



NEW BRUNSWICK COLLEGE
OF DENTAL HYGIENISTS
ORDRE DES HYGIÉNISTES DENTAIRES
DU NOUVEAU-BRUNSWICK

DENTAL X-RAY SAFETY & QUALITY CONTROL (QC) MANUAL

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Dental X-ray Safety & Quality Control (QC) Manual

Scope

The main objectives of this manual are to present standards and procedures for radiation protection of patients, staff, and members of the public, in addition to quality control (QC) standards for dental X-ray equipment owned and operated in a dental hygiene clinic. By fulfilling these objectives, this manual aims to:

- eliminate unnecessary radiation dose to the patient by ensuring that images are obtained only when justified and radiation dose is optimized;
- ensure that imaging equipment operates properly;
- ensure that images are of diagnostic quality; and
- limit radiation dose to staff and members of the public in accordance with the ALARA principle (see Appendix 1 for further details).
- The words *must* and *should* in this manual have been chosen with purpose. The word *must* is used to indicate essential radiation protection requirements, while *should* indicates an advisory recommendation that is highly desirable and is to be implemented where possible. This manual is based on Federal (Safety Code 30) requirements and through guidance of expert advice. Owners of dental hygiene clinics who operate radiograph equipment *must* stay abreast of federal, provincial and NBCDH requirements. It is also essential that dental X-ray equipment is installed, used, maintained, repaired, and inspected per the manufacturer's specifications.
- The New Brunswick Regulation 91-191 under the [Occupational Health and Safety Act](#) *should* be consulted as needed as well in reference to the content in this manual

Qualifications, Roles and Responsibilities of Dental Personnel

Dental hygienist

a) Qualifications

- qualified by education and licensure, dental hygienists are authorized to administer and interpret radiographs for the purpose of dental hygiene services
- b) per Section 298.11(1) of the *New Brunswick Regulation 91-191 under the [Occupational Health and Safety Act](#)*.

c) Roles and Responsibilities

- establishing, reviewing and documenting radiation protection procedures;
- ensuring that published, evidence-based selection criteria are employed when prescribing radiographs;
- instructing all dental staff in radiation protection;

- implementing radiation surveys (including daily and monthly QC) and recording results and corrective actions;
- establishing the monitoring of personnel, if required;
- ensuring that all radiation protection features are functional and the required warning signs are posted;
- implementing and monitoring the use of the ALARA principle; and
- implementing and documenting quality assurance (QA) and QC procedures.
- maintaining their training and credentialing to perform radiological examinations ensuring that radiological examinations are conducted safely
- images are properly identified and stored in the patient record

The dental hygienist (or designated responsible person/radiation safety officer (RSO) *must* establish a radiation protection program that is subject to periodic review and update. The dental hygienist *must* seek guidance of a qualified expert in this activity. The dental hygienist *must* employ published, evidence-based selection criteria when prescribing x-ray imaging.

Qualified Expert (QE)

a) Qualifications

- qualified by education and experience to perform advanced or complex procedures in radiation protection that generally are beyond the capabilities of most dental personnel (e.g. board-certified Diagnostic Medical/Radiological Physicist and/or certified and Technical Healthcare professional – i.e. Biomedical Technologist with formal training in diagnostic imaging and radiation emitting devices)

b) Roles and Responsibilities

- performs a preinstallation radiation shielding design and plan review;
- performs acceptance testing (EPE) and a post-installation radiation protection survey;
- initiates the QC program by evaluating the initial characteristics of the x-ray equipment, measuring patient doses, and assessing image quality;
- establishes the QC program by advising on the individual elements, procedures to be followed, the qualifications of personnel, expected ranges of results, and actions to be taken when results are beyond the expected ranges;
- compares measured metrics of patient dose with published diagnostic reference level (DRL) values and achievable dose (AD) values;
- advises on the x-ray techniques (e.g., exposure time, tube potential, field size or collimation, and other technique factors) to be used to achieve adequate image quality and minimize radiation dose (optimization).

The qualified expert *should* provide guidance for the dental hygienist or facility designer in the layout and shielding design of new or renovated dental hygiene facilities, on implementation of a quality control (QC) program and on achieving and maintaining radiation doses that are as low as reasonably achievable (the ALARA principle).

Education and Training

Radiation safety training *must* be provided to all dental staff and other personnel, including receptionists, office managers, commensurate with the individual's risk of exposure to ionizing radiation.

