation  
- [ ] Replacement

- [ ] Intraoral  
- [ ] Panoramic  
- [ ] Pan/Ceph  
- [ ] Cephalometric  
- [ ] Tomographic (cone beam CT)

- [ ] Laser Class 3B  
- [ ] Laser Class 4

Location in Facility (Room Name): ________________________________  
Installation Date: _____ / ____ / ______

Manufacturer Name: ________________________________  
Model Name: ________________________________

The installation of the above equipment complies with all aspects of the Radiation Protection Act and Regulations and the Radiation Health and Safety Program. I certify that the above information is complete and accurate. (the owner must sign).

(Signature of Owner) ________________________________  
Date: _____ / ____ / ______

yyyyy / mm / dd
Appendix 2 - Authorized Radiation Protection Agencies

All agencies service the entire province.

**Alberta Radiation Service**  
Keith Murland  
8020 182 Street NW  
Edmonton, AB T5T 0Z8  
Phone: 1-888-653-9200 or (780) 487-3889  
Cell: (780) 566-9427  
E-mail: abradser@telus.net

**Diagnostic Solutions Inc.**  
Scott Simmons  
10623 - 59 Street NW  
Edmonton, AB T6A 2K5  
Phone: 1-866-626-1189  
Fax: 1-866-626-1189  
E-mail: diagnosticsolutions@hotmail.com  
Website: www.diagnosticsolutions.ca

**Filipow Associates Inc. (Edmonton)**  
Larry Filipow  
6508 – 109 Avenue  
Edmonton, AB T6A 1S2  
Cell: (780) 288-4833  
Phone: (780) 468-4833  
Fax: (780) 468-4866  
E-mail: info@filipow.ca  
Website: www.filipow.ca

**Filipow Associates Inc. (Calgary)**  
Narinder Sidhu  
161 Strathcona Road S.W.  
Calgary, AB T3H1X9  
Office: (587) 358-0038  
Cell: (250) 640-0208  
E-mail: narinder@filipow.ca

**RadMan Radiation Management Services**  
Marianne Colwell  
868 Prestwick Circle SE  
Calgary, AB T2Z 4E4  
Phone: (403) 903-2020  
Fax: (403) 726-7676  
E-mail: rad_man@telus.net
Appendix 3 – Personal Dosimetry Services

Safety Code 30 and the Radiation Protection Regulation of Alberta indicates that radiation workers must wear personal dosimeters. A facility policy on dosimetry must be incorporated into the Code of Practice.

**Personal dosimetry monitoring:**
- All operators of X-ray equipment, together with personnel who **routinely** participate in radiological procedures **must** wear personnel dosimeters.
- It is **recommended** that dentists also wear personnel dosimeters.

It is **recommended** that dental facilities also have a control badge issued by the Dosimetry Service, to differentiate elevated exposures that may have occurred at the facility from those that may have occurred during shipping of the dosimeter badge.

It is the Radiation Program policy that each dosimeter badge registered within a facility **remains** at that one facility and is **not** used or transferred by any means to another facility. If a dentist owns more than one facility, each facility must register, utilize and monitor its own dosimeter badges. A dentist and/or their staff **cannot** use the badge(s) for multiple facilities.

---

**National Dosimetry Services**  
**Radiation Protection Bureau**  
**Health Canada**  
775 Brookfield Rd.  
Ottawa, ON K1A 1C1  
Phone: 1-800-261-6689  
Fax: 1-800-252-6272  
E-mail: NDS-SND@hc-sc.gc.ca  

**Landauer Inc.**  
2 Science Road  
Glenwood, Illinois  
USA 60425-1586  
Phone: 1-800-323-8830  
(708) 755-7000  
Fax: (708) 755-7016  
E-mail: custserv@landauerinc.com  
Website: [www.landauerinc.com](http://www.landauerinc.com)

**Mirion Technologies**  
Dosimetry Services Division  
2652 McGaw Avenue Irvine, California  
USA 92614  
Phone: 1-800-251-3331  
(949) 419-1000 Fax: (949) 296-1144  
E-mail: info@dosimetry.com  
Website: [www.dosimetry.com](http://www.dosimetry.com)

**National Dose Registry**  
(Repository for personal exposure records)  
**Radiation Protection Bureau**  
**Health Canada**  
775 Brookfield Rd.  
Ottawa, ON K1A 1C1  
Phone: (613) 957-0960  
Fax: (613) 957-0960  
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## Appendix 4 – Compliance Verification Checklist for Dental X-ray Equipment

In accordance with Safety Code 30: "Radiation Protection in Dentistry: Recommended Safety Procedures for the Use of Dental X-ray Equipment" Published by Health Canada

