

# Code of Practice for Veterinary Radiation

ORS C9

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# Introduction

## Purpose and commencement

This Code of Practice for Veterinary Radiation ('code') is issued by the Director for Radiation Safety ('the Director') under section 86 of the Radiation Safety Act 2016 ('the Act'). It provides the operational information necessary to comply with the fundamental requirements in sections 9 to 12 of the Act. Appendix 1 sets out cross-references between clauses in this code and those fundamental requirements. The requirements in this code do not limit the general nature of the fundamental requirements. This code comes into force on 31 July 2020.

## Scope

This code applies to all activities associated with the use and storage of irradiating apparatus and radioactive material for veterinary diagnosis and research. Irradiating apparatus can include fixed and portable X-ray equipment and computed tomography equipment. Radioactive material can include technetium-99m used for veterinary diagnosis and iodine-131 used for veterinary therapy.

The following issues are dealt with in separate codes of practice:

- safety of radioactive material in transport: ORS C5
- security of radioactive material in use, storage or transport: ORS C6.

Activities can include the manufacture, possession, control, management, use, administration, storage, import, export, sale, supply, discharge and disposal of irradiating apparatus and radioactive material.

Compliance with the code does not imply compliance in related areas such as occupational safety, hazards in the workplace and resource management.

## Contact

The Director's contact details are:

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Wellington 6140

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# Roles and responsibilities

The following individuals and bodies have roles and responsibilities in relation to this code.

**Director for Radiation Safety** – the individual appointed under section 76 of the Act to perform functions and duties and exercise powers set out in the Act, including the power to issue this code.

**Managing entity** – the legal entity that manages or controls radiation sources and must, therefore, obtain a source licence as required by section 13(a) of the Act. Normally this will be a private veterinary practice, but it could alternatively be an educational or other organisation involved in veterinary practice.

**Manufacturer/supplier** – the person or organisation that designs, manufactures, produces, constructs, assembles, installs, distributes, sells, exports or imports radiation sources or ancillary equipment that could influence the successful outcome of a radiation procedure.

**Qualified expert** – an individual who is recognised as having expertise in a relevant field of specialisation such as health physics or radiation safety.

**Radiation safety officer** – a person competent in radiation protection and safety who the **managing entity** designates to oversee the application of regulatory requirements.

**Servicing engineer** – a person who has expertise in installing, servicing and maintaining irradiating apparatus.

# Definitions

Defined terms are identified in **bold** and have the following meanings.

**Accident** – any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of **protection and safety**.

**Ancillary equipment** – equipment other than **radiation sources** that has an impact on the successful outcome of a **radiation procedure**, such as radiation measurement equipment, local shielding, equipment for displaying and interpreting radiographs and equipment for processing films.

**Constraint** – a prospective and source-related value of individual dose (dose constraint) or of individual risk (risk constraint) that is used in **planned exposure situations** as a parameter for the **optimisation of protection and safety** for the source, and that serves as a boundary in defining the range of options in **optimisation**. Constraints for **occupational exposure** and **public exposure** are established or approved by the Director and, if established, are published in a compliance guide issued under this code.

**Controlled area** – an area in which specific protection measures and safety provisions are or could be required for controlling exposures in normal working conditions, and preventing or limiting the extent of **potential exposures**.

**Dose limit** – the value of **effective dose** or **equivalent dose** set out in Schedule 3 of the Act.

**Effective dose** – the tissue-weighted sum of **equivalent doses** in all specified tissues and organs of the body.

**Emergency** – any non-routine situation that necessitates prompt action, primarily to mitigate actual or perceived hazards or adverse consequences for human health and safety, quality of life, property or the environment. This includes **radiation emergencies** and conventional emergencies such as fires, release of hazardous chemicals, storms or earthquakes.

**Employer** – the legal entity that employs **workers**. A self-employed person is regarded as being both an employer and a worker.

**Equivalent dose** – the radiation-weighted dose in a tissue or organ of the body.

**Facility** – the location at which **radiation procedures** are performed and **radiation sources** are installed, used, handled or stored.

**Incident** – any **accident** or other unintended event, including initiating events, accident precursors, near misses or other mishaps; or unauthorised acts, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of **protection and safety**.

**Individual monitoring** – **monitoring** using equipment worn by individuals.

**Interventional radiology** – the use of X-rays to provide image-guided assistance, for example fluoroscopy guidance during surgery.