Every person who operates dental x-ray imaging equipment or supervises the use of such equipment *must* have current training in the safe and efficacious use of such equipment.

The dental hygienist *should* regularly participate in continuing education in all aspects of dental radiology, including radiation protection.

Specifically, for Hand-held radiograph equipment:

- Operators *must* read and comply with all safety information and instructions provided in the manufacturer's accompanying documentation prior to operation of the device.
- Operators must be trained for use of the device, as provided by the manufacturer or a service provider with appropriate expertise. Training must also include:
 - o Appropriate justification required for hand-held use of the device, as opposed to using the device mounted on a stand or a permanent wall-mounted unit.
 - o Proper orientation of the device to ensure the operator is appropriately positioned behind the backscatter shield.
 - o Consideration of means, such as shielding, to ensure appropriate radiation protection of personnel and the public for any location in which the device is used.
 - o Prevention of unauthorized use of the device as specified by the applicable regulatory authority.
 - o Any specified training required by the applicable regulatory authorities.

Specifically, for CBCT facilities:

- Dental personnel who operate CBCT units shall be trained in the proper operation and safety of the units, including complete training on each unit they will use. They *should* demonstrate adequate knowledge of different protocols affecting image quality and radiation dose to the patient prior to performing CBCT on patients.
- Every person who operates CBCT equipment, supervises the use of CBCT equipment, or tests and evaluates the functions of CBCT equipment shall have ongoing continuing education in the safe and effective use of that equipment.

X-ray Safety Activities

A. Radiation Protection (ALARA) Program

To the extent practical, the dental hygienist/RSO should assure that the facility uses procedures and engineering controls based on sound radiation protection principles to achieve occupational doses and doses to members of the public that are in line with ALARA. See Appendix 1 for ALARA Program for X-ray policy.

B. Radiation Dose Limits

Currently, there are no radiation dose limits set forth by New Brunswick. The organization will use the following radiation dose limits, however, will implement the ALARA program mentioned above and in Appendix 1.

Radiation Workers and Members of the Public:

<u>Applicable Body Organ or Tissue</u>	<u>Dose Limit for Radiation Workers (mSv/year)</u>	<u>Dose Limit for Members of the Public (mSv/year)</u>
Whole-body	5	1
Lens of eyes	50 (and 20 mSv/year averaged over 5 years)	15
Skin, Hands, and all other organs	500	50

Pregnant Radiation Workers:

	<u>Dose Limit for Embryo/Fetus (mSv)</u>
During gestation	5
Monthly	0.5
From time of written declaration of pregnancy	2
The pregnant individual <i>must</i> declare their pregnancy in writing to the dental hygienist/RSO for this to be in effect	

C. Personal Radiation Monitors

Who *must* be monitored?

- Adults likely to receive more than the annual dose limits for members of the public;

- Declared pregnant women likely to receive (during the entire pregnancy)

Where *must* monitors be worn?

- Per recommendations of the dosimetry service provider
 - Typically, at the neck (collar)
 - Typically, at the waist (for the dose to an embryo/fetus of a declared pregnant woman)

Personal Dosimeters

- Provision of personal dosimeters for external dose measurement *should* be considered for workers who are likely to receive an annual effective dose in excess of 1 mSv. Personal dosimeters *must* be provided for declared pregnant occupationally exposed personnel.
- For new or relocated equipment, facilities *should* provide personal dosimeters for at least 1 year in order to determine and document the doses to personnel, and to determine whether ongoing personnel monitoring is required to be in compliance with applicable regulatory requirements.
- The facility *must* provide personal dosimeters for all new operators of handheld dental x-ray equipment for the first year of use to determine whether ongoing personnel monitoring is required to be in compliance with applicable regulatory requirements.

D. Documentation of New X-ray Machines (or Changes to One)

New X-ray equipment *must* be well-documented with respect to make, model, serial number, and room to be installed in. If there are changes made to equipment (such as replacement of an X-ray tube), these will be identified. This may involve a repeat survey by a Qualified Expert or simply documenting there has been a change. If a machine is decommissioned, it *must* be performed in accordance with manufacturer standards and local standards.

An electronic inventory of all equipment and their respective identifiers (e.g. serial number) *must* be maintained and updated on a continual basis.

Registration form (attached) must be provided to NBCDH.

E. Electronic Image Data Management

To avoid unnecessary repeat exposures due to lost images or redundant examinations, the electronic image data management system *must* provide secure storage, retrieval and transmission of image data sets.

