

Radiation Guideline

6

**Registration requirements
& industry best practice
for ionising radiation
apparatus used in
diagnostic imaging**

Part 3

**Dentistry
(Including
maxillofacial)**



ENVIRONMENT PROTECTION AUTHORITY



Department of
Environment and Conservation (NSW)

This is the Guideline defined in clause 3 of the Radiation Control Regulation 2003 as the 'Dentistry Radiation Guideline'. This edition supersedes the Guideline published in April 2001.

From 24 September 2003 the Department of Environment and Conservation (DEC) incorporates the Environment Protection Authority (EPA), which is defined in section 4 of the *Radiation Control Act 1990* as the Authority responsible for administering the Act and Regulation. Statutory functions and powers in the *Radiation Control Act 1990* continue to be exercised in the name of the EPA.

For technical information about this Guideline contact the Radiation Control Section of the DEC on (02) 9995 5959.

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INTRODUCTION

Radiological procedures are an essential part of dentistry. Although the effective dose from such procedures is low, the frequency of examinations is high enough to warrant monitoring of the doses delivered. Poor performance of radiation apparatus and inadequate quality assurance procedures may cause an unnecessary increase in patient dose.

The need to keep radiation exposure as low as reasonably achievable is fundamental to the philosophy of radiation protection. This document aims to achieve this by:

- ensuring that adequate safety measures are provided to protect patients, occupationally exposed persons and the public from unnecessary radiation exposure
- improving the standard of radiation apparatus in use
- ensuring better monitoring of apparatus performance
- providing reference dose levels as a guide to patient exposure.

The Dentistry Radiation Guideline is for the information of owners and licensed users of ionising radiation apparatus and persons accredited under section 9 of the *Radiation Control Act 1990* as consulting radiation experts (CREs). It is to be used by CREs in the assessment of apparatus for registration purposes and should be read in conjunction with the Act and the Radiation Control Regulation 2003. In the event of an inconsistency between the Guideline and the legislation, the requirements of the legislation prevail to the extent of the inconsistency.

From 24 September 2003 the Department of Environment and Conservation (NSW) incorporates the Environment Protection Authority (EPA). The EPA is defined in section 4 of the *Radiation Control Act 1990* as the Authority responsible for administering the Act. Therefore, statutory functions and powers in the Act and the Radiation Control Regulation 2003 continue to be exercised in the name of the EPA.

The Guideline sets out the minimum requirements for registration of diagnostic imaging apparatus, which are stated as ‘**must**’ statements and are listed in Schedule 1, and promotes industry best practice in radiation safety to be implemented during the use of radiation apparatus for dental and maxillofacial purposes. It covers intra-oral radiography, panoramic tomography and cephalometry.

The Guideline was developed by the Radiation Control Section of the Department of Environment and Conservation (NSW) in consultation with the Radiation Advisory Council.

The Department of Environment and Conservation (NSW) acknowledges the assistance of Mr Lee Collins, Dr Donald McLean and Mr John Robinson, and the input received from stakeholders, in preparing this edition.

SECTION 1—GENERAL REQUIREMENTS

1.1 Advice to owners

- 1.1.1 Compliance testing of diagnostic imaging apparatus for the purpose of certification for registration may only be conducted by an EPA-accredited Consulting Radiation Expert (CRE) using the *Registration requirements & industry best practice for diagnostic imaging apparatus used in diagnostic imaging – Part 6: Test Protocols for Parts 2–5*, a copy of which is available from the Authority.
- 1.1.2 Instruments used for routine radiation dosimetry or equipment performance monitoring should have a current calibration certificate that is traceable to an appropriate national standard.
- 1.1.3 Calibration of instruments should be conducted in accordance with the abovementioned *Test Protocols for Parts 2–5*.
- 1.1.4 Variations in line voltage from 240 V may cause equipment to fail the kVp requirements specified in this Guideline. Compliance testing should be carried out at 240 V, which is the optimal line voltage at which diagnostic imaging apparatus should be used. If equipment has failed kVp requirements the owner should have a qualified person monitor the line voltage.