**Investigation level** – value of a quantity such as **effective dose** at or above which an investigation would be conducted.

**Irradiating apparatus** – electrical equipment that:

- (a) is designed to generate ionising radiation such as X-rays, neutrons, electrons or other charged particles; or
- (b) produces ionising radiation as a by-product:
  - (i) resulting in a dose **equivalent rate** of or exceeding 1 microsievert per hour at a point 0.1 metres from any accessible surface and
  - (ii) that has a maximum energy of or exceeding 5 kiloelectronvolts.

**Justify** – determine that the expected benefits to individuals and society from introducing or continuing a practice outweigh the harm, including the radiation detriment, resulting from the practice. 'Justifies', 'justified' and 'justification' have corresponding meanings.

**Medical exposure** – exposure to ionising radiation experienced by patients for the purposes of medical diagnosis or medical treatment, by comforters/carers while providing care, support or comfort to patients undergoing **radiation procedures**, and by volunteers in a programme of biomedical research.

**Member of the public** – for purposes of **protection and safety**, any individual in the population except when subject to **occupational exposure** or **medical exposure**.

**Monitoring** – the measurement of dose or dose rate to enable the assessment or control of exposure due to radiation, and the interpretation of the results.

**Occupational exposure** – exposure of **workers** incurred in the course of their work.

**Occupationally exposed person** – any person who is subject to **occupational exposure**.

**Optimise** – implement a level of **protection and safety** that results in the magnitude of individual doses, the number of individuals (**workers** and **members of the public**) subject to exposure and the likelihood of exposure being as low as reasonably achievable, taking economic and social factors into account. 'Optimises', 'optimised' and 'optimisation' have corresponding meanings.

**Personal protective equipment** – equipment worn on the person to reduce their exposure to radiation, such as a protective apron.

**Planned exposure situation** – situation of exposure that arises from the planned use of **radiation sources** or from a planned activity that results in an exposure due to a **radiation source**.

**Potential exposure** – possible future exposure that may result from an anticipated operational occurrence or **accident** at a source or due to an event or sequence of events of a probabilistic nature, including equipment faults and operating errors.

**Protection and safety** – the protection of people against exposure to ionising radiation, the safety of **radiation sources**, including the means for achieving this, and

the means for preventing **accidents** and the mitigation of consequences of **accidents** if they do occur.

**Public exposure** – exposure to ionising radiation experienced by a **member of the public** but excluding any **occupational exposure** or **medical exposure**.

**Radiation emergency** – an emergency in which there is, or is perceived to be, a hazard due to radiation exposure.

**Radiation procedure** – a procedure involving the use of a **radiation source**.

**Radiation source** – a **radioactive source** or an item of **irradiating apparatus**.

**Radioactive source** – an individual item that spontaneously emits ionising radiation and is neither permanently sealed in a capsule nor closely bonded in solid form.

**Reportable incident** – an **incident** resulting in (a) a **dose limit** being exceeded or (b) **radioactive sources** that are lost, missing or beyond regulatory control.

**Safety assessment** – assessment of all aspects of a practice that are relevant to **protection and safety** to determine the adequacy of provisions for **protection and safety**.

**Supervised area** – an area other than a **controlled area** in which **occupational exposure** conditions need to be kept under review, even though specific protection measures or safety provisions are not normally needed.

**Veterinarian** – a veterinarian within the meaning of the Veterinarians Act 2005.

**Workplace monitoring** – **monitoring** carried out in the working environment.

**Worker** – an individual who works, whether full time, part time or temporarily, for the **managing entity** or another employer and who has recognised rights and duties in relation to occupational radiation protection. A self-employed person is regarded as being both an employer and a worker.

# Managing entity

## General

1. The managing entity must:
  - (a) take prime responsibility for protection and safety
  - (b) establish a management system to enhance protection and safety that includes:
    - (i) effectively integrating protection and safety into the overall management system of the organisation
    - (ii) making a commitment to protection and safety from the highest level of management at the facility, and by providing all required resources
    - (iii) promoting continuous improvement and a safety culture
    - (iv) delegating the planning and delivery of radiation procedures to a veterinarian
    - (v) appointing a radiation safety officer to oversee the application of regulatory requirements for radiation protection and safety
    - (vi) consulting with and engaging the services of qualified experts and interested parties as necessary
  - (c) for all delegations and appointments under sub-clauses 1(b)(iv) and 1(b)(v):
    - (i) ensure delegates and appointees are notified of their duties in relation to protection and safety and assume responsibility for performing them
    - (ii) fully document the appointments in a letter setting out duties and countersigned by the appointee
  - (d) ensure that:
    - (i) all activities associated with radiation sources are justified and optimised for protection and safety
    - (ii) dose limits for occupational and public exposure are not exceeded as a result of those activities
    - (iii) no person under the age of 16 years is or could be subject to occupational exposure
  - (e) establish an annual review of the protection and safety management system to assess its effectiveness and to verify compliance with the requirements in this code, including:
    - (i) image quality is of a diagnostic standard
    - (ii) X-ray equipment performance is satisfactory

