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**CODE OF SAFE PRACTICE FOR THE USE OF  
X-RAYS IN VETERINARY DIAGNOSIS**

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# 1 INTRODUCTION

## 1.1 Purpose

The purpose of this *Code* is to specify requirements for the protection of veterinary personnel who work with x-rays, other veterinary personnel, and members of the public by ensuring that

- any use of radiation is justified – namely that the benefits from performing a given x-ray exposure outweigh any harm arising from personnel and public doses;
- the dose and risk from any actual or potential exposure to radiation is as low as reasonably achievable;
- the relevant dose limits are not exceeded (sections 4.1.1 and 5.2.1);
- there is sufficient documentation to enable verification of compliance.

## 1.2 Scope

1.2.1 This *Code* covers the use of x-rays in veterinary diagnosis only. The use of x-rays for veterinary radiotherapy is not covered by this *Code*. The use of radioactive material to treat thyroid conditions in cats or possibly other animals is not covered by this *Code*.

1.2.2 This *Code* deals with radiation safety only. Other legislation covering hazardous substances, transport, occupational safety, protection of the environment, local body planning and other issues may overlap with the radiation protection legislation. Compliance with this *Code* in no way implies that all or any of these other requirements have been satisfied.

## 1.3 Application of this Code

1.3.1 The ownership and use of irradiating apparatus is controlled by the *Radiation Protection Act 1965* and *Radiation Protection Regulations 1982*. As well as mandatory compliance with the *Act* and *Regulations*, anyone licensed to use irradiating apparatus for the purpose of veterinary diagnosis (termed “to use x-rays in veterinary

diagnosis” elsewhere in this *Code*) will be required by a condition on the licence to comply with this *Code*.

- 1.3.2 This *Code* stipulates the specific way in which some parts of the *Act* and *Regulations* must be satisfied with respect to the use of x-rays in veterinary diagnosis. As well, there are further requirements that are recognised as good practice necessary for safety. All of these requirements are indicated by the word “**must**”. They are binding on **all** people licensed to use x-rays in veterinary diagnosis. Whenever a responsibility is shared by more than one licensee, to avoid ambiguity, one person must take the role of ensuring the responsibility is carried out. This licensee is referred to in this *Code* as the **principal licensee**. (See also *NRL Matters No. 10*, June 2001, for further information on respective licensees’ responsibilities.)
- 1.3.3 Compliance with this *Code* includes compliance with any addenda or corrigenda that the National Radiation Laboratory (NRL) may issue at some future date. Such addenda or corrigenda will be sent to licensees whose licence conditions include compliance with this *Code*. The copy of the *Code* on the NRL website ([www.nrl.moh.govt.nz](http://www.nrl.moh.govt.nz)) will include all such changes. Any reference to the *Code of safe practice for the use of x-rays in veterinary diagnosis, NRL C21*, will include any addenda or corrigenda subsequently issued.
- 1.3.4 General advice on the safe use of x-rays in veterinary diagnosis and compliance with the radiation protection legislation and this *Code* is given in *Guidance notes: safe practice for the use of x-rays in veterinary diagnosis*.
- 1.3.5 Where the terms “*effective dose*” and “*equivalent dose*” are used for protection purposes they have the meanings defined in ICRP Publication 60 (*Recommendations of the International Commission on Radiological Protection*, Annals of the ICRP **21**(1-3) Pergamon Press, Oxford), and they can be practically represented by the ICRU operational quantities (see *Quantities and units in radiation protection dosimetry*, ICRU Report 51, International Commission on Radiation Units and Measurements, Bethesda, Maryland).

## 1.4 Exemptions from requirements of the Code

- 1.4.1 If for purely technical reasons relating to a particular piece of equipment or procedure it is either not possible or deemed unnecessary to comply with any requirement or requirements in this *Code* then an exemption from the specific requirement or requirements for that piece of equipment or procedure may be granted on application to NRL.
- 1.4.2 An application for exemption will be accepted only if it can demonstrate that the proposed alternative to the requirement does not compromise the intent of the relevant section of the *Code*.
- 1.4.3 Written evidence of this exemption **must** be retained in the *Radiation Safety Plan* (see section 2.1).