1.2 Radiation shielding

- 1.2.1 Appropriate radiation shielding should be provided for the doors, walls, floor and ceiling of the room in which the apparatus is installed and for any protective barrier intended for use as a shield for the operators, to ensure that the radiation dose to any person is as low as reasonably achievable.
- 1.2.2 To achieve the requirements of 1.2.1, the provision of radiation shielding should ensure that the radiation levels behind the shielding will not give rise to a dose equivalent greater than:
 - (a) 100 μ Sv per week for occupationally exposed persons
 - (b) 20 μ Sv per week for members of the general public.
- 1.2.3 A protective shield should be provided for use by the operator.
- 1.2.4 The operator **must** be able to communicate easily with the patient undergoing the examination from the control area and **must** have a clear view of the patient at all times.
- 1.2.5 The lead equivalent and the kVp of the x-ray beam at which the lead equivalent was measured **must**, in the case of new installations, be clearly and durably marked on the protective shield.
- 1.2.6 Where a viewing window is used as part of the protective shield, the lead equivalent and the kVp of the x-ray beam at which the lead equivalent was measured **must**, in the case of new installations, be clearly and durably marked on the viewing window.

1.3 Shielding assessment

- 1.3.1 Specifications for radiation shielding of protective barriers and the design details of rooms used for ionising radiation apparatus should be determined and documented by an appropriately qualified person before building work starts.

1.4 Radiation warning sign

- 1.4.1 A radiation warning sign complying with Schedule 5 of the Regulation **must** be displayed on the outside of the entry to any room that is designated exclusively for the use of dental or maxillofacial apparatus. Where there is no requirement for a radiation warning sign on the outside of the room, there **must** be a radiation warning sign conspicuously displayed in the immediate vicinity of the apparatus.
- 1.4.2 A warning light **must** be positioned at the entry doors to all rooms exclusively used for radiography, except where a CRE has determined that not to do so would not pose a risk to the safety of any person.
- 1.4.3 Where a warning light is provided, it **must** light whenever the x-ray tube is placed in the preparation mode before exposure. The light **must** remain illuminated for the duration of the exposure and **must** bear the words ‘**X-RAYS—DO NOT ENTER**’ or similar. Immediate illumination **must** be ensured.

1.5 Location of exposure control switch

- 1.5.1 The exposure control switch **must** be arranged so that while the x-ray tube is energised, the operator can remain:
- (a) outside the useful x-ray beam and at least 2 m from the x-ray tube and from the patient, or
 - (b) behind a protective barrier.

1.6 Protective devices

- 1.6.1 A protective apron with a shielding value of not less than 0.3 mm lead-equivalent at 150 kVp should be provided for protection of the patient.
- 1.6.2 All protective clothing should be clearly and indelibly marked with the following information:
- (a) manufacturer’s name or trademark
 - (b) lead equivalence at a stated potential difference
 - (c) date of manufacture
 - (d) single or laminated material
 - (e) size.

- 1.6.3 Handling and storage of protective clothing should be in strict accordance with the manufacturer's recommendations. Hangers **must** be provided to ensure that aprons may be hung to prevent cracking of the protective material.
- 1.6.4 Protective clothing should be tested regularly in accordance with Appendix A, *Policy on x-ray protective clothing*.

1.7 Patient restraint

- 1.7.1 Mechanical restraining or supporting devices should be used wherever possible.
- 1.7.2 No person other than the patient should hold the x-ray film during exposure, except in the case of a child or handicapped person, where a parent, relative, guardian or person responsible for the care of the patient may be required to hold the film.
- 1.7.3 Any person who is required to hold a patient during an x-ray exposure should wear a full protective apron of the 'wrap-around' type, with a shielding value of not less than 0.3 mm lead-equivalent at 150 kVp.
- 1.7.4 No person should touch the beam-limiting device or x-ray tube during the exposure.

1.8 Film speed

- 1.8.1 X-ray film used for intra-oral radiography should have a speed not less than that of group 'E'.
- 1.8.2 Electronic image receptors should have a response equivalent to 'E'-speed film or better.
- 1.8.3 The film–screen combination used for panoramic tomography and cephalometry should have a speed of not less than 200, as stated by the manufacturer.