All digital images acquired *must* be retained in the patient's electronic record, which *should* be backed up off-site electronically in a separate, safe and secure location at regular intervals.

F. Equipment Surveys

Registrants *must* have certain tests of equipment performed. It is the responsibility of the registrant to ensure that competent and qualified individuals are utilized. See Appendix 7 (Table 2) for the required tests and their frequencies. It is expected that the dental hygienists will perform the daily and monthly QC, while a Qualified Expert will perform the acceptance testing and annual QC (due to the more complex nature of these tests). The Qualified expert conducting the annual quality control must be approved by the NBCDH.

G. X-ray Room Shielding

New or remodeled facilities or facilities whose use changes in a way that may change radiation exposure levels must have a shielding plan developed by a qualified expert with submission to the provincial authorities or local radiation safety control agency before first use of the equipment. Shielding designs must be performed commensurate with the National Council on Radiation Protection and Measurements (NCRP) 145 but will be ultimately per the Qualified Expert's discretion.

Records related to shielding *must* be maintained for inspection, including lead equivalent thickness of shielding, machine characteristics, and measurements of radiation behind shielding materials. It is important to keep these records to verify current shielding in case a future shielding plan indicates a need to change the shielding.

Surveys *must* be performed after shielding is installed and as needed thereafter to assure that individual exposures do not exceed applicable dose limits.

H. X-ray Equipment Servicing and Services

It is the dental hygienist/RSO's responsibility to ensure outside service providers are properly vetted. See Appendix 2 below for a policy regarding this.

I. Records

The dental hygienist/RSO is responsible for maintaining all records regarding the use of radiation. Records of personnel exposure and records verifying exposure levels to the public *must* be kept indefinitely. Records of surveys, calibrations, maintenance, and modifications performed on the X-ray systems *must* be kept for the lifetime of the equipment. Survey results with any additional changes that arise from the survey results must be provided to the NBCDH.

J. Quality Assurance Program

The facility's Quality Assurance (QA) program includes the following:

- Written standard operating procedures on radiation protection and the practice of radiologic technology reviewed and updated annually by management;
- Employee review and written acknowledgement of standard operating procedures and policies on radiation protection and the practice of radiologic technology;
- Credentialing of appropriate personnel (internal or external);

- Records retention

K. Research Involving Radiation

Any research that uses radiation machines on humans must be approved by an institutional review board and satisfy any federal, provincial, and/or other facility policies.

Appendix 1: ALARA Program for X-ray Policy

Management Commitment

We, the management of *<enter name of facility>*, are committed to the program described herein for keeping individual and collective doses as low as reasonably achievable (ALARA). In accord with this commitment, we will develop the necessary written policies, procedures, and instructions to foster the ALARA concept within our institution. The organization will include a Radiation Safety Committee and a Dental hygienist/Radiation Safety Officer (RSO).

We will perform a formal annual review of the radiation safety program, including ALARA considerations. This will include reviews of operating procedures and past dose records, inspections, etc., as well as consultations with the dental hygienist/RSO and/or outside consultants.

Modifications to operating and maintenance procedures and to equipment and facilities will be made to reduce exposures if the cost, in our judgment, is considered justified. If it is not, we will be prepared to describe the reasons for not implementing the changes.

In addition to maintaining doses to individuals as far below the limits as is reasonably achievable, the sum of the doses received by all exposed individuals will also be maintained at the lowest practicable level. It is not desirable to reduce doses to some individuals to some fraction of the applicable limit if this involves exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

Dental hygienist/RSO Commitment

Annual and Quarterly Review

- A. The dental hygienist/RSO will perform an annual review of the radiation safety program for adherence to ALARA concepts. Reviews of specific methods of use may be conducted on a more frequent basis.
- B. The dental hygienist/RSO will review at least quarterly the external radiation doses of workers to determine that their doses are ALARA in accordance with the provisions of Table 1 below.

Education Responsibilities for ALARA Program

- C. The dental hygienist/RSO will schedule briefing and educational sessions as needed to ensure that users of radiation producing equipment and ancillary personnel who may be exposed to radiation be instructed in the ALARA philosophy. They will also be made aware that management and the dental hygienist/RSO are committed to implementing the ALARA concept.

Cooperative Efforts for Development of ALARA Procedures

- D. Radiation workers will be given opportunities to participate in formulating the procedures that they will be required to follow.
- E. The dental hygienist/RSO will be in contact with users of X-ray equipment and other workers in

order to develop ALARA procedures for working with X-ray equipment.