- (iii) images are processed satisfactorily
- (iv) ancillary and personal protective equipment performs satisfactorily
- (v) working procedures continue to be effective in minimising occupational and public doses
- (vi) radiographic technique charts are current
- (vii) authorisations, equipment registers, and training are up to date.

## Safety assessment

2. The managing entity must conduct, document and keep up to date a safety assessment to:
  - (a) identify the ways in which occupational and public exposures could be incurred
  - (b) determine the expected likelihood and magnitudes of exposures in normal operation and, to the extent reasonable and practicable, assess potential exposures including the possibility of unintended or accidental medical exposures
  - (c) assess the adequacy of provisions for protection and safety in respect of siting, design and operation.

## Facilities

3. The managing entity must:
  - (a) provide facilities that are sited, located, designed, manufactured, constructed, assembled, shielded, commissioned, operated, maintained and decommissioned in accordance with good engineering practice, taking into account workload and minimising the need to rely on administrative controls and personal protective equipment for protection and safety
  - (b) ensure that:
    - (i) radiation procedures involving computed tomography or interventional radiology take place only in rooms dedicated for that purpose
    - (ii) the facility enables radiographs to be properly processed, displayed and interpreted
  - (c) shield or manage all areas where radiation sources will be used or stored so that:
    - (i) no person can receive a dose exceeding 0.3 mSv per year from occupying areas outside the use and storage areas for the radiation source

- (ii) the dose rate at any point outside the use and storage areas is less than 10  $\mu\text{Sv}$  per hour
  - (iii) rooms in which veterinary radiography is performed have a primary barrier of not less than 2 mm lead equivalence at 100 kVp to fully intercept the primary X-ray beam after it has passed through the animal and image receptor
  - (iv) in rooms where interventional radiology is performed, all walls (including doors and windows), floors, ceilings and an operator barrier constructed at the equipment controls are shielded with a lead equivalence at 100 kVp of at least 1 mm
  - (v) in rooms where computed tomography procedures are performed, all walls (including doors and windows), floors, ceilings and an operator barrier constructed at the equipment controls are shielded with a lead equivalence at 150 kVp of at least 1.5 mm
- (d) verify and document the adequacy of shielding required in sub-clause 3(c) at commissioning and whenever circumstances change in ways that could increase the risks
- (e) provide rooms that are well ventilated with impermeable washable floors and benches for all areas in which:
- (i) animals are administered radioactive material
  - (ii) animals are housed following the administration of radioactive material
  - (iii) radioactive waste is stored
- (f) for areas used for radioactive waste storage following administration of radioactive material to an animal, ensure that:
- (i) no person can receive a dose exceeding 0.3 mSv per year from occupying areas outside the radioactive waste storage area
  - (ii) a warning sign is displayed that contains the radiation trefoil and the words 'Caution Radioactive Material' to clearly indicate the containers of radioactive waste
- (g) designate and delineate appropriate areas as controlled areas or supervised areas and periodically review those designations and delineations
- (h) restrict access to controlled areas and supervised areas so that:
- (i) nobody is present in a room when computed tomography equipment is being used
  - (ii) people are only present in other controlled areas or supervised areas if they need to be there for the purpose of the procedure
  - (iii) people under the age of 18 years are allowed access to controlled areas only under supervision and only for the purpose of training for employment in which they are or could be subject to occupational exposure or for the purpose of studies in which radiation sources are used

- (i) prominently display signs:
  - (i) specifying the actual or potential presence of ionising radiation, using the symbol recommended by the International Organization for Standardization at access points to controlled areas and supervised areas and at appropriate locations within controlled areas
  - (ii) controlling access by members of the public to controlled areas and supervised areas.