1.9 Film processing

- 1.9.1 Facilities should be provided that enable x-ray film to be processed in the manner specified by the film manufacturer. Those facilities should include equipment designed for the size of the x-ray film in use.
- 1.9.2 For manual processing, the following equipment should be provided:
- (a) a thermometer designed for use with processing chemicals
 - (b) an accurate timer specified for darkroom use
 - (c) a time–temperature chart for the specific type of film and chemicals in use.
- 1.9.3 Film processing should follow the recommendations in Appendix 4 (A–H) of the NHMRC Radiation Health Series No. 20, *Code of Practice for Radiation Protection in Dentistry (1987)*, as republished from time to time by the Australian Radiation Protection and Nuclear Safety Agency.

SECTION 2—APPARATUS SPECIFICATIONS AND PERFORMANCE

2.1 Intra-oral x-ray source

2.1.1 Any apparatus that uses an intra-oral x-ray source **must not** be used, except with the written approval of the Authority.

2.2 Exposure indication

2.2.1 The apparatus **must** incorporate a device that provides a warning to the operator whenever the tube is energised; that warning **must** consist of:

- (a) a light, clearly marked as to its function
- (b) an audible signal, other than sounds produced fortuitously by switching devices or contactors, to indicate either the duration of the exposure or its termination.

2.2.2 Both audible and visible signals **must** be at the control panel or, for remotely controlled apparatus, where these devices could not otherwise be seen or heard, at the position of the operator.

2.3 Control of operation

2.3.1 An electronic timer **must** be provided that will terminate the exposure after a preset time setting or at a preset product of current and time or programmed exposure.

2.3.2 Termination of the exposure **must** cause automatic resetting of the timer to its initial setting or zero.

2.3.3 It **must not** be possible to energise the x-ray tube if the timer is set to zero.

2.3.4 It **must** be possible to alter the timer setting to a higher or lower value without initiating an exposure.

2.3.5 The exposure control switch, including that for remote-control handpieces, **must** be of the dead-man type, such that continuous pressure is necessary to maintain the x-ray exposure, and it **must not** be possible to make repeat exposures without releasing the switch.

2.4 Remote control

2.4.1 Where the exposure is initiated by a remote-control handpiece, this handpiece **must**:

- (a) be encoded to the x-ray control unit so that no other remote-control handpiece can initiate exposure
- (b) be permanently labelled with a warning identifying the purpose of the control

- (c) have provision at the control panel for its storage
- (d) display a label indicating the date when the battery was last changed.

2.5 Indicators of exposure

- 2.5.1 Analogue meters, digital displays or scales or calibrated permanent markings **must** indicate either:
- (a) The selected voltage (kVp) and current (mA) and the exposure time in fractions of a second, or
 - (b) the selected kVp and the product of tube current and exposure time (mAs).
- 2.5.2 Apparatus that provides for object-programmed control (exposure selection by an icon) **must** indicate the selected exposure time in seconds on the control panel or on the exposure control switch. This may be achieved, for example, by having a table of calibrated times corresponding to each icon permanently fixed on or adjacent to the control panel.
- 2.5.3 When object-programmed control exposure times can be modified by a further control that can be adjusted to account for variations in the speed of the film used, that control **must**:
- (a) require a logical process to ensure that the density setting cannot be accidentally changed and requires the user to recognise or confirm the adjustment
 - (b) be clearly labelled to indicate its purpose
 - (c) clearly indicate on or adjacent to it the setting to be used for normal diagnostic intra-oral techniques.

2.6 Beam-limiting devices

- 2.6.1 For dental radiography using intra-oral image receptors, a beam-limiting device or cone **must**:
- (a) limit the focus-to-skin distance to not less than 200 mm
 - (b) be of the open-ended type
 - (c) limit the maximum dimension of the useful beam at the open end of the cone to not more than 60 mm.
- 2.6.2 For beam-limiting devices for panoramic tomography:
- (a) The dimensions of the primary beam **must not** exceed the slot in the secondary collimator immediately adjacent to the x-ray film.
 - (b) The vertical dimension of the primary beam **must not** exceed the height of the x-ray film.

- 2.6.3 For beam-limiting devices for cephalometric radiography:
- A beam-limiting device **must** be provided to restrict the radiation field to the image receptor area. The dimensions of this field should be 180 mm × 240 mm and **must not** exceed 240 mm × 300 mm.
 - There **must** be markings on the cassette holder to ensure correct alignment of the image receptor and the primary beam.
 - Interchangeable beam-limiting devices **must** be marked with the x-ray beam dimensions.
 - Where the beam-limiting device is a light beam type, the area illuminated by the light field **must** be effectively coincident with the irradiated area. The total misalignment of any margin **must not** exceed 1% of the selected distance from the focus-to-image receptor. The coincidence of light field and irradiated area **must** be determined for each focus.
 - The illuminance of the light beam **must** be not less than 100 lux at a distance of 1 metre from the light source.
 - Light sources should be easily replaced and not be permanently connected.

