Compliance Guide for Veterinary Radiation

ORS G9

2023

Citation: Ministry of Health. 2023. *Compliance Guide for Veterinary Radiation: ORS G9*. Wellington: Ministry of Health.

Published in December 2023 by the Ministry of Health
PO Box 5013, Wellington 6140, New Zealand

ISBN 978-1-991075-65-9 (online)
HP 9059

This document is available at health.govt.nz

Contents

List of Figures

Introduction

Purpose

This *Compliance Guide for Veterinary Radiation* (the Guide) has been published by the Office of Radiation Safety (ORS) to provide guidance for people and organisations on meeting the requirements set out in the *Code of Practice for Veterinary Radiation: ORS C9* (ORS C9), the *Code of Practice for the Security of Radioactive Material: ORS C6* and the *Code of Practice for the Safe Transport of Radioactive Material: ORS C5*.

The Guide should be used in conjunction with these codes.

Scope

This Guide will be useful to any person who deals with[1] irradiating apparatus and radioactive material (radiation sources) that are intended for use for veterinary purposes. This includes a veterinarian (within the meaning of the Veterinarians Act 2005), manufactures and suppliers, and qualified experts.

The codes to which this Guide relates are issued under the Radiation Safety Act 2016 (the Act), and therefore, this Guide is limited in scope to guidance on the requirements of that Act. Other legal controls may also apply, related to occupational health and safety, waste management, transport of dangerous goods and the international movement of radioactive material.

How to use the Guide

The Guide gives practical guidance on some of the most common regulatory compliance issues that arise in dealing with radiation sources in veterinary practice and its associated ancillary services.

The guidelines that appear throughout this document appear in tables. Within these tables, the left-hand column briefly states who or what the guidelines apply to, and the right-hand column presents the guidance.

Following the Guide is not a radiation safety requirement. However, in most cases, following the Guide will be equivalent to demonstrating compliance with radiation safety requirements. The Guide makes references to the relevant radiation safety requirements as appropriate.

ORS inspectors may refer to the guide during on-site inspections and in associated reports.

[1] 'Deal with' has the interpretation assigned it in the Radiation Safety Act 2016 (the Act). It includes the use and storage of irradiating apparatus. Other interpretations are as given in the Act, the Radiation Safety Regulations 2016 and the associated Codes of Practice. For the exact meaning of any legal requirements a reader should refer the Act and the Regulations.

The Guide is not intended to replace advice from a qualified expert.

This Guide was published by the Director for Radiation Safety (the Director) at the Office of Radiation Safety (ORS) in December 2023.

Contact

The Director's contact details are:

Office of Radiation Safety
PO Box 5013
Wellington 6140

Email: **orsenquiries@health.govt.nz**

1 Licensing

All facilities with radiation sources such as X-ray units or radioactive materials require a source licence.

All users of radiation sources must be appropriately authorised. These authorisations can take the form of use licences, users authorised by regulations, use under the direct supervision of an authorised person, or use under the written instructions of an authorised person.

Source licence for the facility

(section 13 of the Act)

All veterinary facilities with radiation sources (X-ray units and/or radioactive materials)	Managing entities[2] must hold a source licence issued under section 13(a) of the Act to protect people and protect the environment from the harmful effects of ionising radiation. See the ORS website. A source licence is required even if the source is just in storage. If the veterinary practice consists of more than one branch, the most straightforward licence structure is for each branch to have their own source licence and manage radiation safety independently. Multiple branches can come under a single source licence provided the managing entity can demonstrate that radiation safety is being managed at the whole-of-organisation level, including through the appointment of a single radiation safety officer (RSO). The tenability of these arrangements should be reviewed during routine compliance monitoring inspections. The scope of the source licence needs to be appropriate for all the types of radiation sources used at the facility. If the managing entity intends to import radioactive material into New Zealand directly without an import agent, the source licence holder must obtain an import consent from the Director before shipping begins. Similarly, if radioactive material is being exported, an export consent will be required. See the ORS website.

[2] A managing entity is a legal entity that manages or controls radiation sources. Normally this will be a private veterinary practice, but it could alternatively be an educational organisation or other organisation involved in veterinary practice.