## Radiation sources and equipment

- 4. The managing entity must:
  - (a) provide, commission, maintain, test and regularly service radiation sources, protective equipment and ancillary equipment so that:
    - (i) they are fit for their intended purpose
    - (ii) they fulfil their design requirements for protection and safety
    - (iii) the primary requirements in column 2 of Appendix 3 are satisfied
    - (iv) all reasonable steps are taken to satisfy the secondary requirements in column 3 of Appendix 3
  - (b) ensure that a servicing engineer verifies that irradiating apparatus complies with this code:
    - (i) at the time the managing entity accepts and commissions the equipment, before the equipment is used
    - (ii) periodically after that first check, but at least every three years
    - (iii) after any major maintenance procedure that could affect protection and safety
    - (iv) after installing any new software or modifying any existing software that could affect protection and safety
  - (c) ensure that the verification required in sub-clause 4(b) takes account of measurements of the physical parameters of the irradiating apparatus, including calibration of its output in terms of appropriate quantities, using internationally accepted protocols
  - (d) use fixed equipment in preference to portable hand-held equipment whenever practicable and reasonable
  - (e) prevent the:
    - (i) holding of X-ray equipment unless it is specifically designed for that purpose and it is impracticable or medically unacceptable to use fixed X-ray equipment

- (ii) manual restraint of animals unless it is medically unacceptable to immobilise the animal by sedation or general anaesthesia and/or mechanical restraint
- (f) provide:
  - (i) restraints and positioning aids to enable mechanical restraint
  - (ii) foot blocks, vice grips and long-handled X-ray plate holders as appropriate to maximise the distance between the person holding the plate and the radiation source
- (g) as appropriate for field radiography, provide and ensure the use of:
  - (i) portable warning signs, cones or tape to mark temporary controlled areas
  - (ii) mobile stands to position the X-ray machine for radiography
  - (iii) devices to hold the image receptor when it cannot be placed horizontally on a surface
  - (iv) protective equipment for the operator and all people providing assistance during the radiation procedure
- (h) provide, as appropriate, at entrances to controlled areas:
  - (i) protective equipment
  - (ii) equipment for individual monitoring and workplace monitoring
- (i) ensure that the radioactivity of radioactive sources has been externally certified at a specified date so that the activity administered to the animal can be accurately calculated
- (j) maintain control of all radiation sources to prevent loss or damage and to prevent any person from carrying out unauthorised activities, including by:
  - (i) maintaining an accurate inventory of all radiation sources, including their location and description
  - (ii) periodically checking that radiation sources are under control and in the locations recorded in the inventory maintained under sub-clause 4(j)(i)
  - (iii) releasing radiation sources only to people who are authorised to assume management and control under the Act
- (k) take immediate steps to regain control of any radiation source that is abandoned, lost, misplaced, stolen or otherwise transferred without proper authorisation
- (l) dispose of irradiating apparatus only if:
  - (i) it is rendered impracticable to restore the unit to a condition where it is capable of producing radiation such as by puncturing the glass tube within the X-ray head or destroying vital components
  - (ii) radiation signs such as trefoils are removed or obscured.

# Procedures for radioactive sources

5. If activities include the administration of radioactive material to animals, the managing entity must ensure that:
  - (a) any spillage of radioactive material is promptly cleaned
  - (b) a properly calibrated radiation survey meter is used to check radiation levels and for possible contamination in all areas where radioactive material could be present
  - (c) disposable impermeable gloves are worn when handling radioactive material before and during administration
  - (d) following administration of radioactive material:
    - (i) small animals are securely housed in a cage in a well-ventilated room
    - (ii) large animals are securely housed in a well-ventilated stable if the administered radioactive source is volatile
    - (iii) adjacent cages or stables are empty or are occupied by other animals that have been treated with radioactive material
    - (iv) animals are handled with disposable gloves and protective gowns and handled whenever possible at arm's length
    - (v) urine and faeces are collected in a disposable container or impermeable cage lining and placed directly into a waste disposal bag
  - (e) animals are returned to their owner following the administration of iodine-131:
    - (i) after five days if the activity administered was 80 MBq or less
    - (ii) after seven days if the activity administered was more than 80 MBq
    - (iii) with written advice containing requirements to protect people from unnecessary exposure to radiation
  - (f) all excrement or vomit is:
    - (i) treated as contaminated waste
    - (ii) handled with disposable gloves
    - (iii) accumulated in airtight bags that are sealed and marked to indicate that they contain radioactive waste
  - (g) all radioactive waste generated following administration of iodine-131 is:
    - (i) retained for at least six weeks if generated in the first three days following administration
    - (ii) retained for at least three weeks if generated more than three days following administration.