## 2 RADIATION SAFETY MANAGEMENT

### 2.1 Radiation Safety Plan

2.1.1 The principal licensee at each veterinary facility where x-rays are used in veterinary diagnosis **must** ensure that there is a *Radiation Safety Plan* for that facility.

2.1.2 The *Radiation Safety Plan* **must** be available for audit by the National Radiation Laboratory.

2.1.3 The *Radiation Safety Plan* **must** comprise:

- a) details of responsibilities and authorisations to use x-rays in veterinary diagnosis;
- b) radiation safety induction and training requirements for personnel, and associated records;
- c) personal monitoring policy, procedures and records (see also section 4.2);
- d) register of x-ray equipment in the facility;
- e) procedures for quality assurance in radiation safety (see section 2.2 for details), and records;
- f) written local rules for the safe use of x-rays in veterinary diagnosis (see also sections 4.1.1 and 5.1.1);
- g) radiographic technique charts for each x-ray tube;
- h) procedures to cover radiation safety aspects of fire, earthquake and other civil defence emergencies (see also section 6.3);
- i) incident and accident reports (see also section 6.1);
- j) records of maintenance and repair work on x-ray units and/or x-ray facilities (see also section 2.3);
- k) any exemptions granted under section 1.4 of this Code.

2.1.4 All records required for the *Radiation Safety Plan* **must** be kept for 10 years.

2.1.5 The principal licensee **must** be responsible for ensuring that all personnel involved in the use of x-rays in veterinary diagnosis at the

facility are familiar with the *Radiation Safety Plan* and that all personnel agree to abide by all policies, procedures and local rules in the *Radiation Safety Plan*.

- 2.1.6 The principal licensee **must** ensure that any unlicensed user of x-rays for veterinary diagnosis is adequately trained for this purpose, including having had instruction in radiation safety and instructions on how to contact a licensee in case of an accident or emergency. Names of persons authorised to act under supervision or instructions together with their training details **must** be documented as part of the *Radiation Safety Plan* (see section 2.1.3a and b).

## **2.2 Quality assurance in radiation safety**

- 2.2.1 The principal licensee **must** maintain a programme of quality assurance in radiation safety (see section 2.1.3e) to ensure continuing compliance with this *Code*. In particular to ensure:

- a) image quality of a diagnostic standard;
- b) satisfactory x-ray equipment performance;
- c) satisfactory darkroom, cassettes, screens, films and processing performance;
- d) satisfactory viewing box performance;
- e) satisfactory protective clothing performance;
- f) working procedures continue to be effective in minimising personnel and public doses;
- g) radiographic technique charts are current;
- h) authorisations, equipment registers and training are up-to-date;
- i) audits of the *Radiation Safety Plan* and the radiation safety quality assurance programme are performed at least annually.

## **2.3 Installation, maintenance and servicing**

- 2.3.1 Any installation, maintenance or servicing of veterinary x-ray equipment that involves the x-ray generator or tube, or production of x-rays, **must** be carried out only by a person appropriately trained and

licensed (under the *Radiation Protection Act* for the purpose Installation and Servicing) to carry out such activities.

- 2.3.2 The principal licensee **must** ensure that all information necessary for the radiation safety of such a person is fully disclosed and effectively communicated to the person prior to the commencement of any work.

## **2.4 Storage and disposal of x-ray equipment**

- 2.4.1 The principal licensee **must** ensure that any veterinary x-ray equipment surplus to current requirements is stored in the following manner:

- a) the mains supply is disconnected from the generator; and
- b) for portable equipment, the x-ray unit is stored in a locked room with controlled access.

- 2.4.2 If any veterinary x-ray equipment is to be disposed of then the principal licensee **must** ensure that the following takes place:

- a) the x-ray unit is rendered inoperable prior to disposal as junk; and
- b) the National Radiation Laboratory is notified in writing, at the time of disposal, with sufficient details to uniquely identify the x-ray equipment disposed of.