Use licences

Section 21(3) of the Act states that the use of a radiation source includes: the use of radiation emitting from the radiation source, causing the radiation source to emit radiation, and administering, injecting, or implanting radioactive material into a person, animal, plant or thing. On this basis, 'use' should be interpreted reasonably narrowly as the action or moment where a person is causing or making a radiation exposure. In the veterinary situation, use can be where a veterinarian pushes the exposure button to take an X-ray, injects radioactive material into an animal, or where a veterinary nurse must protect themself, other people, or the environment, while caring for an animal that has been administered radioactive material.

Ancillary uses of radiation sources in the veterinary situation include repairing or testing irradiating apparatus, or measuring radiation in facilities where radioactive material, or waste, is stored. Ancillary uses of radiation sources also includes activities conducted by enforcement officers conducting compliance monitoring visits.

(section 21 of the Act)

Veterinarians administering radioactive material, using irradiation apparatuses for treatment or interventional procedures, using irradiating apparatuses that utilise computed tomography, service engineers, qualified expert users and related roles, enforcement officers that are on-site	Section 21(2) of the Act specifies that only a natural person can apply for a use licence. Training requirements in the relevant codes of practice issued under the Act set out the basic level of radiation safety knowledge an applicant must possess to be granted a use licence (see Appendix 2 of ORS C9). Schedule 3 of the Radiation Safety Regulations 2016 (the Regulations) authorises registered veterinarians to take plain radiographs (X-rays) for veterinary diagnostic purposes without a use licence. (see section 2 below). As a result, veterinarian use licences are normally only required for the administration of radioactive material and the use of irradiating apparatus that incorporates computed tomography (CT), is used for treatment, or is used for interventional procedures (eg, fluoroscopy). Servicing engineer users need a use licence for service and installation of radiation sources. Qualified expert users need a use licence when using the radiation sources. Enforcement officers conducting compliance monitoring visits also require a use licence. See the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/users-radiation** The managing entity must ensure all persons engaging in these practices have an appropriate use licence and arrange for their own users to also receive regular refresher training, (typically at least every three years) (see clause 6 of ORS C9).

2 Situations where a use licence is not required

Section 16 of the Act sets out the situations where a use licence is not required.

Users authorised by regulations

(section 16(a) of the Act, regulation 9, and Schedule 3 of the Regulations)

Veterinarians registered with the Veterinary Council holding a current practising certificate taking plain radiographs (X-rays) for diagnostic purposes	Schedule 3 of the Regulations sets out situations where authorised people can use radiation sources to perform specified activities without a use licence. A registered veterinarian with a current practising certificate from the Veterinary Council is authorised for the activity of taking plain radiographs (X-rays) for veterinary diagnostic purposes under Schedule 3 of the Regulations. The managing entity needs to maintain an up-to-date list of all users authorised under Schedule 3 of the Regulations that includes evidence that annual practising certificates are current (such as the expiry date) or copies of the current certificates (see clause 6 of ORS C9).

Use under the direct supervision of an authorised person

(section 16(c) and section 21(4)(a) of the Act)

Veterinary nurses or assistants who do not hold a use licence	A person who does not hold a use licence for a specified use may use a source under the direct supervision of an authorised person. Section 21(6)(b) of the Act means an authorised person can be a registered veterinarian (authorised under Schedule 3 of the Regulations) when the activity is taking plain radiographs for veterinary diagnostic purposes. Section 21(6)(a) of the Act means an authorised person can also be a veterinarian who holds a use licence when the activity involves administering radioactive material, using irradiating apparatus that

	utilises computed tomography, or is used for treatment or interventional procedures. Section 5 of the Act states that direct supervision means supervision by a person who is physically present and able to intervene. In a veterinary situation, a veterinarian authorised under Schedule 3 of the Regulations standing next to a veterinary nurse or assistant may direct the nurse or assistant to take the diagnostic radiograph (X-ray).

Use under the written instructions of an authorised person

(section 16(c) and section 21(4)(b) of the Act)

A person who does not hold a use licence may use a radiation source if the use is conducted under the written instructions of an authorised person.