# Training and authorisation

6. The managing entity must ensure that all people with responsibilities for protection and safety:
  - (a) are qualified, educated and trained in protection and safety so that they understand their duties and can perform them competently
  - (b) are suitably trained in accordance with the training requirements set out in Appendix 2, and that they receive regular refresher training
  - (c) are named in a current list with details of their qualifications, education and training
  - (d) are notified of their duties in relation to protection and safety
  - (e) are authorised to assume their roles and responsibilities.

# Restricted activities

7. The managing entity must not, without the prior written approval of the Director, allow:
  - (a) practices that result in an increase in activity by deliberately adding radioactive material or by activation, in food, feed, beverages, cosmetics or any other commodity or product intended for a person to ingest, inhale or take in through the skin, or to be applied to them
  - (b) practices involving the frivolous use of radiation or radioactive material in commodities or in consumer products such as toys and personal jewellery or adornments, which result in an increase in activity by deliberately adding radioactive material or by activation
  - (c) imaging using radiation that is:
    - (i) performed as a form of art or for publicity purposes
    - (ii) performed for occupational, legal or health insurance purposes, and undertaken without referring to clinical indication
    - (iii) used to detect concealed objects
  - (d) the public availability of devices or manufactured items into which radionuclides have deliberately been incorporated or produced by activation, or that generate ionising radiation and that can be sold or made available to members of the public without special surveillance or regulatory control after sale.

## Policies, procedures and local rules

8. The managing entity must establish, implement and maintain policies and procedures to meet the requirements of this code including, without limitation, policies and procedures:
  - (a) to control access to areas where people can be exposed to radiation
  - (b) to prevent people from being exposed to the primary X-ray beam
  - (c) to maintain and use radiographic technique charts for each X-ray tube
  - (d) for the handling and operation of radiation sources
  - (e) to minimise the need to repeat a radiation procedure
  - (f) for the administration of radioactive sources
  - (g) to properly process and develop film
  - (h) to use constraints to optimise protection and safety
  - (i) to prevent accidents and mitigate the consequences of any that occur
  - (j) to report on and learn from accidents and other incidents
  - (k) to comply with operational limits and conditions relating to public exposure
  - (l) for staff who have indicated they may be pregnant to minimise unnecessary exposure to the embryo or fetus
  - (m) to provide protection and safety by applying preventive measures in the following hierarchy:
    - (i) engineered controls
    - (ii) administrative controls
    - (iii) personal protective equipment
  - (n) to set an investigation level and establish procedures to follow if such a level is exceeded
  - (o) to implement the annual review of the protection and safety management system
9. The managing entity must publish and enforce any written local rules that are necessary for protection and safety.

## Monitoring and measurement

10. The managing entity must establish and maintain:

- (a) a programme of continuous individual monitoring whenever appropriate, adequate and feasible, which is sufficient to assess occupational exposures for workers who usually work in a controlled area or who may receive a dose exceeding 10 percent of the dose limits
  - (b) a programme of workplace monitoring that is sufficient to:
    - (i) evaluate radiation conditions in all workplaces
    - (ii) assess exposures in controlled areas and supervised areas that are not assessed under sub-clause 10(a)
    - (iii) review the classification of controlled areas and supervised areas
  - (c) a monitoring programme for all workers who could be subject to exposure due to contamination, which is sufficient to:
    - (i) demonstrate the effectiveness of the measures for protection and safety
    - (ii) assess intakes of radionuclides and, if significant, calculate the committed effective doses
  - (d) a capability that is sufficient to monitor unexpected increases in radiation levels due to an incident attributed to a source or facility for which the managing entity is responsible
  - (e) a programme to monitor areas after unsealed radioactive material has been used to ensure that all contaminated articles have been appropriately disposed of and that surface contamination levels are less than 3 becquerels per square centimetre when averaged over an area of 100 square centimetres
  - (f) other monitoring or measurement programmes as necessary to verify compliance with the requirements in this code.
11. To satisfy the monitoring and measurement requirements in clause 10, the managing entity must:
- (a) use appropriate monitoring equipment
  - (b) for continuous individual monitoring under sub-clause 10(a), use an external that:
    - (i) maintains laboratory accreditation under ISO/IEC 17025 for ionising radiation dosimetry; and
    - (ii) returns results to the managing entity within 20 working days of receiving all necessary raw information.
12. The managing entity must:
- (a) take all reasonable steps to obtain previous dose records
  - (b) maintain records of all monitoring and verification of compliance, including:
    - (i) records of occupational exposure during and after the worker's working life, at least until the worker attains or would have attained the age of 75 years, and for not less than 30 years after ceasing work where the worker was subject to occupational exposure