### 3 FACILITIES AND EQUIPMENT

#### 3.1 X-ray facilities

##### 3.1.1 *General requirements*

- 3.1.1.1 The principal licensee **must** ensure that buildings, rooms or areas where x-rays are used for veterinary diagnosis have appropriate shielding or other protective measures so that the radiation exposure to any member of the public or any other person not involved in using x-rays cannot be in excess of the limits given in section 5.2.1.
- 3.1.1.2 In any room where veterinary radiography is performed there **must** be a primary beam barrier of not less than 2 mm lead equivalence with sufficient dimensions to intercept the x-ray beam, after it has passed through the animal and image receptor, before it would reach areas that may be occupied by persons not involved in that radiography.
- 3.1.1.3 All walls (including any doors and windows), and the ceiling and floor (if there are occupied rooms or spaces above or below, respectively) of a room containing a fluoroscopy system used for veterinary diagnosis **must** have a lead equivalence (at 100 kVp) of not less than 1 mm. There **must** be an operator barrier with a lead equivalence of not less than 1 mm constructed at the generator controls of any fixed fluoroscopy system. Any viewing window in this operator barrier **must** also have a lead equivalence of not less than 1 mm.
- 3.1.1.4 All walls (including any doors and windows), and the ceiling and floor (if there are occupied rooms or spaces above or below, respectively) of a room containing a CT scanner used for veterinary diagnosis **must** have a lead equivalence (at 150 kVp) of not less than 1.5 mm. There **must** be an operator barrier with a lead equivalence of not less than 1.5 mm constructed at the controls of veterinary CT scanners. Any viewing window in this barrier **must** also have a lead equivalence of not less than 1.5 mm.
- 3.1.1.5 For film-based radiography, the principal licensee **must** ensure that the veterinary x-ray facility has at least one light box appropriate for viewing x-ray films. (See also section 2.2.1d.)

### 3.1.2 *Protective equipment in x-ray rooms and in the field*

3.1.2.1 The principal licensee **must** ensure that each veterinary x-ray facility has sufficient protective aprons and gloves or other protective shields for persons involved in the use of x-rays and for all persons likely to be involved in either holding the animals or holding cassette-holding devices in field radiography.

3.1.2.2 The principal licensee **must** ensure that any veterinary x-ray facility where fluoroscopy is performed has sufficient protective aprons and gloves or other protective shields for all persons involved in the fluoroscopy procedures.

3.1.2.3 The principal licensee **must** be responsible for ensuring that:

- a) the protective aprons and gloves are checked at least annually for basic integrity of the radiation shielding (see also section 2.2.1e);
- b) the protective aprons and gloves are clearly labelled with their lead equivalence;
- c) the lead equivalence of protective aprons used during fluoroscopy of large animals (eg, horses, cows) is at least 0.5 mm; and the lead equivalence of protective aprons and gloves or equivalent used for all other procedures is at least 0.25 mm;
- d) the lead equivalence of any glove used for palpation during fluoroscopy is at least 0.5 mm.

3.1.2.4 The principal licensee **must** be responsible for ensuring that there are cassette holders or other mechanical means available for use when the cassette cannot be placed on a table and the primary beam is angulated or horizontal.

## **3.2 X-ray equipment**

### 3.2.1 *General requirements*

3.2.1.1 The principal licensee **must** ensure that any x-ray equipment used for veterinary radiography is of an appropriate type. Dedicated veterinary

dental x-ray equipment **must not** be used for general veterinary radiography.