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Compliance Item Description</th>
<th>Safety Code Section</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
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<tbody>
<tr>
<td></td>
<td><strong>Responsibility and Personnel</strong></td>
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<td>1</td>
<td>Responsible User: Dentist, registered dental hygienist or registered dental assistant - Ensure that the installation complies with all applicable regulatory requirements, including equipment registration - Establish safe working conditions - Ensure that radiation shielding is adequate - Ensure that equipment functions properly and is operated correctly - Ensure that maintenance is performed by competent personnel - Ensure that operators are properly trained - Ensure that operators-in-training work only under the direct supervision of a qualified operator - Implement and maintain a Quality Assurance program for the facility</td>
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<td>2</td>
<td>Equipment Operator - Recognize radiation hazards - Have a thorough understanding of safe working methods and appropriate techniques and procedures - Participate fully in the Quality Assurance program</td>
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<td></td>
<td><strong>Equipment Requirements – General</strong></td>
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<td>3</td>
<td>An X-ray control panel that is equipped with: 1. Warning Signs: a permanent and conspicuous sign prohibiting unauthorized use and warning that hazardous X-radiation is emitted when the equipment is in operation 2. Status indicators -readily discernible indicators on the control panel that indicate: when the control panel is energized and when X-rays are produced</td>
<td>5.2.1.1</td>
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<td>5.2.1.2</td>
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<td>4</td>
<td>When more than one X-ray tube is controlled by one control panel, there must be readily discernible indicators, at or near each X-ray tube housing and on the control panel, showing which tube is connected and ready to be energized. There should be an interlock preventing the energizing of more than one X-ray tube at the same time.</td>
<td>5.2.1.2</td>
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| 5       | **Indication of Loading Factors:**  
 1. For X-ray equipment having adjustable loading factors, the control panel must incorporate indicators that allow these loading factors to be determined.  
 2. For equipment having non-adjustable loading factors, permanent marks or labels may be used to indicate these parameters.                                                                                           | 5.2.1.3             |
| 6       | **Irradiation Control:**  
 1. There must be an irradiation switch to initiate and terminate X-ray production  
 2. This switch must be of a type that requires continuous pressure to produce X-rays  
 3. Where the irradiation switch is a footswitch it must be so constructed that operation of the X-ray tube cannot occur inadvertently should the footswitch be overturned  
 4. Where the irradiation switch is mounted at the end of a cable, the cable must be of sufficient length to enable the operator to stand at least 3 metres from the tube housing and the patient  
 5. If the switch is in a fixed location, it must be at least 3 metres from the tube housing.                                                                                                                | 5.2.1.4             |
| 7       | **Controlling timer:**  
 1. An electronic timing device must be provided to automatically terminate the irradiation. Mechanical timers must not be used.  
 2. The timer must be designed and constructed in such a way that:  
    i. it is not possible to energize the X-ray tube without automatic or manual resetting of the timer after each loading  
    ii. irradiation cannot be started with the timer set at its zero or OFF position; and  
    iii. the production of X-rays is automatically terminated after a preset time, milliampere-second value, or exposure value.                                                                               | 5.2.1.5             |
| 8       | **Filtration:**  
 For a given kilovoltage, the measured value of half-value layer of aluminum must follow the limits below:  
  1.5 mm Al at 50 kVp  
  1.5 mm Al at 60 kVp  
  1.5 mm Al at 70 kVp  
  2.1 mm Al at 71 kVp  
  2.3 mm Al at 80 kVp  
  2.5 mm Al at 90 kVp  
  2.7 mm Al at 100 kVp                                                                                     | 5.2.1.6             |
<table>
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<tr>
<th>Item No.</th>
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<tr>
<td>9</td>
<td>Mechanical Stability:</td>
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<td></td>
<td>1. The X-ray tube must be securely fixed and correctly aligned within the X-ray tube housing.</td>
<td>5.2.1.7</td>
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<td>2. The X-ray source assembly must maintain its required position without excessive drift or vibration during operation.</td>
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<td>10</td>
<td>Irradiation Reproducibility:</td>
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<td>For any selected combination of X-ray tube voltage, current and time, the coefficient of variation of any 10 consecutive irradiations taken at the same distance within a period of 1 hour is not greater than 0.05.</td>
<td>5.2.1.8</td>
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<td>11</td>
<td>X-Ray Tube Voltage Accuracy:</td>
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<td>The actual peak X-ray tube voltage should not deviate from the indicated or selected value by more than 7%, or by the value specified by the manufacturer. It must not be possible to set or operate the X-ray tube with the tube voltage below 50 kilovolts (peak).</td>
<td>5.2.1.9</td>
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<td>12</td>
<td>X-ray Tube Current:</td>
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<td>The actual X-ray tube current should not deviate from the indicated or selected value by more than 5%, or by the value specified by the manufacturer, and be temperature compensated for normal operating conditions.</td>
<td>5.2.1.10</td>
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<td>13</td>
<td>X-Ray Tube Shielding:</td>
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<td></td>
<td>1. The X-ray tube must be enclosed in a shielded housing.</td>
<td>5.2.1.12</td>
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<td>2. The leakage radiation from the X-ray tube housing must not exceed 0.873 mGy (100 mR) in 1 hour at 1 metre at the nominal X-ray tube voltage on the equipment.</td>
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<td>14</td>
<td>Linearity:</td>
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<td>For any selected X-ray tube voltage and for any irradiation time greater than 1/20 second, the following relation must hold: ( X_1 - X_2 &lt; 0.1 (X_1 + X_2) ) where ( X_1 ) and ( X_2 ) are the average values of exposure per second, per pulse or per milliampere-second obtained:</td>
<td>5.2.1.11</td>
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<td>i. where the X-ray tube current is fixed, at each two settings of</td>
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<td>ii. irradiation timer not differing by more than a factor of two, or</td>
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<td></td>
<td>iii. where the irradiation time is fixed, at each two X-ray tube current settings not differing by more than a factor of two.</td>
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<td>15</td>
<td>Applicator:</td>
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<td>A position-indicating device must be provided to limit the minimum focal spot to skin distance to not less than 18 centimetres. The applicator must be an open-ended type. Pointed cone or close-ended applicators must not be used.</td>
<td>5.2.2.1</td>
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| 16      | **Beam Limiting Device:**  
The primary radiation beam must be collimated in size at the end of the applicator to a circle not more than 7 centimetres in diameter, or a rectangle of area not more than 38.5 cm².                          | 5.2.2.2             |     |    |     |
| 17      | **Controlling Timer:**  
The maximum presettable irradiation time must not exceed 5 seconds, or the time required to deliver 50 milliampere-seconds, whichever is shorter.                                                                             | 5.2.2.3             |     |    |     |
|         | **Equipment Requirements – Panoramic**                                                                                                                                                                                                 |                    |     |    |     |
| 18      | **Applicator:**  
A position-indicating device must be provided to limit the minimum focal spot to skin distance to not less than 15 centimetres.                                                                                       | 5.2.3.1             |     |    |     |
| 19      | **Beam Limiting Device:**  
The primary radiation beam must be collimated such that the size of the radiation beam at the image receptor does not exceed any dimension of the scanning slit by more than one-half of that dimension or by more than 2% of the focal spot to image receptor distance, whichever is less. | 5.2.3.2             |     |    |     |
| 20      | **Cassette Carrier:**  
The cassette carrier should be interlocked such that irradiation is not possible, unless a film cassette is in the cassette carrier.                                                                                      | 5.2.3.3             |     |    |     |
| 21      | **Controlling Timer:**  
The maximum presettable irradiation time must not exceed 25 seconds, or the time required to deliver 250 milliampere-seconds, whichever is shorter.                                                             | 5.2.2.4             |     |    |     |
<p>|         | <strong>Film Processing and Handling</strong>                                                                                                                                                                                                 |                    |     |    |     |
| 22      | Manufacturers’ recommendations about the strengths and temperatures of the solutions and immersion times must be followed to ensure optimum film processing.                                                                                                     | 6.1.1               |     |    |     |
| 23      | Developing solutions must be monitored and replenished or changed as necessary and according to the manufacturers’ recommendations.                                                                                                    | 6.1.2, 6.1.3        |     |    |     |
| 24      | Manufacturers’ recommendations about the operation and servicing of automatic film processors must be followed to ensure optimum film processing.                                                                                                         | 6.1.5               |     |    |     |
| 25      | The darkroom must be clean of dirt, dust, and spilled chemical residues.                                                                                                                                                            | 7.4.2               |     |    |     |
| 26      | The darkroom must be light-tight and must be designed to incorporate a lockable door, double doors or a blackened maze entrance                                                                                                         | 6.2.1, 6.2.2        |     |    |     |
| 27      | A warning light or sign should be located outside the darkroom to indicate when the room is in use.                                                                                                                                  | 6.2.3               |     |    |     |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>28</td>
<td>Safelights, fitted with light bulbs of correct intensity, and filters appropriate to the specifications of the film used must be positioned at the proper distances from work areas within the darkroom.</td>
<td>6.2.4</td>
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</table>
| 29      | - Film storage container must be adequately shielded to ensure that excessive irradiation of film by X-rays does not occur.  
- Storage should be provided so that no film receives more than 1.75 μGy (0.2 mR) of stray radiation before use.  
- Films should be stored on end in a cool, dry area.                                                                                                                                                                                                                                                                                                                                                                                  | 6.3                 |     |    |     |
| 30      | - The condition of viewboxes should be checked regularly.  
- Fluorescent tubes should be changed when signs of aging develop  
- The viewing surface should be cleaned carefully                                                                                                                                                                                                                                                                                                                                                                             | 6.4                 |     |    |     |
| 31      | Cassettes and Screens (panoramic equipment)  
- Cassettes should therefore be checked regularly for wear and cleanliness.  
- Screen cleaners recommended by manufacturers should be used.  
- Films should never be left inside cassettes with screens for any extended period of time.                                                                                                                                                                                                                                                                                                                                                               | 6.5                 |     |    |     |
|         | **Quality Assurance Program**                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |     |    |     |
| 32      | Quality Assurance Program must meet minimum standards set by the Alberta Dental Association and College                                                                                                                                                                                                                                                                                                                                                                                               | 7.1                 |     |    |     |
|         | **Radiation Protection**                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 8.0                 |     |    |     |
| 33      | Adequate Shielding:  
1. 20 mSv for radiation workers  
2. 1 mSv for members of the public                                                                                                                                                                                                                                                                                                                                                                                                         | 4.1                 |     |    |     |
<p>| 34      | The operator is not exposed to the primary radiation beam and can keep a distance of at least 3 metres from the X-ray tube when operating the irradiation switch. If this is not possible, an adequately shielded barrier, which allows observation of the patient, must be provided for the operator to stand behind during radiography                                                                                                                                                                                                                                                     | 4.2.1               |     |    |     |
| 35      | The primary radiation beam and scattered radiation are absorbed as close as possible to the source                                                                                                                                                                                                                                                                                                                                                                                                   | 4.2.4               |     |    |     |
| 36      | The primary radiation beam is always directed towards a shielded or unoccupied area.                                                                                                                                                                                                                                                                                                                                                                                                          | 4.2.5               |     |    |     |
| 37      | All personnel must fully use all protective devices available.                                                                                                                                                                                                                                                                                                                                                                                                                                        | 8.1.4               |     |    |     |
| 38      | All operators of X-ray equipment, together with personnel who routinely participate in radiological procedures must wear personnel dosimeters under the protective clothing.                                                                                                                                                                                                                                                                                                                                  | 8.1.9 &amp; 8.1.10      |     |    |     |
| 39      | The dental film should be fixed in position with a holding device, whenever possible, otherwise it should be held by the patient. Personnel must not hold the film or the X-ray tube housing in place during operation.                                                                                                                                                                                                                                                                                                           | 8.1.6 &amp; 8.1.8       |     |    |     |</p>
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<tr>
<td>40</td>
<td>Dental radiography must not be carried out at X-ray tube voltages below 50 kilovolts (peak) and <strong>should</strong> not be carried out at X-ray tube voltages below 60 kilovolts (peak).</td>
<td>9.2.4</td>
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<td>41</td>
<td>The patient must be provided with a shielded apron, for gonad protection, and a thyroid shield, especially during occlusal radiographic examinations of the maxilla. In panoramic radiography, dual (front and back) lead aprons <strong>should</strong> be worn.</td>
<td>9.2.7</td>
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<td>43</td>
<td>Dental X-ray equipment must have a regular preventative maintenance program and <strong>should</strong> be calibrated on a regular basis.</td>
<td>9.2.5</td>
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## Appendix 5 - Compliance Verification Checklist for Class 3b and 4 Lasers

In accordance with

CAN/CSA-Z386-14 “Safe Use of Lasers in Health Care”