- (ii) records and estimated doses to members of the public
  - (iii) records of the tests and calibrations of radiation monitoring equipment carried out
- (c) provide records of occupational exposure to:
  - (i) individual workers in respect of their own exposure
  - (ii) subsequent employers of workers, subject to satisfying confidentiality criteria
  - (iii) the Director on request or if the managing entity is no longer able to maintain records as required under sub-clause 12(b)
- (d) provide records of source monitoring and environmental monitoring to assess public exposure to:
  - (i) members of the public on request
  - (ii) the Director on request
  - (iii) the Director immediately, if any levels exceed operational limits and conditions relating to public exposure or there is a significant increase in dose rate that could be attributed to the authorised practice.

## Incidents, accidents and emergencies

13. The managing entity must:
- (a) take all practicable steps to minimise the likelihood of accidents, including a multilevel system of sequential, independent provisions for protection and safety, commensurate with the likelihood and magnitude of potential exposures
  - (b) take timely action to mitigate the consequences of any accident that does occur and restore radiation equipment to a safe condition
  - (c) promptly investigate any incident, including by:
    - (i) calculating or estimating doses a person has received and, if applicable, the dose distribution within them
    - (ii) identifying corrective actions required to prevent a recurrence
  - (d) implement all corrective actions identified in sub-clause 13(c)(ii)
  - (e) keep a written record of the incident, including the:
    - (i) cause or suspected cause
    - (ii) calculations made under sub-clause 13(c)(i)
    - (iii) corrective actions identified under sub-clause 13(c)(ii)

- (iv) details of the implementation of corrective actions under sub-clause 13(d)
  - (f) notify any reportable incident to the Director as soon as is practicable but not exceeding 48 hours.
14. If the safety assessment required by clause 2 indicates a reasonable likelihood of an emergency affecting either workers or members of the public, the managing entity must prepare an emergency plan to protect people and the environment, which includes:
- (a) arranging to promptly identify an emergency
  - (b) determining the correct level of emergency response
  - (c) providing individual monitoring and area monitoring and arranging for medical treatment
  - (d) arranging to assess and mitigate any consequences of an emergency
  - (e) drills and/or emergency exercises at appropriate intervals, including the involvement of external parties if they are part of the emergency plan.

## Records

15. The managing entity must maintain adequate records, retain records for not less than 10 years or as otherwise specified and make them available as necessary, including:
- (a) the delegation of responsibilities of the managing entity
  - (b) the names of all people with responsibility for protection and safety, including details of their qualifications, education and training
  - (c) annual review of the protection and safety management system
  - (d) cradle to grave records including the manufacturer's original documentation for not less than records for sealed sources 10 years after sale, export or disposal
  - (e) a register of radiation sources
  - (f) local rules issued under clause 8
  - (g) maintenance and repair work carried out on irradiating apparatus
  - (h) information necessary to retrospectively assess doses
  - (i) reports on investigations of unintended and accidental medical exposures
  - (j) exemptions from this code granted under section 86(3) of the Act.

# Other parties

## Radiation safety officer

16. The radiation safety officer must oversee the day-to-day implementation of regulatory requirements by the managing entity, including:
  - (a) maintaining source inventory records
  - (b) inspecting and maintaining engineering controls, safety features and warning features
  - (c) overseeing access control for controlled areas
  - (d) establishing and periodically reviewing arrangements for personal dosimetry, including maintaining and reviewing occupational dose records
  - (e) performing routine operational checks of radiation survey meters and personal alarm monitors to ensure that the instruments are working properly
  - (f) ensuring that everyone with responsibilities for radiation protection and safety is suitably trained in the use of radiation sources and radiation protection, and that they receive regular refresher training
  - (g) ensuring that emergency plans are established and practised
  - (h) supervising workplace monitoring arrangements
  - (i) establishing, issuing and periodically reviewing local rules
  - (j) investigating higher-than-usual exposures and overexposures
  - (k) investigating and reporting incidents, including accidents.
17. The radiation safety officer must work in close cooperation with qualified experts, if appointed, to ensure that all necessary duties and tasks are performed.