3.2.1.2 The principal licensee **must** ensure that the x-ray equipment used for veterinary radiography meets the following performance requirements before initial use:

- a) *X-ray output reproducibility:* the coefficient of variation (the ratio of the standard deviation of the sample to the mean of the sample) of the x-ray output of a series of not less than 5 consecutive exposures at the same settings, representative of veterinary radiography and taken within a time period of 10 minutes, **must** be less than 0.10.
- b) *Leakage radiation:* leakage radiation from the x-ray tube assembly measured at 1 metre from the focus **must not** exceed 1 mGy (dose to air) in an hour when the tube is used at its maximum duty cycle for an hour at the maximum ratings specified by the manufacturer for that tube in that housing; and in addition for capacitor discharge units the leakage radiation from the x-ray tube assembly when the exposure device (or the discharge mechanism) is not activated **must not** exceed 20 µGy in one hour at 50 mm from any accessible surface of the x-ray tube assembly with the x-ray beam collimating device fully open and with the maximum voltage on the capacitors.
- c) *X-ray beam filtration:* the measured half value layer of the incident primary x-ray beam for a given kVp **must not** be less than the following limits:
  - i) 1.5 mm Al at 50 kVp true;
  - ii) 1.6 mm Al at 60 kVp true;
  - iii) 1.8 mm Al at 70 kVp true;
  - iv) 2.1 mm Al at 80 kVp true;
  - v) 2.3 mm Al at 90 kVp true;
  - vi) 2.6 mm Al at 100 kVp true;
  - vii) 2.9 mm Al at 110 kVp true;
  - viii) 3.2 mm Al at 120 kVp true.

3.2.1.3 The principal licensee **must** ensure that the requirement referred to in section 3.2.1.2 is re-validated with respect to x-ray output reproducibility (3.2.1.2a) every 3 years for x-ray units that are used in a portable capacity and every 5 years for all other units.

- 3.2.1.4 The principal licensee **must** ensure that a re-assessment of leakage radiation and x-ray beam filtration (3.2.1.2b and c) is performed on the completion of any maintenance that has required the x-ray tube head assembly to be dismantled and re-assembled.
- 3.2.1.5 With the exception of dedicated veterinary dental x-ray units where the diameter of the x-ray beam **must not** exceed 60 mm at the end of the positioning device, any x-ray unit used for the purpose of veterinary radiography **must** have an adjustable light beam diaphragm that meets the following conditions:
- a) *Accuracy:* The misalignment of each edge of the visually defined light field with the respective edge of the x-ray field **must** not exceed 2.0% of the distance from the focus to the centre of the visually-defined field when the surface on which it appears is perpendicular to the central axis of the useful x-ray beam.
  - b) *Delineation:* The centre of the x-ray beam and indicated centre of the light beam **must** coincide to an accuracy of within 2.0% of the distance from the focus to the point on the illuminated surface at which it appears.
  - c) *Illumination:* The brightness of the light field **must** be sufficiently great that the light field is clearly visible in ambient illumination. The outer edges of the light field **must** be clearly shown and sharply defined.
- 3.2.1.6 The principal licensee **must** ensure that the radiographic exposure device meets the following requirements:
- a) it **must** terminate radiographic exposures after the elapse of a preset time (timer control or anatomical selection), preset exposure to an imaging device (automatic exposure control), or preset mAs;
  - b) it **must not** be possible to make repeat exposures without release of the exposure-initiating control, except in special techniques where a sequence of repeated exposures is knowingly and specifically activated;

- c) it **must not** be possible to make x-ray exposures when the exposure device is set to zero, “0”, “off”, or equivalent positions if these are provided;
- d) operation of the exposure device **must** require continuous firm pressure on the exposure control throughout the exposure. Premature release of this pressure **must** cause the x-ray exposure to terminate immediately;
- e) for mobile or portable units, there **must** be a hand or foot switch at the end of a cord whose length is sufficient to enable the operator to be at least 2 metres from the x-ray tube head and from the animal during radiography.

3.2.1.7 The principal licensee **must** ensure that there are means to support the tube head so that it remains stationary when positioned for radiography.

### 3.2.2 *Capacitor discharge x-ray machines*

3.2.2.1 For capacitor discharge x-ray machines the principal licensee **must** ensure the following requirements are met:

- a) electrically interlocked shutters **must** be fitted to prevent emission of primary beam radiation before exposure and after termination of the exposure;
- b) there **must** be means of discharging the capacitor, irrespective of whether the unit is connected to the mains supply or not, in a manner that does not result in the emission of x-radiation from the x-ray tube enclosure, with the x-ray beam collimating device fully open, that would exceed 1 mGy (dose to air) in an hour measured at 1 metre from the focus when the tube is discharged at its maximum duty cycle for an hour at the maximum ratings specified by the manufacturer for that tube in that housing.