Section 21(6)(b) of the Act means an authorised person can be a registered veterinarian (authorised under Schedule 3 of the Regulations) when the activity is taking plain radiographs for veterinary diagnostic purposes.
Section 21(6)(a) of the Act means an authorised person can also be a veterinarian who holds a use licence when the activity involves administering radioactive material, using irradiating apparatus that utilises computed tomography, or is used for treatment or interventional procedures.

Using a radiation source under written instructions is restricted to uses that are 'mechanical or procedural in nature'. Section 21(4)(b)(ii) means that written instructions can only enable an otherwise unauthorised person to lawfully use a radiation source if that person is able to meet the fundamental requirements (sections 9 to 12) of the Act when they use the radiation source.

Written instructions must meet the requirements set out in section 21(5) of the Act to:

- contain procedures for the safe use of the radiation source
- comply with the fundamental requirements (sections 9 to 12) of the Act
- be recorded by the authorised person in accordance with section 35 of the Act.

Written instructions must credibly achieve radiation protection and ensure safety of a radiation source. Protection and safety includes how security needs are met and information on how a person using a radiation source can access support from the authorised person. Written instructions must also establish the limits of the uses they authorise.
It is not credible or viable to consider that the fundamental requirements of the Act (sections 9-12) can be met by an otherwise unauthorised user in veterinary situations (or any other situation) that involve the administration of radioactive material. Therefore, written instructions are not available to authorise this category of use.

It is also not credible or viable to consider that the fundamental requirements of the Act (sections 9-12) can be met by an otherwise unauthorised user in veterinary situations (or any other situation) that involve using irradiation apparatus for the purposes of treatment or interventional procedures. Therefore, written instructions are not available to authorise these categories of use.

It is credible and viable to consider that the fundamental requirements of the Act (sections 9-12) could be met by an otherwise unauthorised user in veterinary situations that involve using irradiation apparatus for the purposes of taking non-complex plain radiographs or for using some categories of irradiating apparatus that utilises computed tomography.

In taking this view, the written instructions, the 'mechanical or procedural nature' of the use, the training of the otherwise unauthorised person, and the availability of support if the mechanism or procedure break down must credibly ensure that the fundamental requirements of the Act can be met.

This view interprets 'mechanical or procedural' to mean that a mechanism or procedure is present that enables all the written instructions requirements of the Act to be met.

See the ORS website: **health.govt.nz/our-work/radiation-safety/users-radiation/licensing-radiation-users/exemptions-licensing**

(section 21(4) of the Act)

Veterinarian students at late-stage training to take plain radiographs for veterinary diagnostic purposes	Veterinarian students during the later stages of their training can operate under the written instructions of an authorised person: normally a registered veterinarian. In this scenario, situations may arise where the use cannot be authorised by written instruction. These situations can be dealt with by ensuring that the written instructions allow for an on-call person to attend and provide direct supervision (and therefore, authorisation) for the critical activities.
Veterinary nurses or assistants taking plain radiographs (X-rays) or using CT equipment for routine procedures	Suitably trained veterinary nurses or assistants, approved by the managing entity and who receive regular refresher training, could operate under written instructions issued by an authorised person for a routine procedure that is identified, recorded and limited to: • small animal general radiography involving non-complex views • X-ray beam pointing downwards • X-ray unit not held by hand (fixed X-ray equipment) • manual restraint or positioning of the animal is not required.
Veterinary nurses or assistants caring for animals that have been treated with radioactive material	Suitably trained veterinary nurses or assistants approved by the managing entity and receiving regular refresher training could perform this duty under the written instructions of a licensed veterinarian (see clause 6 of ORS C9).

3 General

Radiation safety officer

(clause 1(b)(v) of ORS C9)

Radiation safety officers	An RSO must be appointed to oversee the application of regulatory requirements for occupational and public radiation protection and safety. The duties fulfilled by, or under the oversight of, an RSO include (see clause 16 of ORS C9): • maintaining source inventory records • inspecting and maintaining engineering controls, safety features and warning features • overseeing access control for controlled areas • establishing and periodically reviewing arrangements for personal dosimetry, including maintaining and reviewing occupational dose records • performing routine operational checks of radiation survey meters and personal alarm monitors to ensure that the instruments are working properly • 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 • ensuring that emergency plans are established and practised • supervising workplace monitoring arrangements • establishing, issuing, and periodically reviewing local rules • investigating higher-than-usual exposures and overexposures • investigating and reporting incidents, including accidents. The RSO must be appointed by way of a formal letter of appointment, which has been counter-signed to indicate the RSO's acceptance and understanding of their duties. A person appointed to this role should have appropriate qualifications, training, and experience (see Appendix 2 of ORS C9). An appropriately trained and authorised veterinarian or senior veterinary nurse usually takes on this role. Appendix 9 provides an example RSO appointment letter.