## Qualified expert

18. The qualified expert, if appointed, must work in close cooperation with the radiation safety officer to ensure that all necessary duties and tasks are performed.

# Manufacturer/supplier

19. The manufacturer/supplier of radiation sources, protective equipment and ancillary equipment must:
  - (a) supply well-designed, well-manufactured and well-constructed radiation sources and equipment that:
    - (i) provides for protection and safety in line with the requirements of this code
    - (ii) meets engineering, performance and functional specifications
    - (iii) meets quality standards appropriate to the significance of systems and components, including software, for protection and safety
    - (iv) provides clear displays, gauges and instructions on operating consoles
  - (b) test radiation sources and equipment to demonstrate compliance with relevant specifications
  - (c) provide information on how to properly install and use radiation sources and equipment and on associated radiation risks, including performance specifications, instructions for operating and maintenance, and instructions for protection and safety
  - (d) optimise the protection provided by shielding and other protective equipment
  - (e) supply all radiation sources and equipment with all appropriate radiation protection tools as a default, rather than as optional extras.
20. The manufacturer/supplier must:
  - (a) make suitable arrangements with managing entities to share information on use and operating experience that may be important for protection and safety
  - (b) cooperate with the managing entity for the purpose of meeting the requirements in clause 4.

# Servicing engineer

21. The servicing engineer must:
- (a) install and service irradiating apparatus competently, so that it complies with the requirements in clause 4
  - (b) after installing or servicing the equipment, provide a written report to the managing entity verifying that the equipment complies with this code and describing:
    - (i) the equipment fault (if any)
    - (ii) the tests and measurements carried out
    - (iii) the work done and any adjustments made, including parts replaced
    - (iv) any changes that may affect protection and safety
  - (c) ensure that the report required in clause 22(b) takes account of measurements of the physical parameters of the equipment, including calibration of its output in terms of appropriate quantities, using internationally accepted protocols.

# Appendix 1:

## Cross-reference to

# Radiation Safety Act 2016

As required by section 87(1) of the Radiation Safety Act 2016, clauses in this code apply to the fundamental requirements in sections 9–12 of the Act as follows.

Section in Act	Clauses in code
9(1)	1–2, 6–9, 15–19
9(2)	1–6, 10–12, 15–19
9(3)	1–6, 10–12, 15–19
10(1)	2–6, 8–9, 15–22
10(2)	2–6, 8–9, 13–19
10(3)	2–6, 8–9, 15–22
11	3–4, 6, 8–9, 17–19
12	2–6, 8–9, 15–19

# Appendix 2:

## Training requirements

	User (X-ray)	User (radioactive material)	Radiation safety officer	Servicing engineer	Qualified expert
Atomic structure and interaction of radiation	l	l	l	m	h
X-ray production	l	x	l	m	h
Nuclear structure and radioactivity	x	l	l	m	h
Radiological quantities and units	l	l	l	m	h
Physical characteristics of irradiating apparatus	m	m	m	m	h
Fundamentals of radiation detection	m	m	m	h	h
Principle and process of justification	l	l	m	x	h
Fundamentals of radiobiology, biological effects of radiation	l	l	l	l	h
Risks of cancer and hereditary disease	l	l	l	l	h
Risks of deterministic effects	l	l	m	l	h
General principles of radiation protection, including optimisation	m	m	m	m	h
Operational radiation protection	h	h	h	m	h
Particular staff radiation protection aspects	h	h	h	m	h
Risks from fetal exposure	l	l	m	l	h
Quality control and quality assurance	l	l	m	h	h
National regulations and international standards	m	m	h	h	h

## Level of knowledge

- x – no requirement
- l – low level of knowledge (general awareness and understanding of principles)
- m – medium level of knowledge (basic understanding of the topic sufficient to influence practices undertaken)
- h – high level of knowledge (detailed knowledge and understanding sufficient to be able to educate others)

## Equivalence

Qualified expert: The training requirements for a qualified expert in this appendix are deemed to be satisfied by Australasian Radiation Protection Accreditation Board certification in radiation protection.