2.7 Filtration

- 2.7.1 The total filtration **must** ensure that the HVL of the primary beam for a given x-ray tube and collimator is not less than the values shown in Table 1.
- 2.7.2 Where apparatus may operate with more than one thickness of filtration, an interlock system combined with the kilovoltage selector **must** be used to prevent exposure if the minimum filtration is not present in the beam.

TABLE 1 MINIMUM HVL FOR X-RAY TUBE VOLTAGE

Type of apparatus	X-ray tube voltage (kVp)	Minimum HVL (mm Al)
Apparatus using intra-oral image receptors	60	1.5
	70	1.5
	80	2.3
	90	2.5
Other dental apparatus	50	1.5
	60	1.8
	70	2.1
	80	2.3
	90	2.5
	100	2.7
	110	3.0
	120	3.2
	125	3.3

Note: HVL for intermediate voltages should be obtained by linear interpolation.

2.8 Operating kilovoltage

- 2.8.1 The nominal kVp of dento-maxillofacial apparatus **must** satisfy the requirements of Table 2.

TABLE 2 RANGE OF X-RAY TUBE VOLTAGE

Apparatus	Nominal tube voltage (kVp)
Apparatus designed for use with intra-oral image receptors	60–90
Panoramic tomography	55–125
Cephalometric	60–125

2.9 Accuracy of kilovoltage

- 2.9.1 The kVp **must** be accurate to within ± 5 kVp of the indicated value measured after the first 100 ms from the initiation of the exposure.
- 2.9.2 The coefficient of variation of at least five consecutive measurements at the same kVp setting **must not** exceed 0.02.

2.10 Accuracy of timer controls

- 2.10.1 The exposure controls **must** ensure that the measured exposure time across the clinical range is within $\pm 10\%$ or \pm one pulse of the indicated time, whichever is greater.
- 2.10.2 The exposure time **must** be determined from the time the kV waveform first rises to 75% of the kVp or 50% of the radiation output until it falls below this value.
- 2.10.3 The coefficient of variation of at least five consecutive measurements at the same timer setting **must not** exceed 0.05.

2.11 Exposure consistency and linearity

- 2.11.1 The apparatus **must** produce a consistent radiation output so that the coefficient of variation of at least five consecutive measurements, taken at the same control settings, does not exceed 0.05.
- 2.11.2 Where the current is selectable (mA can be manually controlled) the apparatus **must** produce a linear radiation output over a continuous range of clinically used settings with respect to the current, so that the coefficient of linearity does not exceed 0.1 for each focal spot size.
- 2.11.3 Where the current is not variable (mA cannot be manually controlled) the apparatus **must** produce a linear radiation output with respect to the product of the exposure time and the current. The coefficient of linearity **must not** exceed 0.1 for each focal spot size.

2.12 Absorbed dose in air at the patient's skin surface

- 2.12.1 The absorbed dose in air at 10 mm from the end of the collimator for a typical bitewing should be in the range of 2–3 mGy.
- 2.12.2 The absorbed dose in air at 10 mm from the end of the collimator for any single bitewing radiograph **must not** exceed 5 mGy on any density setting.

2.13 Radiation leakage

- 2.13.1 The x-ray tube **must** be enclosed in a housing in such a manner that the air kerma from radiation leakage measured at a distance of 1 m from the focus of that tube in 1 hour, averaged over an area not larger than 100 cm², does not exceed:
- (a) 0.25 mGy for apparatus used with intra-oral image receptors
 - (b) 1 mGy for other apparatus.
- 2.13.2 Beam-limiting devices referred to in clause 2.6 used to limit the primary beam to the area of clinical interest **must** be constructed so that, in combination with the tube assembly, they comply with the leakage limits set out in clause 2.13.1.

2.14 Stability of x-ray tube assembly

- 2.14.1 The x-ray tube assembly **must** remain stationary when placed in position for radiography, except for panoramic tomography.