### 3.2.3 *Fluoroscopy systems*

3.2.3.1 The principal licensee **must** ensure that all veterinary fluoroscopy systems comply with the requirements given in Appendix A of this *Code* before initial use and every three years thereafter.

### 3.2.4 *Computed tomography systems*

3.2.4.1 The principal licensee **must** ensure that all veterinary CT systems comply with the requirements given in Appendix B of this *Code* before initial use and every three years thereafter.

## 3.3 **Warning systems**

### 3.3.1 *Warning lights at the x-ray controls*

3.3.1.1 There **must** be a prominent light on the x-ray control panel which is illuminated when the x-ray machine is switched on to the electrical mains. Alternatively the meters, indicators, etc, of the x-ray control panel **must** clearly indicate when the electrical mains are switched on to the x-ray machine.

3.3.1.2 There **must** be a prominent light on the x-ray control panel which is illuminated when x-rays are being produced.

3.3.1.3 Where there is more than one x-ray tube connected to the generator the tube selector switch at the x-ray control panel **must** be clearly and unambiguously labelled and the x-ray tube presently connected **must** be indicated by an illuminated sign close to the selector switch or by other clear and unmistakable means.

### 3.3.2 *Warning signs for rooms and other areas where x-rays are used*

3.3.2.1 Any entrance to a room where x-rays are used **must** have a warning sign that clearly indicates the nature of the hazard and restricts access.

3.3.2.2 In field radiography, whenever there is a possibility of persons other than those involved in the radiography entering the area of radiation-use, portable radiation warning signs of sufficient size to clearly indicate the nature of the hazard and warn against access **must** be used.

## 4 OCCUPATIONAL SAFETY

### 4.1 General requirements

- 4.1.1 All persons using x-rays in veterinary diagnosis **must** follow written local rules (section 2.1.3f) designed to keep the radiation doses to all personnel as low as reasonably achievable, social and economic considerations being taken into account, and such that the doses to veterinary personnel whose duties involve working with x-rays do not exceed the following dose limits:
- a) an *effective dose* of 20 mSv per year averaged over any five-year period and 50 mSv in any one year;
  - b) an *equivalent dose* of 500 mSv to the skin (at the nominal depth of 7 mg/cm<sup>2</sup>) averaged over 1 cm<sup>2</sup>, regardless of the total area exposed, in any one year;
  - c) an *equivalent dose* of 150 mSv to the lens of either eye in any one year;
  - d) an *equivalent dose* of 500 mSv to the hands and feet in any one year;
  - e) for women who declare themselves pregnant, a dose of 2 mSv at the surface of the abdomen over the remainder of the pregnancy.
- 4.1.2 The principal licensee **must** ensure that the doses to veterinary personnel whose duties do not involve working with x-rays do not exceed the dose limits for members of the public given in section 5.2 of this *Code*.
- 4.1.3 The principal licensee **must** ensure that no person under the age of 16 years is allowed to participate or assist in work involving the use of x-rays in veterinary diagnosis.
- 4.1.4 The principal licensee **must** ensure that no person is present in any room housing a CT scanner when that CT scanner is being used for veterinary diagnosis.