published by the Canadian Standards Association

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<thead>
<tr>
<th>Item No.</th>
<th>Compliance Item Description</th>
<th>Standard Section</th>
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<th>No</th>
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<tbody>
<tr>
<td><strong>Risk Assessment - Hazards, Risks and Control Measures</strong></td>
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<td></td>
<td>The LSO shall ensure that the hazard classification and nominal ocular hazard area (NOHA) are determined for each laser in use</td>
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<td></td>
<td>A risk assessment shall be performed before policies and procedural guidelines are developed to determine engineering and procedural control measures</td>
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<td></td>
<td>Persons administering and assisting in the administering of the laser systems, as well as the patient, shall be protected through the implementation of appropriate control measures and other provisions described in this Standard</td>
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<tr>
<td><strong>Ocular &amp; Skin Control Measures</strong></td>
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<td>All protective eyewear and filters shall be selected with an optical density (OD) sufficiently high to protect against the wavelengths of the laser in use in the NOHA</td>
<td>5.3.1.3</td>
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<td></td>
<td>Appropriate protective eyewear shall be made available at each point of access to the laser controlled area</td>
<td>5.3.1.3</td>
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<td>The protective eyewear shall be permanently labelled with applicable optical densities (OD) and wavelengths</td>
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<td>The protective eyewear shall be worn by all personnel in the NOHA during laser use</td>
<td>5.3.1.3</td>
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<td>The protective eyewear and filters shall be maintained according to manufacturer’s instructions</td>
<td>5.3.1.3</td>
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<td>The eyewear shall have side guards to protect against the beam entering between the eye and the eyewear</td>
<td>5.3.1.3</td>
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<td>The protective eyewear and filters shall be inspected prior to use for pitting, crazing, cracking, mechanical integrity, discoloration, and coating damage</td>
<td>5.3.1.3</td>
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<td>Optical viewing equipment (such as, but not limited to, a viewing port, microscope, endoscope, bronchoscope, ophthalmoscope, magnifying glass, loupes, or binoculars) shall be used with eye protection such as protective eyewear or a protective filter</td>
<td>5.3.1.3</td>
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<td>All windows shall be covered with coverings or filters with an optical density sufficiently high to protect against all the wavelengths of the lasers in use in the NOHA. Window barriers shall meet the infection control requirements of the facility and shall be non-flammable</td>
<td>5.3.1.3 &amp; 5.3.2.3</td>
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<td>Visual indications shall be used, e.g., a sign at eye level at entry points that shows the laser’s operational status</td>
<td>5.3.1.3 &amp; 5.3.2.3</td>
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<td>A patient eye protection method shall be selected according to the positioning of the patient, the part of the body to be treated, the level of anesthesia, and both the wavelength and delivery system of the laser to be used.</td>
<td>5.3.1.3</td>
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<td>Matte finished or diffusive surface instruments or other LSO-approved instruments (i.e., wet gauze) shall be used close to the beam path and adjacent to the laser impact site to reduce reflection hazards</td>
<td>5.3.1.3 &amp; 5.3.2.3</td>
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<td>Conducting fire drills at least once a year;</td>
<td>5.3.3.3</td>
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<td>Keeping any fire extinguishers located in the controlled area free of obstruction;</td>
<td>5.3.3.3</td>
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<tr>
<td>Ensuring that all laser personnel know how to access and operate fire extinguishers;</td>
<td>5.3.3.3</td>
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<td>Testing the delivery system prior to each laser procedure;</td>
<td>5.3.3.3</td>
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<td>Monitoring the laser status;</td>
<td>5.3.3.3</td>
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<td>Monitoring the delivery system (fibre/arm/waveguide), the path of the beam, and tissue interaction</td>
<td>5.3.3.3</td>
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<td>Providing access to open or available water/saline;</td>
<td>5.3.3.3</td>
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<td>Keeping wet cloths/drapes on hand to protect non-targeted areas as needed;</td>
<td>5.3.3.3</td>
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<td>Evacuating gases from the body cavity or using an appropriate barrier, for example, an incise drape;</td>
<td>5.3.3.3</td>
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<td>Using only nonflammable instruments and instruments with minimally reflective surfaces in the path of the beam;</td>
<td>5.3.3.3</td>
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<td>Minimizing electrical hazards through inspection for the integrity of cords and plugs prior to use;</td>
<td>5.3.3.3</td>
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<td>Adhering to drying times of flammable preparations and solutions as indicated by the manufacturer;</td>
<td>5.3.3.3</td>
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<tr>
<td>Evacuating plume.</td>
<td>5.3.3.3</td>
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**Controls for Endotracheal (ET) Tube Procedures**

A medical protocol for management of the airway during laser surgery shall be written by the ENT surgeon and the anesthesiologist. 5.3.3.4

All personnel working in a room during a shared airway procedure shall be competent in airway management procedures in the event of an airway fire. 5.3.3.4

Laser-resistant endotracheal tubes purposely manufactured for laser airway procedures shall be used. ET tubes shall be selected based on the wavelength of laser to be used and proof of manufacturer’s testing within the surgical parameters anticipated during the surgery. 5.3.3.4

If the ET tube is taped to the patient’s tissue or materials in the surgical field, nonflammable tape shall be used. 5.3.3.4

All emergency equipment designated in the airway management protocol shall be present in the room prior to beginning the surgical procedure. 5.3.3.4

A CO2 laser shall be tested for coaxial alignment of laser beams, and proper beam mode, prior to the patient undergoing anesthesia. 5.3.3.4

During jet ventilation anesthesia procedures, personnel shall be aware of the need for clear communication. The laser operator shall not place the laser in the ready mode until a verbal order is given to hold ventilation. 5.3.3.4

Protection of the patient’s face and eyes shall be provided by applying wet eye pads, metal shields taped into place by non-flammable tape, and wet towels placed over the face. The patient’s teeth shall be protected by a non-flammable tooth guard covered with wet gauze or alternative methods approved by the LSO and ENT surgeon. 5.3.3.4

Cotton patts used to pack the inflated ET tube cuff shall be included in the nurse’s surgical sponge count. 5.3.3.4

**Plume and LGAC Control Measures** 5.3.3.4

Plume shall be captured and evacuated in accordance with CSA Z305.13 5.3.4.3

**Infection Control Measures** 5.4.1.3

Biohazardous waste shall be disposed of in accordance with the policies of the
<table>
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<tr>
<th>Facility and/or jurisdiction.</th>
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<tr>
<td>All laser delivery components shall be processed according to the manufacturer’s instructions.</td>
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<tr>
<td>Standard precautions or universal precautions shall be used when caring for patients. If materials are contaminated by blood-borne pathogens, staff shall adhere to the requirements for precaution in accordance with the PHAC’s <em>Infection Control Guidelines for Preventing the Transmission of Bloodborne Pathogens in Health Care and Public Service Settings</em>. Note: Jurisdictional regulations should be followed as they apply.</td>
</tr>
<tr>
<td>Personnel shall follow facility procedures for draping of delivery systems, pre- and post-procedure cleaning of equipment, decontamination, and disposal of biohazardous waste or materials.</td>
</tr>
<tr>
<td><strong>Gases, Dyes, and Liquid Coolants Control Measures</strong></td>
</tr>
<tr>
<td>The manufacturer/distributor using gases, dyes, and liquid coolants in its lasers shall provide the health care facility with the material safety data sheets (MSDS) for gases, dyes, and coolants in accordance with the Workplace Hazardous Material Information System (WHMIS).</td>
</tr>
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</table>
| The health care facility shall have a policy on prevention and management of possible exposure to gases, dyes, and coolants that includes:  
  i) educating all personnel in proper handling of gases, dyes, and coolants;  
  ii) developing a plan to contain gases, dyes, and coolants in case of a leak, which includes the evacuation of persons present;  
  iii) establishing a response protocol in the event of a leak, which includes:  
    1) personnel required;  
    2) equipment needed;  
    3) automatic increase in ventilation as needed; and  
    4) hazardous materials disposal; and  
  iv) generating and submitting an incident report according to facility policy. |
| Persons exposed to gases, dyes, and coolants shall be referred to a physician and the appropriate health and safety committee personnel. | 5.4.2.3 |
| **Purge Gas Control Measures** |
| Caution should be exercised when using purge gases in a body cavity in laser surgery. |
| Purge gases should be filtered. | 5.4.3 |
| Whenever possible, CO₂ should be used as a purge gas instead of air or medical air. | 5.4.3 |
| **Administrative Controls** |
| - The facility administration shall ensure that a laser safety program is established and maintained in accordance with this Standard, applicable regulations, and professional guidelines.  
  - Policies and procedures shall be reviewed yearly and revised as necessary to follow recent standards.  
  - The development and revision/updating of laser safety procedures shall be performed by personnel directly involved in laser use and operation, in collaboration with the LSO and with final approval by the facility administration. |
| Documentation shall include:  
  a) Laser utilization record for each laser system: This record should include:  
    i) patient identification; | 7.1 |
|  | 7.2 |
ii) date, treatment, and location;
iii) equipment identification;
iv) wavelength of laser, if a multi-wavelength laser is used;
v) laser user;
vi) laser operator;
vii) operational procedures;
*viii) delivery system (e.g., objective lenses, fibre size, lot number, serial number);
ix) range of treatment parameters (e.g., power (watts), energy (joules), pulse duration, pulse repetition rate, total energy delivered);
x) signature of the laser operator or designate; and
xi) record of laser system shutdowns.

b) Laser safety checklist: If operational procedures are not included on the laser utilization record, a safety checklist shall be completed for each use of the laser separate from the patient record, in accordance with manufacturer’s instructions and as revised by the LSO or designate.

c) Facility laser policies and procedures: Personnel shall have access to facility policies and procedures, and access to policies and procedures specific to each laser use area.

d) Incident reports: Incident reports shall be made for adverse events in accordance with facility requirements. The LSO shall be advised of all incidents or adverse events immediately.

e) Audit reports: Audits shall be conducted on an annual basis, and audit reports shall be submitted to the LSO.

f) Service and maintenance reports: The LSO shall have access to service and maintenance reports on lasers and related equipment.

g) Laser safety committee minutes: The LSO shall have access to laser safety committee minutes, if applicable.

h) Education and training records: The LSO shall maintain current lists of competent personnel and authorized users. Records should include date of renewal of applicable personnel training.

i) Hazard analysis and risk assessment: The LSO shall maintain documentation of hazard analysis and risk assessment.

Indications for laser system shutdown
- The administrator shall provide standard operating procedures (SOPs) (see Annex B) and a checklist to deal with unscheduled shutdowns of health care lasers in case of an event or equipment malfunction. In the case of an event, the SOPs shall indicate the person(s) to be notified, and in the case of equipment malfunction, the facility’s protocol for health care equipment servicing shall be followed.
- The manufacturer’s recommendations shall be followed during an unscheduled laser system shutdown, and the following information should be recorded in the laser utilization record:
  a) time and date of shutdown;
  b) time and date of notification of problem, if any;
  c) nature of problem;
  d) person notified (to be stated in the facility’s standard operating procedures (SOPs)); and
  e) date of return to service.
Note: The laser might need to be shut down under any of the following conditions:
   a) shutter failure (i.e., shutter for the aiming lamp and/or laser lamp remains open);
   b) beam delivery system is not connected to the laser aperture securely;
   c) unexplained or uncontrolled operation occurs (i.e., inconsistent pulse power, power outage);
   d) if a fire occurred in the room; and
   e) other equipment malfunctions affecting the safety of the patient and attending personnel.