2.15 Control of multiple x-ray tubes

- 2.15.1 Where it is possible to control more than one x-ray tube with a single control unit, it **must not** be possible to energise more than one x-ray tube at any one time. Safety procedures **must** be provided to ensure against accidental activation of the wrong x-ray tube.
- 2.15.2 Where more than one x-ray tube can be operated from a control panel, there should be a clear indication on the control panel to signify which tube is energised.

2.16 Markings on x-ray generators and/or tube assemblies

- 2.16.1 X-ray generators and/or tube assemblies **must** be permanently marked in English and the markings **must** be clearly visible.
- 2.16.2 Generators and/or tube assemblies **must** bear the following markings:
- (a) the name or trademark of the manufacturer
 - (b) the type or model number
 - (c) the serial number or EPA registration number
 - (d) the maximum kVp
 - (e) the maximum mA or mAs.

2.17 Cephalometry

- 2.17.1 Any dental unit designed for use with intra-oral film should not be used for cephalometry other than with specifically designed ancillary equipment. Use of such equipment may be approved after a CRE has assessed the apparatus and details of this assessment have been provided to the EPA and the EPA is satisfied that such apparatus does not cause a safety risk to any person.

SECTION 3—QUALITY ASSURANCE

3.1 Quality assurance program

- 3.1.1 A quality assurance (QA) program approved by a CRE **must** be instituted and maintained.
- 3.1.2 The program should ensure that consistent, optimum-quality images are produced so that the exposure of patients, staff and the general public to radiation satisfies the ‘as low as reasonably achievable’ principle.
- 3.1.3 QA procedures **must** be standardised and documented in a QA manual.

3.2 Maintenance

- 3.2.1 Regular maintenance of dento-maxillofacial apparatus should be carried out in accordance with the manufacturer’s instructions.
- 3.2.2 Only persons appropriately licensed under Section 6 of the Act should carry out maintenance of dento-maxillofacial apparatus.

3.3 Processing quality control

- 3.3.1 The owner should ensure that a test film is exposed and processed at regular intervals, not exceeding one week, before the processing of normal dental x-ray film.
- 3.3.2 The test film procedure should follow the protocol described in Appendix 5 of the NHMRC Radiation Health Series No. 20, *Code of Practice for Radiation Protection in Dentistry (1987)*.
Note: The Australian Radiation Protection and Nuclear Safety Agency is publishing the Radiation Safety Series to replace over time the documents comprising the National Health & Medical Research Council Radiation Health Series.
- 3.3.3 The owner should ensure that a logbook is maintained in which all details of test films, processing chemistry, apparatus faults and repairs are recorded. This logbook should be made available to the Authority on request.

SCHEDULE 1—REGISTRATION REQUIREMENTS FOR DENTAL RADIATION APPARATUS

The clauses contained in this Schedule are the requirements referred to in Section 7(5) of the Act that the apparatus **must** meet before the apparatus will be registered.

Requirement	Clause(s)	Requirement	Clause(s)
Radiation shielding	1.2.4, 1.2.5, 1.2.6	Operating kilovoltage	2.8.1
Radiation warning sign	1.4.1, 1.4.2, 1.4.3	Accuracy of kilovoltage	2.9.1, 2.9.2
Location of exposure control switch	1.5.1	Accuracy of timer controls	2.10.1, 2.10.2, 2.10.3
Protective devices	1.6.3	Exposure consistency and linearity	2.11.1, 2.11.2, 2.11.3
Intra-oral x-ray source	2.1.1	Absorbed dose in air at patient's skin surface	2.12.2
Exposure indication	2.2.1, 2.2.2	Radiation leakage	2.13.1, 2.13.2
Control of operation	2.3.1-2.3.5	Stability of x-ray tube assembly	2.14.1
Remote control	2.4.1	Control of multiple x-ray tubes	2.15.1
Indicators of exposure	2.5.1, 2.5.2, 2.5.3	Markings on x-ray generators etc.	2.16.1, 2.16.2
Beam-limiting devices	2.6.1, 2.6.2 (a)–(e), 2.6.3	Quality assurance program	3.1.1, 3.1.3
Filtration	2.7.1, 2.7.2		