- F. The dental hygienist/RSO will establish procedures for receiving and evaluating the suggestions of individual workers for improving health physics practices and will encourage the use of those programs.
- G. Workers will have the opportunity for additional education to be made available to them if requested to the RSO.

Reviewing Instances of Deviation from Good ALARA Practices

- H. The dental hygienist/RSO will investigate all known instances of deviation from good ALARA practices and, if possible, will determine the causes.
- I. When the cause is known, the dental hygienist/RSO will implement changes in the program to maintain ALARA doses.

Review of Radiation Doses of Users and Workers

Table 1. Investigational levels for dental radiology (based off shielding design goals of NCRP 147 – 0.1 mGy/week - as there are no New Brunswick radiation exposure limits as well as Health Canada Safety Code 35 Table AI.1 limits for radiation workers). Note *: monitor readings may be modified using Webster’s equation (Ref: Webster EW. EDE for exposure with protective aprons. Health Phys. 1989;56:568–569) to arrive at the whole-body effective dose for individuals who must wear lead aprons.

Investigational Levels	mSv Per Calendar Quarter
Total effective dose equivalent*	1.25
Lens of eyes	11.25
Skin, hands, and all other organs	37.5

The ALARA principle pertains to keeping radiation exposure “as low as reasonably” achievable, taking into account societal and economic factors. From an occupational health perspective, this generally means ensuring the following three aspects related to radiation exposure are balanced accordingly:

- Time near the radiation source (the patient and primary beam)
 - The lesser your time, the lesser your exposure
- Distance from the radiation source
 - The greater you are away, the lesser your exposure
 - Follows the square of the distance (e.g. if moving from 2 m away to 3 m away, your exposure decreases by ~ 2.25x)
- Shielding between the radiation source and you
 - If there is a physical barrier &/or lead shielding worn, your exposure will be less

Appendix 2: Quality Control ALARA Program for X-ray Policy

Policy Owner: Director of facilities management

Information Resource: Dental hygienist/Radiation Safety Officer (RSO)

Applicable to: Biomed, radiology, RSO, medical physicists

Policy Statement: All X-ray-producing equipment will be tested at regular intervals to assure proper function related to radiation safety of patients and personnel.

Responsibilities:

Biomed Staff

- Servicing or repair of dental X-ray equipment

QE

- Acceptance testing and annual evaluations of dental X-ray equipment per applicable standards
- Performing shielding designs of X-ray rooms

Dental hygienist/RSO

- Annual audit of the equipment quality control program

Appendix 3: Delegation of Authority for a Radiation Safety Officer for an X-ray Facility

Facility Name: <enter name of facility>

<enter of name of RSO> is hereby appointed Radiation Safety Officer (RSO) for our X-ray equipment and is responsible for ensuring the safe use of radiation.

These responsibilities include managing the radiation protection program, identifying X-ray radiation protection problems, ensuring quality control tests are completed and documented, recommending or providing corrective actions, verifying implementation of corrective actions, stopping unsafe activities, and ensuring compliance with regulatory requirements.

The RSO is hereby delegated the time and authority necessary to meet those responsibilities, including prohibiting the use of radiation-producing equipment by employees who do not meet the necessary requirements and shutting down operations where radiation safety is compromised. The RSO is required to notify management if staff do not cooperate and do not address radiation safety issues. It is estimated that the RSO will spend <enter # of ~ hours> per week conducting radiation protection activities.

The signature below as RSO indicates acceptance of the above responsibilities.

Name of RSO

Name of Management

RSO Signature

Management Representative Signature

Date

Date

Appendix 4: Employee X-ray Safety Procedures

Policy Owner: Dental hygienist/Radiation Safety Officer (RSO)

Information Resource: Dental hygienist/RSO

Applicable to: X-ray operators and ancillary staff

Policy Statement:

- Except for the patient, only the staff and ancillary personnel required for performance of a procedure may remain in the room during the X-ray exposure. All staff and ancillary personnel who must remain in the room to assist during X-ray procedures must be protected from scatter radiation by protective aprons or a whole-body radiation protective barrier of not less than 0.5-millimeter lead equivalence.
- All staff and ancillary personnel required for assistance with X-ray procedures must be positioned so that no part of the body can be struck by the useful beam unless protected by 0.5 lead-equivalent shielding material.
- Mechanical support or restraining devices should be utilized for holding either the patient or image receptor whenever possible.
- During any X-ray procedures, any door designed to be part of a protective barrier must be closed.
- Prior to putting on a radiation protection garment, personnel will verify that the most recent safety check is within a year. A visual cue (e.g., sticker or color-coded tag) should be apparent to let staff know the check is current.
- Personnel who have to stand with their backs to the X-ray source or patient should wear wraparound aprons.
- Personnel who do not need to be close to the patient or X-ray source should stand as far away as is practical without compromising patient care.
- Personnel whose hands must be very close to the X-ray beam should wear lead-containing gloves. Do not place hands in the direct beam, even with lead gloves, as the lead will only cause a higher level of radiation to be produced.
- Personnel radiation monitoring devices must be worn that are appropriate to the individual work environment (See Appendix 5 for details).
- Additional consideration for protection of the fetus requires the pregnant employee to declare her pregnancy in writing if she opts to accept this added level of protection (See Appendix 5 for details).

Appendix 5: Personnel Radiation Monitoring

Policy Owner: Dental hygienist/RSO

Information Resource: RSO

Applicable to: Managers, Dental hygienist/RSO

Policy Statement:

- Personnel likely to receive a dose in excess of the annual dose limits of members of the public or those working in high radiation areas or very high radiation areas will be supplied with personnel monitors.
- Additional dosimeters will be supplied to pregnant individuals who declare their pregnancy in writing.

Responsibilities

- Dental hygienist/RSO (or trained designee where appropriate)
 - o Maintain program for providing radiation monitors to all workers that require a monitor.
 - o Designate managers (supervisors) who will be responsible for the program for workers in their areas.
 - o Establish action limits and provide managers with information regarding exposures exceeding the action limits.
 - o Review exposure history of declared pregnant workers to determine if a change in duties is required to reduce fetal dose.
 - o Provide consultation as needed to workers with elevated monitor readings.
 - o Provide monthly or quarterly exposure reports to manager for posting.
 - o Provide individual annual reports to manager for distribution to workers.
 - o Retain records of radiation monitoring as required by provincial law (three years).
- Manager/Supervisor
 - o Supply workers in their area with radiation monitors as required by law
 - o Provide dental hygienist/RSO with changes in personnel who have or require a monitor.
 - o Provide new employees with release of monitoring information form if needed to obtain past radiation history
 - o Obtain previous occupational exposure records from the employee and forward to the dental hygienist/RSO.
 - o Advise personnel of excess radiation monitor readings.
 - o Inform dental hygienist/RSO of employee being terminated, obtain a return address, and send employee a report of exposure while employed at facility.

- **Monitored Individual**

- **Exchange monitors either monthly or quarterly as required**
- **Advise dental hygienist/RSO in writing of need for fetal radiation monitoring.**
- **Wear monitors as required (per recommendations of dosimetry service provider)**
- **Protect monitor from damage (such as heat or moisture)**

Appendix 6: Patient X-ray Safety

Policy Owner: Dental hygienist/RSO

Information Resource: Dental hygienist/RSO

Applicable to: X-ray operators and Dental hygienist/RSO

Policy Statement:

Precautions will be taken to avoid unnecessary radiation exposure to patients. Patient and gonadal shielding is no longer recommended as a standard practice (unless a CBCT examination); this facility will adhere to current consensus of the scientific community within constraints of jurisdictional regulatory requirements. All procedures must be performed under the direction of a dental hygienist/RSO.

<u>Responsibility</u>	<u>Action</u>
X-ray operators	Question female patients of childbearing age regarding the possibility of pregnancy or perform a pregnancy test if the procedure may involve a higher risk of exposure to the uterus to someone who would have the possibility of being pregnant (such as no period in the last 28 days per guidance from the American College of Radiology). If a woman is pregnant, the continuation of a radiation procedure will be at the discretion of the dental hygienist and the informed consent of the patient.
	Demonstrate collimation on all images and limit to the area of interest.
	Select the imaging X-ray technique factors to achieve adequate image quality at a minimum patient radiation dose.
RSO	Respond to requests for patient radiation dose estimates as needed.

Appendix 7: Acceptance Testing and Performance Evaluations (Qualified Expert)

The Qualified Expert shall conduct an initial dental X-ray equipment performance evaluation upon installation and after major upgrades (per Table 2 below). This evaluation should be comprehensive and completed before clinical use. The Qualified Expert responsible for acceptance testing may diverge from these recommendations and the extent of the measurements depending on the designated use(s) of the dental X-ray equipment.