Qualified expert

(clause 1(b)(vi) of ORS C9)

Qualified experts	The facility should maintain and develop a relationship with a recognised qualified expert in health physics or radiation safety, so that staff at the facility can draw upon their expert opinion and involvement for technical matters such as training, facility design and procurement, and developing policy and procedure, and when making decisions affecting radiation safety. For example, a facility that handles radioiodine will require a qualified expert to help design the facility, establish a radiation management plan (see the following section), select an appropriate contamination monitor and provide training on safe handling unsealed radioactive material.[3] A qualified expert needs to have appropriate qualifications, training, and experience (see Appendix 2 of ORS C9). A person certified by the Australasian Radiation Protection Board, or a medical physicist accredited by the Australasian College of Physicists and Engineers in Medicine usually takes on this role.

Protection and safety management system (radiation management plan)

(clause 1(b) and (e) of ORS C9)

Overview	To meet the requirements of ORS C9, the managing entity must have a management system for radiation protection and safety. This should take the form of a radiation management plan (previously called a radiation safety plan). The managing entity should review this plan annually. It should include the following topics: • responsibilities and authorisations • training procedure and records • source inventory • safety assessment • local rules • emergency procedures • incident procedures and records • individual monitoring procedures and records • workplace monitoring procedures and records

[3] Unsealed radioactive material is radioactive material that is nether permanently sealed in a capsule nor closely bonded in solid form.

	• transport procedures • security procedures • disposal procedures • annual protection and safety management system reviews • any other matters specified as conditions of the source licence. The remainder of this section sets out guidelines for the particular sections a radiation management plan should contain. Appendix 7 gives an example of a radiation management plan for a small animal X-ray facility.
Radiation management plan: responsibilities and authorisations	This section of the plan should give details of authorisations the managing entity makes, such as the appointment of the RSO and qualified expert, a list of authorised users and a list of any other persons authorised to access controlled areas. The appointment letter for the RSO and training records for all authorised persons should appear either in this section or in an appendix. This section should also contain: • for veterinary X-ray users, either a copy of their current annual practice certificate or the expiry date of their annual practice certificate • for veterinary X-ray nurses, either a copy of their current annual practice certificate or the expiry date of their annual practice certificate, along with the activities the nurse is authorised for (eg, holding animals or use under direct supervision of a veterinarian) • for veterinary X-ray assistants, the activities they are authorised for (this will just be holding animals) • for veterinary I-131 and Tc-99m unsealed radioactive materials users,[4] either a copy of their ORS use licence for administering unsealed radioactive materials to animals or their ORS user licence number and expiry date • for veterinary I-131 and Tc-99m unsealed radioactive materials veterinary nurses, proof of a current annual practice certificate, along with the activities the nurse is authorised for (eg, taking care of the treated animals while they are housed at the facility) • for qualified experts, details of their ORS use licence and details of any certification or accreditation from the certifying/accrediting body.
Radiation management plan: training procedures and records	This section of the plan should describe what training is provided for authorised persons. Appendix 2 of ORS C9 sets out the radiation safety training requirements and the level to which they need to be covered. Veterinarian X-ray users, if they have a current annual practice certificate, are assumed to already have received the required radiation safety training for taking X-rays.

[4] 'Veterinary radioactive material can include iodine-131 (I-131) used for veterinary therapy and technetium-99m (Tc-99m) used for veterinary diagnosis.