APPENDIX A—POLICY ON X-RAY PROTECTIVE CLOTHING

A1 Conditions for use

A1.1 General

- A1.1.1 All staff in a radiographic room during x-ray exposures not standing behind protective screens must wear protective clothing. In general, this means protective aprons of not less than 0.3 mm lead equivalence.
- A1.1.2 Protective gloves should also be worn if it is essential for the hands to be placed in the direct beam at any time, although there may be cases where this is impractical.
- A1.1.3 Aprons and gloves must have radiation attenuation of not less than 0.3 mm lead equivalence at 150 kVp.
- A1.1.4 Aprons must cover the full width of the front of the body from the throat to within 10 cm of the knees, as well as the sides of the body. Wrap-around types of aprons must cover from the shoulder blades to below the buttocks. Fastenings must be provided to keep aprons closed.
- A1.1.5 All staff working in a room where fluoroscopy or cineangiography is being performed must wear a lead apron.
- A1.1.6 If the operator's eyes or thyroid are likely to be exposed when working in the immediate vicinity of the patient, then it is advisable to wear additional protection for these organs. The patients' thyroid should be protected where appropriate.
- A1.1.7 Where appropriate, protection for the patient should also be provided in the form of a lead apron or gonad shield.
- A1.1.8 Personal dosimeters must be worn under the lead apron. A dosimeter must not be worn outside the apron unless it is additional to one worn underneath, and this fact is appropriately reported to the body issuing the dosimeter.
- A1.1.9 An appropriately qualified person, for example, a Chief Radiographer, must be consulted before the purchase of x-ray protective clothing.
- A1.1.10 The manufacturer's recommendations regarding the handling and storage of protective clothing must be strictly observed. Lead aprons must be stored either flat or on hangers to prevent the development of cracks in the protective material.
- A1.1.11 Inspection and testing of protective clothing must be performed as described in section A2 of this Appendix.

A2 Inspection and testing requirements

A2.1 Identification

- A2.1.1 Each item of protective clothing must be identified with a number that is indelibly marked on the outside of the article.
- A2.1.2 A register must be kept that includes the identification number, usual location, date of purchase, lead equivalence, style, testing dates and results.

A2.2 Visual inspection

- A2.2.1 Each user must visually inspect each article of x-ray protective clothing at the time of each use and be confident of its integrity. Clothing must not be used if the surface appears cracked or damaged. (Note that most aprons have a non-shielding protective cover that may appear undamaged even if the shielding material underneath is faulty.)
- A2.2.2 If there is a suspicion that protective clothing is faulty, it must be tested by a licensed radiographer or other appropriate person.

A2.3 Shielding integrity testing procedures

- A2.3.1 All new protective clothing must be tested for shielding integrity before use.
- A2.3.2 Protective clothing must be tested at regular intervals of no more than 12 months, or more frequently if indicated.
- A2.3.3 A licensed radiographer or other appropriate person must carry out testing.
- A2.3.4 Testing may be performed using fluoroscopy at approximately 60 kVp (ideally with a floating-top table), which gives good radiographic contrast. Faults or inhomogeneities in shielding should be easily observed. (Note that the lead equivalence cannot be measured or verified by this method.)
- A2.3.5 If faults are found, a radiograph should be taken, and the article must be immediately removed from use and returned to the Chief Radiographer or an appropriately qualified person.
- A2.3.6 The date, article identification and outcome of each test must be recorded in the register.

For further information, the following British Standards should be consulted:

- BS 2606 X-ray Protective Gloves for Medical Diagnostic Purposes up to 150 kV (Peak)
- BS 3783 X-ray Lead–Rubber Protective Aprons for Personal Use.

Radiation Advisory Council (October 1992)

REFERENCES AND FURTHER READING

Australian Radiation Protection and Nuclear Safety Agency & National Occupational Health & Safety Commission, 2002, *Recommendations for Limiting Exposure to Ionizing Radiation (1995) (Guidance Note [NOHSC:3022(1995)])* and *National Standard for Limiting Exposure to Ionizing Radiation [NOHSC:1013(1995)]*, Radiation Protection Series Publication No. 1, ARPANSA, Yallambie, Victoria.

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Note: The Australian Radiation Protection and Nuclear Safety Agency is publishing the Radiation Safety Series to replace over time the documents comprising the National Health & Medical Research Council Radiation Health Series.