Additionally, each dental X-ray unit must be evaluated at least annually (per Table 2 below). Equipment performance and usage may necessitate increased periodic testing. If a major component is replaced or repaired (e.g, x-ray tube replacement, detector replacement, software changes, etc.), a Qualified Expert should evaluate, in a timely manner, the need for performance testing of the equipment. The scope of the evaluation should be determined by the Qualified Expert based on the component that was replaced or repaired.

Table 2: Description of Performance Tests and Frequencies

<u>Parameter</u>	<u>Acceptance Testing</u>	<u>Daily</u>	<u>Monthly</u>	<u>Annually</u>
<u>Mechanical Integrity</u>	<u>INT, PAN, CEPH, CBCT</u>	<u>INT, PAN, CEPH, CBCT</u>		
<u>Safety Systems</u>	<u>INT, PAN, CEPH, CBCT</u>			
<u>X-ray Tube Voltage</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Current Time Product</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Loading Time</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Automatic Exposure Control</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>X-ray Beam Filtration</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>X-ray Beam Limitation and Alignment</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Focal Spot to Skin Distance</u>	<u>INT, PAN, CEPH, CBCT</u>			

<u>Radiation Output (Reproducibility/Linearity)</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Leakage Radiation</u>	<u>INT, PAN, CEPH, CBCT</u>			
<u>As Applicable: DAP/KAP, Incident or Detector Air Kerma, and CTDI</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Dosimetric Indicator Accuracy</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Spatial Resolution</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Contrast Detectability</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Patient Positioning Indicators</u>	<u>PAN, CBCT</u>			
<u>Focal Trough Alignment</u>	<u>PAN</u>			
<u>Mean Voxel Values (calibration and linearity)</u>	<u>CBCT</u>			
<u>Uniformity and Artifacts</u>	<u>INT, PAN, CEPH, CBCT</u>		<u>INT, PAN, CEPH, CBCT</u>	<u>INT, PAN, CEPH, CBCT</u>
<u>Noise</u>	<u>INT, PAN, CEPH, CBCT</u>			<u>INT, PAN, CEPH, CBCT</u>
<u>Modulation Transfer Function</u>	<u>CBCT</u>			
<u>Geometric Accuracy</u>	<u>CBCT</u>			<u>CBCT</u>
<u>Electronic Display Device Evaluation</u>	<u>INT, PAN, CEPH, CBCT</u>		<u>INT, PAN, CEPH, CBCT</u>	<u>INT, PAN, CEPH, CBCT</u>
<u>Reject/Retake Analysis</u>			<u>INT, PAN, CEPH, CBCT</u>	
<u>Scatter Survey</u>	<u>INT, PAN, CEPH, CBCT</u>			

Appendix 8: Routine QC Tasks (Dental Hygienists)

A continuous QC program must be implemented for all dental X-ray equipment with the assistance of a Qualified Expert. The QC program should include, but not necessarily be limited to, the QC tests listed in Table 3 below. The results of the QC program must be monitored routinely by the person responsible for performing the tests and at least annually by a Qualified Expert. If any monitored QC parameter falls outside of the control limits, corrective action must be taken. A Qualified Expert should be consulted regarding corrective actions for issues that cannot be resolved or are difficult to resolve.

Table 3: Description of Performance Tests and Frequencies

<u>Parameter</u>	<u>Daily</u>	<u>Monthly</u>
<u>Mechanical Integrity</u>	<u>INT, PAN, CEPH, CBCT</u>	
<u>Uniformity and Artifacts</u>		<u>INT, PAN, CEPH, CBCT</u>
<u>Electronic Display Device Evaluation</u>		<u>INT, PAN, CEPH, CBCT</u>
<u>Reject/Retake Analysis</u>		<u>INT, PAN, CEPH, CBCT</u>

Appendix 9: General Considerations for Radiation Protection in dental hygiene facilities

Diagnostic Reference Levels and Achievable Doses

Diagnostic reference levels (DRLs) and achievable dose (AD) values *should* be developed and regularly updated for intraoral radiography, cephalometric radiography, panoramic radiography, and dental CBCT imaging and used by all dental hygiene facilities.

Each dental facility *should* record and track indicators of patient dose, such as entrance air kerma and associated technique factors.

Protection of the Patient (Selection Criteria)

Radiographic examinations *must* be performed only when patient history and physical examination, prior images, or laboratory findings indicate a reasonable expectation of a health benefit to the patient.