Nominal Ocular Hazard Area (NOHA)

If entrances to the laser-controlled area fall within the boundaries of the NOHA, administrative, engineering, or architectural design controls shall be initiated to prevent the NOHA from extending beyond the entrances.

Note: Examples of suitable controls include
   a) repositioning the patient or laser within the laser-controlled area;
   b) placing barriers in front of the entrances; and
   c) sealing cracks between doors and their frames.

Laser-controlled Area

The administrator shall ensure that the area in which the health care laser is used provides a safe work environment. The following procedures shall be followed in the laser-controlled area:

a) Access by staff shall be ensured at all times by controlling the entrances (in accordance with local rules for fire safety). Doors providing access to the laser-controlled area shall not be interlocked to the firing mechanism of the health care laser, i.e., the opening of a door to the laser-controlled area shall not switch off the laser.

b) Signage shall comply with Figure 1 and 2, be posted at every door at eye level, and be visible only when the laser is in use and then be removed or covered.

c) Personal protective equipment (PPE) intended for use with the laser in the controlled area shall be posted with each door warning sign.

d) Windows and openings permitting viewing access to the laser-controlled area shall be covered or rendered in such a way as to restrict the passage of the laser beam through them. Window barriers shall be used for wavelengths shorter than 4000 nm and in between 180 nm to 300 nm, tested and approved to attenuate transmission of the laser beam to below the MPE, in accordance with the following:
   i) barriers shall be labelled in accordance with IEC 60825-1 (2007);
   ii) protection shall meet infection control requirements;
   iii) barriers shall be controllable from inside the laser room; and
   iv) barriers shall not allow any light leakage at the perimeters of the barriers.

If the MPE is exceeded at the entryway, a curtain or barrier is also needed.

Note: The beam of a CO2 laser does not pass through glass. Therefore, windows and other openings might not require covering when this type of laser is in use.

e) The area shall be supervised by credentialed personnel trained in laser safety and approved by the LSO.

f) The area shall be occupied by personnel approved by the LSO.

g) The environment shall be free of highly reflective surfaces that could interfere with the beam path or might be present within the NOHA.
h) The environment shall be free of flammable surfaces or materials that could interfere with the beam path.
i) Keys shall be removed from the control panel and stored with access only by personnel approved by the LSO.

j) When more than one wavelength is present in the NOHA, only one may be activated at a time, and only one set of corresponding protective eyewear shall be out and available.
k) The NOHA shall be reassessed if it increases during repair, service, or maintenance.

The presence of highly reflective surfaces in laser-controlled areas for Classes 3R, 3B, and 4 lasers should be minimized. Sources of reflections can include mirrors, highly polished glass, and surgical instruments.

### Heating, Ventilation, and Air Conditioning

- Heating, ventilation, and air conditioning (HVAC) systems shall comply with appropriate national or provincial building codes and shall comply with CAN/CSA-Z317.2 or ANSI/ASHRAE 170 (ventilation standards for air quality, air changes per hour, etc.).
- For the purpose of HVAC requirements, a laser-controlled area where a laser plume is generated should be considered similar to an operating room.
- HVAC upgrades shall be considered for laser-controlled areas where:
  a) the existing HVAC system does not meet the minimum air exchange rates described in Clause 8.3.2; and
  b) large volumes of laser plume are produced.
- Augmentations to the existing HVAC system could include:
  a) using a dedicated high-volume scavenging system, linked or vented into a permanently installed ventilation system and separate from the HVAC system, that can be localized close to the operative site;
  b) exhausting return air to the outdoors; or
  c) increasing the number of air changes per hour.
- New health care facilities or those undergoing renovation should consider provisions for venting scavenged air to the outdoors so that it need not be recirculated within the laser-controlled area.
- Laser equipment shall be used in a well-ventilated area to help remove excess heat generated by the laser. The air intake and outlet shall be kept unobstructed at all times.

### Engineering Controls (Equipment)

The health care laser shall, as a minimum, include the following features:

a) a power meter (or an energy meter in the case of a pulsed laser) capable of indicating tissue incident power for Classes 3R, 3B, and 4 lasers;

*Note: In the case of pulsed lasers, the energy meter should indicate the average power of the laser, or the number of pulses per second, or both, as well as the pulse energy (per pulse).*

b) a removable key (i.e., the laser shall be inoperable without key) or similar device without a key (i.e., keyboard or other means for on/off mechanism) for Classes 3R, 3B, and 4 lasers;

c) a visual warning activated during laser emission (in some circumstances, an audible warning may also be present);
Note: Laser users need to be aware of the status of the laser at all times. The status indicators described in Item c) should fulfill this requirement.

- d) warning labels at all apertures (i.e., at apertures and other locations on the laser system);
- e) a switch guard to prevent unintended operation of the laser system (e.g., a guarded foot pedal); and
- f) a laser operating manual that thoroughly addresses its use and associated hazards.

*Note: The LSO needs to reassess his or her hazard analysis and procedures following software upgrades.*

Laser delivery devices shall be in accordance with the following:

- a) Only the manufacturer’s laser delivery devices shall be used on the laser.
- b) Laser delivery devices shall be assembled and tested according to the manufacturer’s instructions. Testing shall be done with the laser delivery devices that will be used for the procedure.
- c) Optics shall be checked for their integrity and cleaned according to the manufacturer’s instructions.
- d) The laser user handling the laser delivery device shall be the only one operating the laser footswitch or handheld device. The footswitch shall not be bagged, as this can cause inadvertent firing.
- e) Laser delivery devices shall be maintained and serviced according to the manufacturer’s instructions.
- f) A laser delivery device operating manual shall thoroughly address its use and associated hazards.

All instruments used in the beam path or adjacent to the treatment site shall have a matte finish or a diffusive surface to prevent specular reflections and shall be checked and reprocessed as surfaces become smooth after use.

### Warning Signs

- Warning signs posted in the vicinity of the laser-controlled area shall
  - a) identify the laser-controlled area;
  - b) establish the nature of the hazard by specifying the wavelength and class of laser being used;
  - c) be posted on all means of access to the area;
  - d) only be posted or illuminated when the system is powered on or in standby; and
  - e) indicate that protective eyewear shall be worn.

- Permanently mounted, non-illuminated warning signs shall be avoided, as some personnel might become used to their presence and ignore them.

- Where illuminated signs are in use, they shall be illuminated only when the laser system is switched on.

- The appropriate warning signs shown in Figure 3 shall be posted when health care lasers are used in laser-controlled areas. The wording of the warning signs is recommended but not mandatory. Other wording that conveys the same message may be substituted.

- Adequate space shall be left on all signs to permit the inclusion of pertinent information. and shall include the following:
  - a) at Position 1, above the tail of the sunburst, special precautionary instructions or protective actions required, such as
    - i) for Class 3B health care lasers and laser systems, “LASER
### Patient Protection

To avoid accidental exposure, teeth in the operative field shall be protected with a wrapping of material appropriate to the wavelength emitted by the laser.

**Note:** Laser irradiation of tooth enamel could leave permanent marks.

A patient undergoing a laser procedure shall be fitted with protection, e.g., padding, eye cups, glasses, etc., appropriate to the procedure, wavelength, and power levels being used.

**Notes:**

1. *In the case of visible or near-infrared wavelengths (0.4 μm to 1.4 μm), the moist eye pad should be covered with a metal eye shield and another moist pad should be placed on top.*
2. *Appropriate eye shields should be placed on top of the cornea to protect the eye during laser treatment of the eyelid. Lubricant, if used, should be water based.*

Prior to the procedure, patients should be provided with brochures or other illustrative materials explaining the laser procedure to be performed, the steps involved during the procedure, and pre- and post-treatment instructions. Patients shall be provided with information describing the risks associated with the laser procedure and the patient protective measures that will be taken.

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| RADIATION - AVOID DIRECT EXPOSURE TO BEAM” and i) for Class 4 health care lasers and laser systems, “LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION” b) at Position 1, above the tail of the sunburst, special precautionary instructions or protective action such as “LASER TREATMENT IN PROGRESS - EYE PROTECTION REQUIRED, OD ___” c) at Position 2, below the tail of the sunburst, the type of laser (ruby, helium-neon, etc.) and the emitted wavelength, pulse duration (if appropriate), and maximum output; and d) at Position 3, the class of the health care laser or laser system. | 8.7.8 |  

The warning sign shown in Figure 4 shall be posted outside of a temporary laser-controlled area, e.g., during periods of servicing. When a temporary laser-controlled area is created, the area outside the temporary area remains Class 1 while the area within is either Class 3B or 4, and the appropriate danger warning is required (see Figure 3). The wording of the warning sign is recommended but not mandatory. Other wording that conveys the same message may be substituted.

Adequate space shall be left on all signs to permit the inclusion of pertinent information and shall include the following:

a) at Position 1, above the tail of the sunburst, “SERVICE IN PROGRESS”

b) at Position 2, “DO NOT ENTER”

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Alberta Dental Association and College
Guide for Radiation Health and Safety Program
**Laser Acquisition**

The health care facility shall have a documented process for the selection and acquisition of health care lasers. The same type of evaluation process applied to purchased equipment shall be applied to donated, leased, and loaned equipment. This process shall include an assessment of the need and usefulness of the equipment within the facility.