## 4.2 Personal radiation monitoring

- 4.2.1 The principal licensee **must** ensure that personal monitoring, using a method approved by the NRL to provide a continuous measure of effective dose or equivalent dose as appropriate, of personnel whose duties involve working with radiation is performed unless it has been demonstrated, via documentation in the *Radiation Safety Plan*, that occupational doses will be less than one-tenth of the dose limits in section 4.1.1.
- 4.2.2 The principal licensee **must** ensure that any person who is involved in performing veterinary fluoroscopy is monitored using a method approved by NRL to provide a continuous measure of effective dose or equivalent dose as appropriate.
- 4.2.3 The principal licensee **must** ensure that any person who is involved in performing radiography of large animals (eg, horses, cows) is monitored using a method approved by NRL to provide a continuous measure of effective dose or equivalent dose as appropriate.
- 4.2.4 The principal licensee **must** ensure that records of personal monitoring are provided to all monitored personnel, and copies held for at least 10 years.
- 4.2.5 If any person required to be monitored under this section receives in any three-month period an effective dose of more than 1 mSv or an equivalent dose of more than 9 mSv to the eyes or an equivalent dose of more than 30 mSv to the hands, the reason for this **must** be investigated by the principal licensee. If the dose were received under normal working conditions, the written local rules **must** be reviewed with the aim of reducing the operator dose. Full records of the result of the investigation and any resulting changes to standard practice **must** be kept in the *Radiation Safety Plan*.

## 5 PUBLIC SAFETY

### 5.1 Control of visitors

5.1.1 The principal licensee **must** ensure that there are written local rules controlling access of visitors or members of the public (including the animal's owner) to areas where radiation is used (see *Radiation Safety Plan* section 2.1.3f).

### 5.2 Sources of exposure

5.2.1 The principal licensee **must** ensure that the radiation exposure to any member of the public or any personnel whose duties do not involve the use of x-rays in veterinary diagnosis is as low as reasonably achievable, social and economic considerations being taken into account, and does not exceed the following dose limits:

- a) an *effective dose* of 1 mSv in any one year;
- b) an *equivalent dose* to the skin of 50 mSv over any 1 cm<sup>2</sup>, regardless of the total area exposed, in any one year;
- c) an *equivalent dose* of 15 mSv to the lens of either eye in any one year.

## 6 INCIDENTS, ACCIDENTS AND EMERGENCIES

- 6.1 The principal licensee **must** ensure that any person involved in an incident or accident, where persons may have been exposed to levels of radiation exceeding what normally would be expected, reports the details of the event to him/her immediately. The principal licensee **must** then:
- a) fully investigate the event in consultation with other personnel involved;
  - b) review the standard working and quality assurance procedures to see if any deficiency was a factor in the occurrence;
  - c) cause a record of the report and investigation to be kept for at least 10 years (see section 2.1.3i).
- 6.2 In the event of a suspected or actual exposure to radiation exceeding any of the dose limits given in section 4.1.1 for personnel working with radiation or section 5.2.1 for a member of the public or non-radiation personnel, the principal licensee **must**
- a) immediately advise NRL of the circumstances; and
  - b) make available to the person exposed such medical examinations as may be appropriate to manage any injury.
- 6.3 There **must** be written emergency procedures (section 2.1.3h) for radiation safety and the security of the x-ray equipment during a civil emergency.

## APPENDIX A

### Requirements for fluoroscopic equipment in veterinary diagnosis

- A.1 Image intensification **must** always be used. Direct-viewing fluoroscopes are not permitted.
- A.2 The x-ray tube assembly and fluoroscopic imaging assembly **must** be ganged together such that there can be no lateral movement of the one with respect to the other. Where the ganging is disconnected it **must** no longer be possible to perform fluoroscopy.
- A.3 The fluoroscopy assembly **must** have as an integral part a primary barrier of lead equivalence of 2.0 mm.
- A.4 Collimation:
- a) Where an x-ray beam collimating device (eg, shutter diaphragm system) is present to give variable x-ray beams then at all focus-table top and image intensifier-table top distances the primary barrier **must** completely intercept the primary beam for all openings of the collimating device.
  - b) Where a fixed diaphragm is used with a fixed focus to image intensifier distance, as in mobile image intensifier x-ray machines, the cross-section of the x-ray beam **must** match the cross-section of the image intensifier at the input plane of the image intensifier.
- A.5 The central axis of the primary beam **must** pass through the geometric centre of the input face of the image intensifier.
- A.6 The focus to the animal's skin distance **must not** be less than 350 mm.
- A.7 The total filtration of the incident primary x-ray beam **must not** be less than 2.5 mm aluminium equivalent.
- A.8 X-ray exposure device:
- a) The fluoroscopy exposure switch **must** require continuous pressure to produce x-rays. Release of this pressure **must**

immediately stop x-rays being produced. The fluoroscopy exposure switch **must** be clearly identified and **must** be located so that it can be controlled by the fluoroscopist.