For each new or referred patient, the dental hygienist *must* make a good faith attempt to obtain previous, pertinent images prior to acquiring new patient images.

Symptomatic and Asymptomatic Patients

For symptomatic patients, radiological examinations *must* be limited to those images required for diagnosis and treatment of current disease.

For asymptomatic patients, the extent of radiological examination of new patients, and the frequency and extent for established patients, *must* adhere to current published selection criteria.

Administrative Radiographs

Administrative use of radiation to provide information that is not necessary for the treatment or diagnosis of the patient *must not* be permitted.

Students or candidates for licensure *must not* be compelled or permitted to perform radiographic exposures of humans solely for purposes of education, licensure, credentialing, or other certification.

Image-viewing Environment

Images *must* be viewed in an environment adequate to ensure accurate interpretation.

Use of Radiation Protective Aprons

Thyroid shielding *shall* be provided for patients when it will not interfere with the examination.

No other lead aprons are required for patients (unless undergoing a CBCT examination). Protective aprons and thyroids *should* be evaluated for damage (e.g. tears, folds, and cracks) quarterly using visual and manual inspection.

Selection of Technique Factors

Technique factors and selection criteria shall be appropriate to the age and size of the patient.

Protection of the Operator

Shielding Designs

A repeat scatter survey (after acceptance testing) of facility shielding must be determined by the qualified expert whenever the average workload increases by a factor of two or more from the initial design criteria.

In the absence of a barrier in an existing facility, the operator *must* remain at least 2 m, but preferably 3 m, from the x-ray tube head during the exposure. If the 2 m distance cannot be maintained, then a barrier *must* be provided (so long as the patient can still be observed). This recommendation does not apply to handheld units with integral shields.

Protection of Members of the Public

In dental hygiene facilities using large, multi-patient open-bay designs, a patient in proximity to another patient being radiographed *must* be treated as a member of the public for radiation protection purposes.

When portable or handheld x-ray machines are used, all individuals in the area other than the patient and operator *must* be protected as members of the public.

Quality Assurance and Quality Control

Newly purchased x-ray machines *should* provide a range of exposure times suitable for twice the speed of the fastest available image receptors at the time of purchase.

Quality Control for Film Imaging

Film-processing quality *must* be evaluated daily, before processing patient films, for each film processor or manual processing system.

Image Receptors

Direct Exposure X-ray Film

Image receptors of speeds slower than ANSI Speed Group E/F *must not* be used for intraoral radiography (i.e., D-speed film *must not* be used).

Each darkroom and daylight loader *must* be evaluated for fog at initial installation, and then at least quarterly and following any change of room lighting or darkroom safelight lamp or filter.

Film *must* be processed with active, properly replenished chemicals, and time-temperature control, according to manufacturers' recommendations.

Screen-Film Systems

Screen-film systems of speeds slower than ANSI 400 *must not* be used for panoramic or cephalometric imaging. Rare-earth systems *must* be used.

Digital Imaging Systems

The dental practice *should* enlist assistance from a qualified expert to ensure each new digital system is properly configured with regard to both patient dose and image quality.

Intraoral Dental Imaging

The operating potentials of intraoral dental x-ray units *must not* be <60 kVp and *should not* be >80 kVp.

Position-indicating devices (PIDs) *must* be open-ended devices and *should* provide attenuation of scattered radiation arising from the collimator or filter.

Source-to-skin distance for intraoral radiography *must* be at least 20 cm and *should* be at least 30 cm.

Rectangular collimation of the x-ray beam *must* be used routinely for periapical and bitewing radiography and *should* be used for occlusal radiography when imaging children with Size 2 receptors. Receptor-holding devices *must* be used whenever possible.

Occupationally exposed personnel *should not* routinely restrain patients and *must not* hold the image receptor in place during an x-ray exposure.

Comforters and caregivers who restrain patients or hold image receptors during exposure *must* be provided with shielding (e.g., radiation protective aprons), and *should* hold the image receptor holding device. No unshielded body part of the person restraining the patient *must* be in the primary beam.

Conventional X-ray Systems (Permanently mounted and portable)

Only the patient and operator *must* be in the area during an exposure, unless special circumstances do not allow this.

Operators of handheld x-ray equipment *must* have the physical ability to hold the system in place for multiple exposures.

Operators *must* store handheld x-ray equipment so that it is not accessible to members of the public when not in use.