The following factors shall be taken into consideration when acquiring a health care laser:

a) The health care facility designee should prepare a clear statement of objectives on the use of the laser system to ensure its safe and efficient use. **Note:** It is vital that a needs assessment and impact analysis be performed to ensure the safety of both patients and personnel.

b) The health care facility shall ensure that all policies, procedures, education, training, and safety guidelines are in place prior to the use of the laser systems with patients, even when the equipment is being evaluated on a trial basis.

c) The model of the laser to be acquired should be determined by the features and capabilities of the system, the laser user’s preference, and the expected results. The level of difficulty in servicing the system and operating the system, and the financial practicality of using a laser system should also be taken into consideration. **Note:** The laser user’s preference should not necessarily be the primary determination of the laser selection process. The efficiency, reliability, ease of servicing, costs of service contracts, and other costs are important factors. The laser user might leave the health care facility at some time in the future; the facility could then be left with the responsibility of maintaining a laser for which there is limited use.

d) The appropriateness of the room(s) in which the laser is to be used should be reviewed for the laser system’s requirements and the hazard controls affecting both the patient and laser personnel. As a minimum, the following factors should be considered during this evaluation:

   i) electrical services;
   ii) ventilation services;
   iii) fenestrations;
   iv) physical dimensions and storage space;
   v) access restrictions;
   vi) safety needs of maintenance and service personnel; and
   vii) additional services required to support the procedures performed in the room(s).

**Note:** Adequate consideration of these factors can lead to an improved quality of care (i.e., favourable patient recovery and outcome, laser personnel comfort and efficiency) and could have beneficial financial implications.

Health care laser equipment shall be marked with an appropriate risk class or equipment type in accordance with the requirements of CAN/CSA-E60825-1, as applicable. Any laser system being considered for acquisition should, if possible, be installed at the health care facility for use on a trial basis by all the laser users intending to use the laser system, in order to evaluate the appropriateness of the technology and the expected use of the equipment.
The laser system which is being used on a trial basis shall only be operated by facility credentialed personnel (see Clause 6) when used with patients. The system may be operated under the supervision of a qualified clinical and/or technical representative when used on inanimate teaching or test objects.

Safety equipment may be available at the time the laser system is acquired. The following equipment could be part of the laser accessory list:
- a) protective eyewear for patients and personnel;
- b) laser-use warning signs;
- c) laser-resistant endotracheal tubes;
- d) laser-compatible endoscopes and endoguides;
- e) slit lamps, indirect ophthalmoscopes, and/or fiber optic delivery systems;
- f) disposable filtration respirators; and
- g) plume-scavenging systems and their replacement filters.

Instruments to be used with the laser shall have a matte or diffusive surface finish to prevent errant specular reflections of the laser light.

**Laser Installation**

The space or room in which the laser system is installed shall meet the appropriate requirements of the Canadian Electrical Code, Part I, and the equipment manufacturer’s instructions.

**Note:** Users of this Standard should refer to Sections 24 and 52 of the Canadian Electrical Code, Part I, and to CSA Z32.

**Laser Maintenance**

The health care facility LSO or designee shall ensure that a maintenance program for health care lasers is in place and that personnel are appropriately qualified, whether in-house services or contracted services are used.

Inspections, tests, and maintenance, as described in this Standard, shall be:
- a) made in accordance with a written plan approved by the health care facility;
- b) made upon failure of the equipment to operate properly (equipment function settings and parameters should be noted at the time of equipment malfunction);
- c) made at the intervals indicated in the description of each test or inspection (these intervals should not be less than those recommended by the manufacturer); and
- d) recorded in a maintenance record which forms a part of the facility’s permanent records. The maintenance record shall contain a page, card, or file for each laser.

All laser equipment malfunctions shall be recorded and corrected. The dates on which each malfunction, e.g., deviation from present requirements or the manufacturer’s specifications, or physical damage, was first noted and ultimately corrected shall be entered in the record.

Equipment service information, i.e., repairs, maintenance, calibration, and compliance with the preventive maintenance program, shall be made available to equipment users to ensure that they are kept informed of the status of the equipment.

Preventive maintenance assurance shall verify, but not be limited to,
- a) correct operation of key functions of the laser’s operation in conjunction with the manufacturer’s service and operator manuals;
- b) the power output of the laser beam;

**Note:** This should be verified periodically, at least every six months to a year, and checked against the output rating on the control panel. With time and use, components age, dirt accumulates, and optics can become misaligned.
c) the integrity of all covers and insulation designed to prevent access to live parts; and
d) that leakage currents are within proper limits.

- Inspection and maintenance shall be provided if there are indications that the health care laser system:
  a) has been subjected to extreme mechanical stress (e.g., been bumped or struck);
  b) has had fluid invasion into or on the laser;
  c) has been subjected to extreme temperature or humidity;
  d) performance appears to have changed;
  e) has portions of the enclosure cracked, removed, or missing;
  f) has had any attachment plug, power supply cord, or patient connection deteriorate; or
  g) has smoke or odours being released.

- Personnel who require access to the laser or laser system contained within a protective housing or beam enclosure shall comply with the appropriate control measures of the embedded laser or laser system. The service personnel shall have education and training commensurate with the class of the embedded laser or laser system.

- Secured entry or an enclosure shall be used when laser hazards that are otherwise normally shielded are exposed (i.e., during repair and maintenance).

- Alignment of laser optical systems, e.g., mirrors, lenses, and beam deflectors, shall be performed in such a manner that the primary beam, or a specular or diffuse reflection of a beam, does not expose an eye to a level above the applicable MPE.

Responsibilities, Education, Training and Credentials

1. Each member of the laser team shall have the authority, as well as responsibility, to halt an unsafe practice. All team members shall be equally knowledgeable and aware of activities occurring in the laser controlled area to ensure patient and staff safety at all times.

- Health care facilities where lasers are in use should have or establish a laser safety committee (LSC). The LSC shall consist of the LSO and should include, but not be limited to, representatives from:
  a) nursing administration;
  b) medical administration;
  c) biomedical or clinical engineering;
  d) risk management and quality assurance;
  e) laser users;
  f) anesthesia;
  g) laser operators;
  h) occupational health professionals;
  i) infection control professionals; and
  j) clinical education services.

- The duties of the LSC should include, but not be limited to:
  a) development and approval of policies governing the safe use of lasers in the health care facility;
  b) definition and implementation of maintenance guidelines for the laser system;
  c) definition, monitoring, and enforcement of safety standards and policies developed for laser applications;
  d) definition of the LSO’s duties and responsibilities (See Clause 6.3.1);
| e) ensuring that a safety survey is conducted in all areas using laser equipment at intervals determined by the LSO; |
| f) recommendation of laser-safety criteria for granting laser privileges to qualified physicians; |
| g) facilitating safety training and education of all staff involved with laser surgery; |
| h) review of all laser equipment and related health care facility modifications with respect to acquisition, with input from medical personnel when appropriate; |
| i) review of new applications for laser equipment as they become available; |
| **Note:** When improving or expanding laser facilities, examine existing equipment or possible upgrades (laser accessories as well as the laser system) to determine to what extent already-acquired equipment can be utilized. |
| j) review and recommendation of data elements to be included in facility-approved records, logs, and documentation forms; and |
| k) development of quality assurance and risk management programs. |

**Facility administration shall:**

1. Verify initial and continuing credentials or approvals for all personnel responsible for working with lasers (e.g., physicians, laser operators, associated health care staff, laser users other than physicians, laser service providers, and manufacturers).
2. Ensure that laser safety and education programs for all personnel are conducted
   a) when an existing laser system
      i) is used in a new application;
      ii) undergoes a change to operational components (e.g., software updates); or
      iii) is used with a new delivery device;
   b) when a new or replacement laser system is to be placed into service;
   c) following a period of absence (as determined by the LSO) from participating in laser procedures;
   d) at the request of the administrator, the LSO, the LSC, or the staff member concerned; and
   e) at a minimum of every 2 years.
3. Require that a written program be developed and used for the education and training of personnel appropriate to their responsibilities in the laser-controlled area, as recommended by the LSC and approved by the LSO.
4. Determine the qualification of instructors. Criteria and qualifications to consider are as follows:
   a) minimum 2 years clinical experience with lasers in a clinical environment;
   b) recommendations from the LSC;
   c) LSO (laser safety officer) or DLSO (deputy laser safety officer);
   d) CMLSO (certified medical laser safety officer) or equivalent;
   e) perioperative educators (laser experience preferred); and
   f) third-party experts in laser safety education.

**Training programs shall be evaluated by the LSO and the LSC for applicability to the facility’s practice.**

**Successful completion of the program for all personnel responsible for working with lasers shall be documented.**

6.2.2.1

6.2.2.2

6.2.2.3

6.2.2.4

6.2.2.5
Health care facilities where lasers are in use shall appoint an LSO and should appoint a deputy laser safety officer (DLSO) as needed.  
**Note:** The LSO may delegate any responsibilities to a designate with the appropriate qualifications or credentials.

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|**6.3.1.2** | The LSO shall be responsible for the following:  
a) facilitating the development of the laser safety program;  
b) implementing and enforcing all laser safety policies and procedures approved by the facility administration;  
c) supporting and advising the health care administration with respect to the safe use of lasers and compliance with protective measures;  
d) participating in the investigation of all laser-related incidents and malfunctions and making recommendations for remedial and preventive action;  
e) conducting hazard evaluations of sites, including determination of the NOHA;  
f) advising on the purchase of all laser-related personal protective equipment (PPE) and laser systems and instrumentation;  
g) auditing the effectiveness of  
   i) the laser safety program;  
   ii) maintenance of appropriate documentation;  
   iii) compliance with policies and procedures; and  
   iv) compliance with applicable standards and regulations;  
h) recommending the suspension, restriction, or termination of the use of a laser or laser system if it is determined that the laser hazard controls are inadequate or unsafe conditions are present;  
i) verifying that preventive maintenance, repair, and servicing are performed and advising the user of any resulting changes or modifications to the system;  
j) verifying that the manufacturer/distributor is in compliance with all applicable legislation;  
k) ensuring the safety education and training of all personnel involved in laser procedures;  
l) verifying and maintaining a list of health care personnel, authorized laser operators, and assistants, as well as documentation of their clinical competency; and  
m) any additional services requested by facility administration.  