- b) A cumulative timing device activated by the control circuit for fluoroscopy **must** be provided to display elapsed time in seconds or minutes.
- c) The fluoroscopy timing device **must** give a characteristic audible signal at the end of a predetermined time interval not longer than 10 minutes. The audible signal **must** continue until the timer is reset. Or, alternatively, if the cumulative timing device terminates the irradiation when the total exposure time of fluoroscopy exceeds the predetermined time interval then a characteristic continuous and audible signal **must** be given at least 30 seconds before the end of the time interval in order to permit the device to be reset if necessary.

A.9 The entrance surface dose rate to air measured free-in-air in the central axis of the x-ray beam at the position of the animal's skin **must not** exceed 50 mGy per minute for any field size of the image intensifier. Means **must** be employed to prevent the screening output from exceeding this dose rate for normal use. However, dose rates greater than 50 mGy per minute are permitted for special modes of operation provided that:

- a) there **must** be a special control to activate and de-activate the high dose rate mode;
- b) the special control **must** be clearly labelled as a "high dose rate control", or equivalent statement;
- c) the entrance surface dose rate to air measured free-in-air in the central axis of the x-ray beam at the position of the animal's skin **must not** exceed 100 mGy per minute for any field size of the image intensifier;
- d) the high dose rate mode **must** be de-activated if the x-ray machine is turned off while the high dose rate mode is still selected.

A.10 Image quality: the fluoroscopy image contrast measured at 70 kVp, 1 mm added copper filtration **must not** be worse than 5.0% for a 10 mm diameter detail, and 15.0% for a 1.0 mm diameter detail, at dose rates in compliance with section A.9.

## APPENDIX B

### Requirements for CT equipment in veterinary diagnosis

- B.1 The computed tomography dose index (CTDI) **must** be measured in air at the iso-centre of the CT scanner for all collimation widths available and the results verified as being within specification.
- B.2 The CT number of air determined by the CT scanner (ie, the average pixel value of a region of air) **must** be  $-1000 \pm 10$  HU.
- B.3 The CT number of water determined by the CT scanner (ie, the average pixel value of a region of water) **must** be  $0 \pm 4$  HU.
- B.4 The uniformity of CT numbers for a large region of water, or similar material: the difference between the mean CT number for a central region of the material and the mean CT number for peripheral regions **must not** exceed  $\pm 5$  HU.
- B.5 Noise: this **must** be assessed using a cylindrical water phantom, or similar, and determining the standard deviation of the HU values in a central region whose diameter is approximately 40% of the diameter of the image of the test phantom.
- a) On commissioning, noise assessment **must** be performed at a range of dose levels to establish baseline performance; and
  - b) The results of on-going noise assessment, performed at a specified typical level of dose, **must not** exceed 150% of the baseline performance at that dose.
- B.6 Localisation (axial, sagittal and coronal) lights or lasers **must** be provided. The coincidence of the axial scan localisation light or laser and the scan plane **must** be within  $\pm 2$  mm. The coincidence of the sagittal and coronal scan localisation lights or lasers with the gantry iso-centre **must** be within  $\pm 5$  mm.
- B.7 The tolerance on the actual distance moved by the CT couch (in both directions) **must** be within  $\pm 2$  mm for a selected, indicated or displayed movement of 200 mm.

B.8 The tolerance on localisation of the axial scan plane derived from a scan projection radiograph (eg, scoutview, etc) **must** be within  $\pm 2$  mm.

## CROSS-REFERENCE INDEX

The regulatory framework for this *Code* is provided by the radiation protection legislation.

This index provides references to specific parts of the legislation, some of which, while not directly cited in the *Code*, do provide the regulatory authority for its requirements.

The references are from this *Code of safe practice for the use of x-rays in veterinary diagnosis, NRL C21* to:

- *Radiation Protection Act 1965;*
- *Radiation Protection Regulations 1982.*

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