DEFINITIONS

In this Guideline:

Absorbed dose means energy delivered from radiation per unit mass of absorbing material, measured in Gray (Gy) or mGy. One Gray equals one joule per kilogram.

Act means the *Radiation Control Act 1990*.

Air kerma means *kerma* measured in a mass of air.

Added filtration means quantity indicating the *filtration* affected by added filters in the useful beam, but excluding inherent filtration.

Authority means the NSW Environment Protection Authority.

CRE means consulting radiation expert.

Coefficient of variation means the quotient of the standard deviation and the mean.

Coefficient of linearity = $(X_{\max} - X_{\min}) / (X_{\min} + X_{\max})$.

Council means the Radiation Advisory Council.

Dento-maxillofacial apparatus means radiation apparatus, which emits ionising radiation, used for the purpose of radiographic imaging of the teeth and maxillofacial region. This includes apparatus with extra-oral x-ray sources designed for use with intra-oral image receptors, dental panoramic tomography and cephalometric radiography.

EPA means the NSW Environment Protection Authority

Filtration means modification of the spectral distribution of an x-ray beam as it passes through matter, by the differential absorption of poly-energetic photons.

Focal spot means the area of the *target* from which x-rays are emitted.

Half-value layer (HVL) means the thickness of a specified material that reduces the absorbed dose in air of a given x-ray beam to half its original value.

Inherent filtration means the *filtration* affected by the irremovable materials of an *x-ray tube assembly* (glass, oil and port seal), through which the radiation beam passes before emerging from the x-ray tube assembly. It is expressed in thickness of a reference material that, at a specified potential difference and waveform, gives the same radiation quality in terms of the *half-value layer*.

Kerma (K): means kinetic energy relaxed in a material by ionising radiation, and is determined as the quotient of dE_{tr} by dm , where dE_{tr} is the sum of the initial kinetic energies of all the charged ionising particles liberated by uncharged ionising particles in a material of mass dm (i.e. $K = dE_{tr}/dm$). The unit of kerma is the gray (Gy), or joule per kilogram.

Kerma rate: means *kerma* per unit time and is determined as the quotient of dK by dt , where dK is the increment of kerma in the time interval dt .

Lead equivalent means the thickness of lead causing the same attenuation of a beam of a specified radiation quality as the material under consideration.

NHMRC means National Health and Medical Research Council.

Optical density (OD) means the degree of film blackening produced during development, where optical density is the log of the reciprocal of the fraction of light transmitted through the blackened film.

Operator means a person licensed under Section 6 of the Act to use ionising radiation.

Owner means the owner of radiation apparatus to which Section 7 of the Act applies.

Phantom means a test object that simulates the average composition of various structures.

Primary beam means all ionising radiation that emerges through the specified aperture of the protective shielding of the x-ray tube and the collimating device.

Radiation leakage means ionising radiation transmitted through the protective shielding of a radiation source other than the primary beam.

Radiation quality refers to the penetrating ability of a beam of x-rays. It is determined by the energy distribution of the photons in the beam, which in turn depends on the kV waveform and peak voltage across the tube, and on the filtration through which the beam has already been transmitted. The quality of an x-ray beam is described by the HVL of the beam and is measured in terms of mm of aluminium in the diagnostic range.

Regulation means the Radiation Control Regulation 2003.

Scattered radiation means ionising radiation produced from the interaction of electromagnetic ionising radiation with matter. It has a lower energy than, or different direction from, that of the original incident ionising radiation.

Target means the area of the anode that is struck by the electrons from the cathode.

Total filtration means the sum of *inherent filtration* and *added filtration* between the radiation source and the patient or other defined plane.

X-ray tube assembly means the *x-ray tube housing* with an *x-ray tube insert*, but not including a collimating device.

X-ray tube housing means a container in which an x-ray tube is mounted for normal use, providing protection against electric shock and ionising radiation except for an aperture for the useful beam. It can contain other components.

X-ray tube insert means a highly evacuated vessel for the production of x-radiation by the bombardment of a target, usually contained in an anode, with a beam of electrons accelerated by a potential difference.

X-ray tube potential difference means the peak value of the potential difference applied to the x-ray tube, expressed as kilovolts peak (kVp).

Unless otherwise defined, all words in this Guideline have the same meaning as in the Act and the Regulation.