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|**6.3.1.3** | The education and training for the LSO and the DLSO shall include, but not be limited to,  
a) principles of laser science and tissue interactions;  
b) risk assessment;  
c) evaluation and selection of PPE;  
d) facility policies, procedures, and applicable standards and regulations for laser safety;  
e) wavelength-specific applications;  
f) laser set-up, testing, and shutdown procedures;  
g) monitoring the environment and equipment during laser use; and  
h) emergency procedures (e.g., in case of fire).  

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|**6.3.1.4** | A list of personnel with procedure-specific and wavelength-specific laser privileges shall be maintained by the LSO and within those departments providing laser services.  

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|**6.3.1.4.2** | The LSO, in collaboration with the facility administration, shall ensure that laser safety and education programs for all personnel are conducted  
a) when an existing laser system  
   i) is used in a new application;  
   ii) undergoes a change to operational components (e.g., software  

| updates); or  
| iii) is used with a new delivery device;  
| b) when a new or replacement laser system is to be placed into service;  
| c) following a period of absence (as determined by the LSO) from participating in laser procedures;  
| d) at the request of the administrator, the LSO, the LSC, or the staff member concerned; and  
| e) at a minimum of every 2 years.  

The assignment of a laser user shall be approved by the facility’s credentials committee and administration. Maintenance of competencies, including updates on safety education, shall be monitored by the laser safety officer (LSO) at a frequency determined by facility administration. Candidates for laser user shall meet the qualifications and credentials for a given clinical setting and application.

| 6.3.2.2  
| In the absence of a laser operator or assisting staff, the responsibilities of the laser user shall include, but are not limited to, the following:  
| a) Pre-laser set-up: ensuring that laser safety procedures, including correct set-up and testing of the laser and related equipment, are followed. This includes, but is not limited to,  
| i) checking the laser system before operation;  
| ii) ensuring controlled access to laser operation (e.g., operation key and power switch locks are restricted to authorized personnel only);  
| iii) ensuring that the laser is in “standby” or “off” mode when not in use;  
| iv) checking the laser beam alignment and fibre integrity;  
| v) visually inspecting the laser equipment for potential electrical malfunctions;  
| vi) ensuring that user/operator manuals and facility policies are present in the laser-controlled area.  
| b) Laser treatment: ensuring that safe laser treatment is employed for the patient and all personnel in the treatment area. This includes, but is not limited to,  
| i) being in the room at all times during laser usage;  
| ii) selecting appropriate laser parameters for a given clinical application;  
| iii) ensuring appropriate eye and skin protection is employed by all personnel in the treatment area;  
| iv) ensuring the safe and proper use of ancillary equipment (such as plume evacuators or cooling apparatus);  
| v) safeguarding against laser beam reflection or inadvertent transmission to unintended targets (e.g., use of beam stops and minimally reflective instruments);  
| vi) assembly of safety equipment and ensuring that it is immediately accessible should it be needed (e.g., wet gauze); and  
| vii) immediate identification of laser-tissue complications and subsequent management.  
| c) Post-laser treatment: ensuring the safe conclusion of laser operation. This includes, but is not limited to,  
| i) completing documentation as required by the facility (e.g., operating checklist, log book, patient admission forms);  
| ii) ensuring post-procedure cleaning and storage of the laser and related equipment;  
| iii) reporting unusual events and safety concerns to the LSO;  
| iv) ensuring that the laser equipment, patient, and laser personnel are all in safe condition to exit the laser-controlled area; and  
| v) post-operative instructions to the patient and arrangement of
<table>
<thead>
<tr>
<th>Section</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3.2.4</td>
<td>Laser users shall undergo Level 4 laser training as outlined in Annex E with review of education at a minimum of every 2 years.</td>
</tr>
<tr>
<td>6.3.3.2</td>
<td>The assignment of a laser operator shall be approved by the facility’s credentials committee and administration. Maintenance of competencies, including updates on safety education, shall be monitored by the laser safety officer (LSO) at a frequency determined by facility administration. Candidates for laser operator shall meet the qualifications and credentials for a given clinical setting and application.</td>
</tr>
<tr>
<td>6.3.3.3</td>
<td>The responsibilities of the laser operator shall include, but are not limited to, the following: a) Pre-laser set-up: ensuring that laser safety procedures, including correct set-up and testing of the laser and related equipment, are followed. This includes, but is not limited to, i) establishing the laser-controlled area; ii) obtaining the laser key, and positioning the laser and all required laser-related and safety equipment in the laser-controlled area; iii) visually inspecting the laser equipment for potential malfunctions or damage; iv) performing applicable testing or calibration as indicated in the manufacturer’s instructions; and v) returning the laser to the “standby” position or shutting down and removing the key if laser use is delayed. b) Laser treatment: ensuring that safe laser treatment is employed for the patient and all personnel in the treatment area. This includes, but is not limited to, i) monitoring all aspects of laser and laser-related device use at all times when the laser is in “ready” mode; ii) being in the room at all times during laser usage, and remaining at the control panel when the laser is in “ready” mode; and iii) ensuring good communication between laser user and laser operator (e.g., regarding status of laser and parameters). c) Post-laser treatment: ensuring the safe conclusion of laser operation. This includes, but is not limited to, i) completing documentation as required by the facility (e.g., operating checklist, log book, patient admission forms); ii) ensuring post-procedure cleaning and storage of the laser and related equipment; and iii) reporting unusual events and safety concerns to the LSO.</td>
</tr>
<tr>
<td>6.3.3.4</td>
<td>Laser operators shall undergo Level 2 laser training as outlined in Annex E with review of education at a minimum of every 2 years.</td>
</tr>
<tr>
<td>6.4.1.2</td>
<td>The assignment of health care personnel shall be approved by the facility’s credentials committee and administration. Health care personnel shall be authorized to perform specific duties in a laser-controlled area. Candidates for health care personnel shall meet the qualifications and credentials for a given clinical setting and application.</td>
</tr>
<tr>
<td>6.4.1.3</td>
<td>Responsibilities of health care personnel in a laser-controlled area shall be clearly assigned and be understood by all respective individuals. Health care personnel should restrict their actions during laser treatment to their specific role only and not engage in activities beyond their scope.</td>
</tr>
<tr>
<td>6.4.1.4</td>
<td>Health care personnel shall undergo Level 1 laser training as outlined in Annex E with review of education at a minimum of every 2 years.</td>
</tr>
<tr>
<td>6.4.2.2 &amp;</td>
<td>Responsibilities of observers in a laser-controlled area are to remain non-obstructive to the process of laser treatment and to not interfere with any aspect</td>
</tr>
</tbody>
</table>
of activities during the session. If an observer is feeling unwell or anticipates disruption of the laser treatment process in any way, that individual shall inform the laser user or laser operator of the situation and ask permission to leave the laser-controlled area. Observers shall comply with all facility policies and procedures. The LSO shall determine the level of education or orientation required for observers in the NOHA.

| 6.4.2.3 |

Trainees shall be under the direct supervision and responsibility of authorized laser personnel. Responsibilities of trainees in a laser-controlled area are to remain non-obstructive to the process of laser treatment and to not interfere with any aspect of activities during the session. Trainees shall strictly abide by instructions outlined by their laser personnel supervisor. If a trainee is feeling unwell or anticipates disruption of the laser treatment process in any way, that individual shall inform the laser user or laser operator of the situation and ask permission to leave the laser-controlled area. Trainees shall undergo Level 1 laser training as outlined in Annex E.

| 6.4.3.1 |
| & |
| 6.4.3.2 |
| & |
| 6.4.3.3 |

## Annex E - Education and Training

### Level 1

- This is necessary for:
  - non-clinical facility personnel who are involved in the management of the laser program or laser services
  - observers
  - trainees

This is suggested for:
- non-clinical members of the laser safety committee (LSC)
- administration and management, assumed to be non-clinical personnel.

Need is education on the risk management aspects - standards, audit, and compliance.