The operator of a Health Canada approved handheld x-ray unit *must not* be required to wear a personal radiation protective garment.

Rectangular collimation *must* be used with handheld devices whenever possible.

Handheld X-ray Systems

A hand-held dental X-ray device must only be used in exceptional situations, due to the location where imaging is being undertaken and/or the conditions of the patient, where it is not reasonably feasible to use a device that is wall-mounted or mobile/transportable that permits the operator to initiate X-ray exposures from a distance of at least 2 m from the device.

Further to the above, hand-held dental X-ray devices must only be held by hand when it is not reasonably feasible for it to be supported on a stand and used remotely with the corded or remote irradiation switch (which allows the operator to stand at least 2 m from the device) or when specific patient needs necessitate hand-held use to obtain a diagnostically acceptable image.

For any location where a given hand-held dental X-ray device is used, all persons, except the operator and patient, must be at least 2 m from the hand-held dental X-ray device during operation and access to the controlled area where the imaging is performed must be restricted.

For at least the first year of operation of a hand-held dental X-ray device where the device is routinely held by hand, each operator must wear a personal dosimeter until a baseline annual radiation dose is established. The personal dosimeter is to be placed on the body at waist height, but not located directly behind the hand-held device such that the device blocks the dosimeter. After review of the first annual radiation dose (In consultation with an expert in radiation protection as needed), along with consideration of any potential variation in factors contributing to future radiation dose, if the dose is expected to be below 1 mSv/yr the use of a personal dosimeter can be discontinued. Any significant changes to workload, equipment or techniques would require a new review of the risk by an expert in radiation protection, including whether another fixed evaluation period or continuous personal monitoring is required.

When portable or handheld x-ray machines are used, all individuals in the area other than the patient and operator must be protected as members of the public.

Operators of handheld x-ray equipment *must* have the physical ability to hold the system in place for multiple exposures.

Operators *must* store handheld x-ray equipment so that it is not accessible to members of the public when not in use.

The operator of a Health Canada approved handheld x-ray unit *must not* be required to wear a personal radiation protective garment.

Rectangular collimation *must* be used with handheld devices whenever possible.

Extraoral Dental Imaging

Panoramic

The x-ray beam for rotational panoramic tomography *must* be collimated such that its vertical

dimension is no greater than that required to expose the area of clinical interest and *must not* exceed the size of the image receptor.

The fastest imaging system consistent with the imaging task (equal to or faster than ANSI 400 speed or digital) *must* be used for all panoramic radiographic projections.

Panoramic machines *must* be on a dedicated electrical circuit.

CBCT

CBCT should be used for cross sectional imaging as an alternative to conventional computed tomography (CT) when the radiation dose of CBCT is lower and the diagnostic yield is at least comparable.

CBCT examinations shall use the smallest field-of-view (FOV) and technique factors that provide the lowest dose commensurate with the clinical purpose.

CBCT examinations shall not be obtained solely for the purpose of producing simulated bitewing, panoramic or cephalometric images.

CBCT examinations shall not be used as the primary or initial imaging modality when a lower dose alternative is adequate for the clinical purpose and shall not be used for routine or serial orthodontic imaging.

Appendix 10: References

- 1) NCRP (2019). National Council on Radiation Protection and Measurements. Radiation Protection in Dentistry and Oral & Maxillofacial Imaging, NCRP Report No. 177 (NCRP, Bethesda, Maryland).
- 2) Health Canada (2022). [Radiation Protection in Dentistry: Safety Procedures for the Installation, Use, and Control of Dental X-ray Equipment Safety Code 30](#), NCRP Report No. 177 (Health Canada, Ottawa, Ontario).
- 3) Mihailidis D., et. al. (2024). *AAPM Task Group Report 261: Comprehensive quality control methodology and management of dental and maxillofacial cone beam computed tomography (CBCT) systems*. American Association of Physicists in Medicine.
- 4) Kwan A., et. al. (2016). *Acceptance Testing and Quality Control of Dental Imaging Equipment: The Report of AAPM Task Group 175*. American Association of Physicists in Medicine.
- 5) New Brunswick College of Dental Hygienists Rules Under the New Brunswick Dental Hygienists Act (<https://www.nbcdh.ca/wp-content/uploads/2024/02/Rules-English-Revised-February-2024.pdf>).
- 6) New Brunswick Regulation 91-191 under the Occupational Health and Safety Act (<https://laws.gnb.ca/en/pdf/cr/91-191.pdf>)