# Appendix 3:

## Equipment requirements

### Irradiating apparatus

#### General radiography

Parameter	Requirement	
	Primary	Secondary
X-ray machine		
Minimum aluminium equivalent filtration in the incident primary X-ray beam	1.5 mm	2.5 mm
Maximum leakage radiation 1 metre from the focus, averaged over an area of 100 cm <sup>2</sup> at every rating specified by the manufacturer for that tube and housing	1 mGy/hr	100 µGy/hr
Clear indication on the X-ray control panel when the X-ray machine is switched on to the electrical mains	Yes	
Collimation		
Capability to collimate the primary beam to the region of clinical interest	Yes	
X-ray detector completely intercepts the primary X-ray beam	Yes	
Maximum misalignment of each edge of the visually defined light field with the edge of the X-ray field at 1 metre focus to image receptor distance (FID)	20 mm	15 mm
Light field clearly visible in ambient illumination and the outer edges of the light field clearly shown and sharply defined	Yes	
Exposure device		
Terminates the exposure after a preset time, exposure or mAs	Yes	
Prevents repeat exposures without the release of the exposure-initiating control except in special techniques where a sequence of repeated exposures is deliberately activated	Yes	
Prevents X-ray exposures when the device is set to 'zero', '0', 'off' or an equivalent position	Yes	
Requires continuous firm pressure on the exposure control throughout the exposure to avoid immediate termination of the exposure	Yes	
Includes, for mobile or portable units, a hand or foot switch at the end of a cord that enables the operator to be at least 2 metres away from the X-ray tube head and from the animal during radiography	Yes	

Parameter	Requirement	
	Primary	Secondary
Maximum coefficient of variation of X-ray output from a series of at least five consecutive exposures	0.1	
Prominent light on the X-ray control panel that is illuminated when X-rays are being produced	Yes	
X-ray tube output linearity		
Maximum deviation of output for any two mA, mAs or exposure time settings that do not differ by more than a factor of 4 <sup>1</sup>	0.1	
Grids		
Significant grid artefacts visible on the image	No	

## Dedicated dental equipment

Parameter	Requirement	
	Primary	Secondary
Maximum diameter of the X-ray beam at the end of the positioning device	60 mm	

## Digital and computed radiography

Parameter	Requirement	
	Primary	Secondary
X-ray dose to the image receptor indicated after each exposure	Yes	

## Computed tomography

Parameter	Requirement	
	Primary	Secondary
CT dose index in air at the iso-centre of the CT scanner for all collimation widths is within manufacturer's specification	Yes	
CT number in water	$-1000 \pm 10$	
CT number of air	$0 \pm 4$	

<sup>1</sup> Using the formula  $|X_1 - X_2| / (X_1 + X_2)$  where  $X_1$  and  $X_2$  are the X-ray outputs at settings 1 and 2 respectively.

## Fluoroscopy

Parameter	Requirement	
	Primary	Secondary
Minimum primary barrier lead equivalence at 100 kVp	2 mm	
Minimum measured half value layer aluminium equivalent filtration in the incident primary X-ray beam at 90 kVp	2.5 mm	
Maximum fluoroscopic entrance surface dose rate at 30 cm from the detector cover:		
• normal mode	50 mGy/min	
• boost mode	100 mGy/min	
X-ray beam exceeds the actual field of view as seen on the display monitor	No	

## Protective equipment

Parameter	Requirement	
	Primary	Secondary
<b>For general radiography and fluoroscopy</b>		
Aprons and gloves clearly labelled with their lead equivalence	Yes	
Minimum lead equivalence of aprons used for fluoroscopy of large animals	0.5 mm	
Minimum lead equivalence of gloves used for palpation during fluoroscopy	0.5 mm	
Minimum lead equivalence of aprons and gloves for all other procedures	0.25 mm	
For administration of radioactive sources		
Gowns, impermeable gloves and disposable overshoes	Yes	

# Ancillary equipment

Parameter	Requirement	
	Primary	Secondary
<b>For personal decontamination</b>		
Mild soap, chelating agent or surfactant, sponge	Yes	
<b>For surface decontamination</b>		
Bucket, brush, towels and absorbent pads, forceps or tongs, decontaminating agent, plastic bags and sealing tape	Yes	
<b>For spillage of radioactive sources</b>		
Roll of tape to demarcate areas	Yes	
Radioactive contamination warning sign	Yes	
<b>Survey meter for radioactive sources</b>	Yes	
<b>Cages for animals after administration of radioactive sources</b>		
Signage on or near the cage with the radiation trefoil and a notice indicating that the animal has been treated with radioactive material	Yes	
Disposable absorbent waterproof lining on the base to permit ease of waste disposal	Yes	