The content shall include, but is not limited to, the following:
- overview of this Standard
- facility policy and procedure
- types of lasers used and general applications in the facility
- roles, authority, and responsibilities of laser team members
- contact information for the LSO

| E.1 |

### Level 2

- This is necessary for:
  - Laser operator (LO)

This includes:
- Level 1 laser training

The content shall include, but is not limited to, the following:
- laser physics
- laser–tissue interaction
- types of lasers and their delivery systems
- accessory equipment and instrumentation needed for specific applications
- understanding treatment parameters and dosimetry
- roles, authority, and responsibilities of laser team members
- assessment of hazards and risks
- reporting
- applicable documentation

<p>| E.2 |</p>
<table>
<thead>
<tr>
<th>Level 3</th>
<th>This is necessary for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Laser safety officer (LSO)</td>
<td></td>
</tr>
<tr>
<td>This includes:</td>
<td></td>
</tr>
<tr>
<td>• Level 2 laser training</td>
<td></td>
</tr>
</tbody>
</table>

The content shall include, but is not limited to, the following:

• all items in Level 1 and 2 training
• regulatory requirements in the specific jurisdiction
• application of this Standard
• hazard identification and implementation of applicable control measures
• facility reporting for accidents, incidents, or occurrences

<table>
<thead>
<tr>
<th>Level 4</th>
<th>This is necessary for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Laser users (LU)</td>
<td></td>
</tr>
</tbody>
</table>

The content shall include, but is not limited to, the following:

• all items in Level 1 and 2 training
• clinical application and techniques for intended procedures
• treatment parameters and dosimetry for intended procedures
• patient safety
• management of complications
• competency in operating the laser and its delivery systems
• competency in use of safety equipment (e.g., protective eyewear, emergency stop switch, standby switch, plume evacuator, microscope eye safety filters, accessory instrumentation, fire extinguisher, wet drapes, etc.)
## Appendix 6 - Compliance Verification Checklist Dental Cone Beam CT X-ray Equipment

In accordance with:
- Radiation Emitting Device Regulations (Nov 4, 2009), and
- Radiation Protection Act (November 1, 2010)

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Compliance Item Description</th>
<th>General Information &amp; Facility Requirements</th>
<th>Reference</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>There is an existing certificate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>If (1) is &quot;yes&quot;, the certificate must be posted in the room or nearby (except mobile).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>For mobile: If (1) is &quot;yes&quot;, where is the certificate?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>The radiation shielding of the room is adequate and meets regulatory standards.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5.</td>
<td>The X-ray warning signs are posted on the entrance doors to the X-ray room.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Protective apparel is available to patient and any individual in the irradiation area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>A quality assurance program exists for the equipment</td>
<td>SC30: 7.5.3 RPA: 14(1)-(2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>A preventive maintenance program exists for the equipment.</td>
<td>RPA: 14(1)-(2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>A scattered radiation profile is provided for information.</td>
<td>SC30: 5.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>The radiation equipment has been approved for use in Canada</td>
<td>SC30: 5.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Radiation Protection

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Compliance Item Description</th>
<th>General Information &amp; Facility Requirements</th>
<th>Reference</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>I. Shielding and Protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. 20 mSv per year for radiation worker in controlled areas</td>
<td>SC30: 4.1(i)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. 1 mSv per year for members of the public in uncontrolled areas</td>
<td>SC30: 4.1(ii)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Rooms which can be accessed from public areas should be equipped with a self-closing door.</td>
<td>SC35: B1.2.2.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>The X-ray equipment should be positioned in the room in such a way that, during an irradiation, no one can enter the room without the knowledge of the equipment operator.</td>
<td>SC35: B1.2.2.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>The operator is not exposed to the primary radiation beam.</td>
<td>SC30: 4.2.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>The operator keeps a distance of at least 3 metres from the X-ray tube and the patient. If this is not possible, an adequately shielded barrier, which allows observation of the patient, must be provided for the</td>
<td>SC30: 4.2.1</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
16. The primary radiation beam and scattered radiation are absorbed as close as possible to the source. SC30: 4.2.4

17. The primary radiation beam is always directed towards a shielded or unoccupied area. SC30: 4.2.5

18. All personnel must fully use all protective devices available. SC30: 8.1.4

19. All operators of X-ray equipment, together with personnel who routinely participate in radiological procedures must wear personal dosimeters under their protective clothing. SC30: 8.1.9 & 8.1.10

20. Radiation protection surveys have been performed as required. SC30: 4.2.7

21. Dental Radiography
   (a) must not be carried out at X-ray tube voltages below 50 kilovolts (peak); SC30: 9.2.4
   (b) should not be carried out at X-ray tube voltages below 60 kilovolts (peak).

22. Protective apparel
   (a) the patient must be provided with a shielded apron, for gonad protection, and a thyroid shield; SC30: 9.2.7
   (b) the apparel should have adequate lead equivalency: (0.25 mm for gonads and thyroid shields and preferably 0.5 mm for aprons);
   (c) in panoramic radiography, dual (front and back) lead aprons should be worn;
   (d) in CT radiography, dual (front and back) lead aprons should be worn.

General Requirements of the Equipment

23. II. Labelling
   For Generator
      (a) the name of the manufacturer,
      (b) the model designation,
      (c) the serial number,
      (d) the date of manufacture, and
      (e) the country of manufacture.

   For X-ray Tube
      (a) the name of the manufacturer,
      (b) the model designation,
      (c) the serial number,
      (d) the country of manufacturer,
      (e) specification of the minimum permanent inherent filtration (expressed in mm Al).

REDR: II 5.(1)(c) REDR: II 5.(1)(d)
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24.</td>
<td>III. Warning Signs</td>
<td>SC30: 5.2.1.1</td>
</tr>
<tr>
<td></td>
<td>The X-ray control panel must bear a permanent, visible and legible sign warning that hazardous X-rays are emitted when the equipment is in operation and prohibit unauthorized use.</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>IV. Markings</td>
<td>SC35: B2.5.1.2</td>
</tr>
<tr>
<td></td>
<td>All controls, meters, lights and other indicators relevant to the operation of the equipment must be readily discernible and clearly labelled or marked as to function.</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>V. Mechanical Stability</td>
<td>SC35: B2.5.1.3</td>
</tr>
<tr>
<td></td>
<td>1. The X-ray tube must be securely fixed and correctly aligned within the CT gantry.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. The X-ray source assembly must maintain their required positions without excessive drift or vibration during operation.</td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>VI. Indicators and Indicator Lights</td>
<td>SC30: 5.2.1.2</td>
</tr>
<tr>
<td></td>
<td>1. There must be readily discernible, separate indicators on the control panel that indicate:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) when the control panel is energized and the machine is ready to produce X-rays;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) when X-rays are being produced.</td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>VII. Indication of Loading Factors</td>
<td>SC30: 5.2.1.3</td>
</tr>
<tr>
<td></td>
<td>1. Dental X-ray equipment having adjustable loading factors must incorporate meters or other indicators on the control panel that enable determination of the X-ray tube voltage, X-ray tube current and time, or combination of these.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. For equipment having non-adjustable loading factors, permanent marks or labels may be used to indicate these parameters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. All CT conditions (section thickness, pitch factor etc…) of operation during a scan series must be indicated prior to the initiation of a scan or scan series.</td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>VIII. Irradiation Control and Movement Termination</td>
<td>SC30: 5.2.1.4</td>
</tr>
<tr>
<td></td>
<td>1. There must be an irradiation switch to initiate and terminate X-ray production.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Initiation or continuation of irradiation is only possible from the control panel.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. An emergency stop switch must be in place on or near the patient support and/or gantry to immediately terminate the motion of the equipment and the emission of X-rays.</td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>IX. Controlling Timer</td>
<td>SC30: 5.2.1.5</td>
</tr>
<tr>
<td></td>
<td>1. An electronic timing device must be provided to automatically terminate the irradiation. Mechanical timers must not be used.</td>
<td></td>
</tr>
</tbody>
</table>
2. The timer must be designed and constructed in such a way that:
   (a) it is not possible to energize the X-ray tube without automatic or manual resetting of the timer after each loading;
   (b) irradiation cannot be started with the timer set at its zero or OFF position;
   (c) the production of X-rays is automatically terminated after a preset time, milliampere-second value, or exposure value.

Equipment Performances

31. X. X-ray Tube Shielding
   (1) The X-ray tube must be enclosed in a shielded housing.
   (2) The shielding of the housing must be such that the leakage radiation from the X-ray source assembly shall not exceed an air kerma rate of 1.0 mGy/h at a distance of 1 m away from the focal spot, when operated at the nominal X-ray tube conditions of loading corresponding to the maximum specified energy input in one hour and, when the equipment is not in the loading state, 20 uGy/h at a distance of 5 cm from any accessible surface.

32. XI. X-ray Beam Filtration
   There must be radiation-absorbing filters that provide a degree of attenuation such that the first Half-Value Layer (HVL) of aluminum is not less than the values shown below for a selected X-ray tube voltage. For other X-ray tube voltages, the HVL of the radiation beam must be calculated by linear interpolation from that table.

<table>
<thead>
<tr>
<th>X-ray Tube Voltage (kV)</th>
<th>Half-Value Layer of Aluminum (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>1.9</td>
</tr>
<tr>
<td>70</td>
<td>2.1</td>
</tr>
<tr>
<td>80</td>
<td>2.4</td>
</tr>
<tr>
<td>90</td>
<td>2.7</td>
</tr>
<tr>
<td>100</td>
<td>3.0</td>
</tr>
<tr>
<td>110</td>
<td>3.4</td>
</tr>
</tbody>
</table>

33. XII. Radiation Output Reproducibility
   For any combination of operating loading factors, the coefficient of variation of any ten consecutive irradiation measurements, taken at the same source to detector distance within a time period of one hour, is no greater than 0.05. The coefficient of variation is the ratio of the standard deviation to the mean value of a series of measurements calculated by using the following equation:

\[
C = \frac{S}{\bar{X}} = \frac{1}{\bar{X}} \left[ \frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1} \right]^{\frac{1}{2}}
\]
where \( C \) is the coefficient of variation, \( S \) is the estimated standard deviation, \( X_i \) is the value of the \( i \)th measurement, \( \bar{X} \) is the mean value of the measurements, and \( n \) is the number of measurements.

34. III. Radiation Output Linearity
For any preselected value of X-ray tube voltage, within an applicable range, and for any irradiation time greater than 1/20 second, the quotient of the average air kerma measurement divided by the indicated current time product obtained at two applicable settings must not differ by more than 0.10 times their sum, that is,

\[
| X_1 - X_2 | \leq 0.10 \left( X_1 + X_2 \right)
\]

where \( X_1 \) and \( X_2 \) are quotients of the average air kerma measurement divided by the current time product at two applicable settings of X-ray tube current (fixed irradiation time) or irradiation timer (fixed tube current). Both settings must not differ by more than a factor of two.

35. XIV. X-ray Tube Voltage
1. The actual peak X-ray tube voltage should not deviate from the indicated or selected value by more than 7%, or by the value specified by the manufacturer.
2. It must not be possible to set or operate the X-ray tube with the tube voltage below 50 kilovolts (peak).

36. XV. Computed Tomography
1. The performance of the CT X-ray equipment is evaluated using phantoms of proper design.
2. The dose delivered by the CT X-ray system is determined using a CT dosimetry phantom.
3. Base-line dose and image information required to assess the Continuing performance of the CT X-ray system has been obtained from the manufacturer or has been established by a qualified medical physicist.
4. In normal use the information indicating the orientation of the displayed image with respect to the patient must be displayed with each image.
5. Light Field
   (a) A light field must be provided for marking the tomographic section or reference plane.
   (b) The light must be visible under ambient light conditions of up to 500 lx.
   (c) The width of the light field must not exceed 3 mm, measured in the centre of the gantry opening, and the coincidence of the centre of the light field and the centre of the tomographic plane must be
within 2 mm.

6. The minimum focal spot to skin distance must be at least 15 cm.
7. The collimation must be such that the primary radiation beam is fully intercepted by the detector at the focal spot to film distance.

SC35: B2.5.4.4
SC30: 5.2.4
Appendix 7 – Registration Process Charts

Registration is required in the following situations:

Registration Process #1 – New Facilities
Installation of equipment in a new dental facility regardless of how the equipment was obtained (purchased, leased, gift) or how old the equipment is (new or resale). A complete application form and compliance inspection report for each piece of radiation equipment located in the facility is required to be sent to the Alberta Dental Association and College.

Registration Process #2 – Annual Confirmation Update for Existing Facilities
This annual confirmation of equipment is sent by the Alberta Dental Association and College to all registered facilities. The owner must review the facility, owner and equipment information on the confirmation form. The owner must sign the confirmation form and submit it to the Alberta Dental Association and College with required documentation, including evidence of dosimetry service and management of quality assurance and preventative maintenance.

Registration Process #3 – 5 Year Compliance Verification Renewal
Every 5 (five) years after the original compliance inspection and registration of the equipment. Requires a complete application form and compliance inspection report for each piece of radiation equipment that will expire located in the facility.

Registration Process #4 – Relocation, Modification or Replacement of Equipment
A complete application form and compliance inspection report for each piece of radiation equipment located in the facility is required to be sent to the Alberta Dental Association and College if:

- relocated within the facility;
- modified the characteristics of the radiation emitted from the equipment or the protective properties of the facility
- replaced a piece of equipment.
A. Registration Process #1 – New Facilities

Owner requests Application for Registration form from ADA&C or copies form from their Radiation Manual

Owner completes the Application for Registration and returns this form to the ADA&C

Owner hires ARPA to do Compliance Verification testing

Compliance:

ARPA submits Compliance Verification Report to Owner and a copy to the ADA&C

Owner ensures ADA&C has received a copy of the Compliance Verification Report

ADA&C issues invoice and Confirmation of Registration Form for Owners to sign and return with verification of Dosimetry and QA Program

ADA&C issues Registration Certificate

Non-Compliance:

ARPA submits Non-Compliance Report to Owner and a copy to the ADA&C

Owner addresses Non-Compliance item(s)

Yes

ARPA submits Compliance Verification Report to Owner and a copy the ADA&C indicating Facility is now compliant

Owner ensures ADA&C has received a copy of the Compliance Verification Report

ADA&C issues invoice and Confirmation of Registration Form for Owners to sign and return with verification of Dosimetry and QA Program

ADA&C issues Registration Certificate

No

ADA&C issues Written Directive under Section 16 of the Radiation Protection Act (the owner is prohibited from using the equipment)
B. Registration Process #2 – Annual Confirmation Update for Existing Facilities

1. **ADA&C send Annual Confirmation Form and Invoice (if applicable) to Owner**
   - Owner reviews Annual Confirmation Form
     - Information on Annual Confirmation Form is correct?
       - Yes: Owner signs Annual Confirmation Form and returns to ADA&C with proof of Dosimetry and QA Program along with payment (if applicable)
       - No: Are there equipment modifications, additions or relocations?
         - No: Is there an Ownership change?
           - No: Are there Clerical errors?
             - Yes: Owner contacts ADA&C to discuss changes that do not pertain to this flowchart
             - No: Owner indicates changes directly on Annual Confirmation Form and returns to ADA&C with proof of Dosimetry and QA Program along with payment (if applicable)
         - Yes: See Registration Process #4 Flowchart

2. **ADA&C updates new Owner information and sends revised Confirmation Form to new Owner**
   - Owner reviews revised Confirmation Form and returns to ADA&C with proof of Dosimetry and QA Program along with payment (if applicable)
C. Registration Process #3 – 5 Year Compliance Verification Renewal

ADA&C sends reminder notice and Application for Registration to Owner each month starting 6 months prior to expiry date of Radiation Certificate indicating their inspection is due by the expiry date

Owner completes the Application for Registration and returns this form to the ADA&C

Owner hires ARPA to do Compliance Verification testing

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**Compliance**

ARPA submits Compliance Verification Report to Owner and a copy to the ADA&C

Owner ensures ADA&C has received a copy of the Compliance Verification Report

ADA&C issues Confirmation of Registration Form for Owners to sign and return with verification of Dosimetry and QA Program

ADA&C issues Registration Certificate

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**Non-Compliance**

ARPA submits Non-Compliance Report to Owner and a copy to the ADA&C

Owner addresses Non-Compliance Item(s)

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**Yes**

ARPA submits Compliance Verification Report to Owner and a copy to the ADA&C indicating Facility is now compliant

Owner ensures ADA&C has received a copy of the Compliance Verification Report

ADA&C issues Confirmation of Registration Form for Owners to sign and return with verification of Dosimetry and QA Program

ADA&C issues Registration Certificate

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**No**

ADA&C issues Written Directive under Section 16 of the Radiation Protection Act (the owner is prohibited from using the equipment)
D. Registration Process #4 – Relocation, Modification or Replacement of Equipment

Owner requests Application for Registration form from ADA&C or copies form from their Radiation Manual

Owner completes the Application for Registration and returns this form to the ADA&C

Owner hires ARPA to do Compliance Verification testing

Compliance

ARPA submits Compliance Verification Report to Owner and a copy to the ADA&C

Owner ensures ADA&C has received a copy of the Compliance Verification Report

ADA&C issues invoice and Confirmation of Registration Form for Owners to sign and return with verification of Dosimetry and QA Program

ADA&C issues Registration Certificate

Non-Compliance

ARPA submits Non-Compliance Report to Owner and a copy to the ADA&C

Owner addresses Non-Compliance Item(s)

Yes

ARPA submits Compliance Verification Report to Owner and a copy to the ADA&C indicating Facility is now compliant

Owner ensures ADA&C has received a copy of the Compliance Verification Report

ADA&C issues invoice and Confirmation of Registration Form for Owners to sign and return with verification of Dosimetry and QA Program

ADA&C issues Registration Certificate

No

ADA&C issues Written Directive under Section 16 of the Radiation Protection Act (the owner is prohibited from using the equipment)
Appendix 8 – Standard Procedure: Investigation Procedures

The receiving of reports of the conduct of radiation workers in respect of section 16(1)(b) of the Radiation Protection Act will be dealt with as a complaint.

Where investigations by the Alberta Dental Association and College are deemed necessary, only qualified personnel employed by the Alberta Dental Association and College or authorized accredited agencies will be used.

Where a written directive is issued by the Alberta Dental Association and College pursuant to section 16(2) of the Act, the Association shall determine if the directive has been complied with in the time period prescribed by the written directive and shall notify Alberta Jobs, Skills, Training and Labour of the issuance and the status of conformance.
Appendix 9 – Standard Procedure: Investigations of Overexposures

• Section 2(6) of the Radiation Health Administration Regulation delegates all the powers, duties and functions of the Minister under sections 13(2) (Notice of Incidents and Overexposures) and 16(2) (Remedial Action) of the Radiation Protection Act to authorized Radiation Health Administrative Organizations.

• If a radiation worker receives a reading from their commercial dosimetry service in excess of allowable limits, then the National Dose Registry (NDR) sends a High Exposure Notification to both the owner and Alberta Jobs, Skills, Training and Labour.

• If the incidence of overexposure occurred from x-ray equipment, Alberta Jobs, Skills, Training and Labour will contact the Radiation Health Administrative Organization which oversees that owner group, requesting the Organization to co-ordinate an investigation into the overexposure.

• The Radiation Health Administrative Organization will contact the owner, instructing the owner to:
  (a) notify the Organization as to the time, place and nature of the overexposure or incident,
  (b) carry out an investigation into the circumstances surrounding the overexposure or incident, and
  (c) prepare a report outlining the circumstances of the overexposure or incident and the corrective action, if any, undertaken to prevent a recurrence of the overexposure or incident

• The owner has responsibility to organize the overexposure investigation. The investigator can be:
  (a) an Organization with its delegated authority to investigate; or
  (b) an Agency that has been contracted:
    i) by the owner; or
    ii) by an Organization.

• If the Organization is satisfied with the results of the investigation, they will forward the report to Alberta Jobs, Skills, Training and Labour.

• Alberta Jobs, Skills, Training and Labour will give the report final approval prior to forwarding a recommendation to the National Dose Registry.

• If the report concerns any condition that contravenes the Radiation Protection Act and Regulation, the Organization may issue a directive to:
  (a) Prohibit the use of the facility or equipment; or
  (b) Require action to remedy a danger.
References


3. Quality Control in Diagnostic Imaging; Joel E. Gray, Ph.D. et al.