	Veterinarian I-131 and Tc-99m unsealed radioactive materials users will need additional training, as directed by ORS. See the ORS website for training providers: **health.govt.nz/our-work/ionising-radiation-safety/radiation-services-and-training-providers** Training should also include an induction into the radiation management plan, including the local rules for the site. Before a user is authorised, the RSO is responsible for ensuring that they are suitably trained and can operate safely. This can be checked through observation. Records must be kept of all training and refresher training provided, typically every three years.
Radiation management plan: source inventory	This section of the plan should provide a list of all radiation sources, including their make, model, serial number, location, and description. Any sealed radioactive sources such as a Cs-137[5] check sources should also be listed with the radionuclide, activity, serial number, date of measurement and form of the material. It is best practice to include photos of all sources on the source inventory. Complete records need to be kept of the receipt, administration, and waste disposal of any unsealed radioactive material. Radiation sources that have been sold, relocated, or disposed should also be noted on the register, with details of where the source was sold or relocated to.
Radiation management plan: safety assessment	The radiation management plan should include a safety assessment for the facility. This should be specific to the sources and uses of sources for the facility and assess potential exposures and provisions for protection and safety. (See also section 4 'Safety assessment' below for further details and examples.)
Radiation management plan: local rules	This section of the plan should contain specific rules for safe use and storage at the facility, including rules for controlling access to storage and use areas (eg, by way of cones and warning markers during field use), rules to prevent exposure to the primary beam (eg, an assistant should only hold an animal if it is medically unacceptable to immobilise the animal by sedation or mechanical restraint, and only a licensed service engineer should undertake maintenance involving dismantling the shutter or shielding), rules to prohibit bypassing safety features, rules for pregnant staff and rules to prevent accidents.
Radiation management plan: emergency preparedness and response	This section of the plan should contain a separate plan: the emergency plan, setting out emergency procedures. It should give details of the postulated scenarios that are covered by the emergency plan, emergency contact details, how often emergency exercises are going to be performed and associated records.

[5] Cessium-137 (Cs-137) check sources, are a type of low activity long half-life small sealed source used to check the long-term consistency of radiation measurement equipment performance.

Radiation management plan: incident reporting, investigation, and records	This section of the plan should include procedures for reporting and investigating incidents. These procedures should include reporting the incident to the RSO, who should then promptly investigate the incident. Managing entities should take timely action to mitigate the consequences of any accident and restore radiation equipment to a safe condition. The investigation should include the cause or suspected cause of the event, calculations or estimates of doses for any person who was exposed to radiation, corrective actions to prevent a recurrence of the incident, and details of the implementation of identified corrective actions. Managing entities must keep a record of investigations into all reportable incidents, and should also investigate other incidents and near misses.
Radiation management plan: individual monitoring and records	This section of the plan should give details of the managing entity performs individual monitoring. It should state who is monitored (eg, all radiation workers), where dose monitors are worn, how long dose monitors are worn for, who is responsible for changing dose badges at the end of each wearing period and sending the old badges to be read (usually the RSO), who is responsible for monitoring dose levels and how staff are informed of their doses. An investigation level should be set to prompt investigations of higher-than-usual doses readings. Previous dose records should be reviewed to find the usual range of doses received, and the investigation level should be set above this. If there are no previous dose records available, a suggested starting point is 0.5 mSv per three months. Managing entities should keep records of all individual dose monitoring until staff reach at least 75 years of age, and for not less than 30 years after they cease work. Digital copies of dose records should be kept, ensuring their long-term retention, and enabling them to be shared. Managing entities should request previous dose records of new workers as part of the on-boarding process. Dose constraints are set well below dose limits to demonstrate that radiation doses to radiation workers and members of the public are maintained at levels that are as low as reasonably achievable. Typically, a dose constraint for a member of the public is set at 0.3 mSv per year. For radiation workers, a dose constraint of 2 mSv per year would be appropriate, depending on various factors.

Radiation management plan: workplace monitoring and records	This section of the plan should give details of how a managing entity performs workplace monitoring, including what checks are undertaken and how often. See 'Workplace dose monitoring' in section 9 below for details on the form this monitoring should take. Managing entities should keep records of radiation surveys.
Radiation management plan: transport procedures (unsealed radioactive material)	This section of the plan should give details of procedures for the safe and secure transport of radioactive materials. It should include details of transport documentation (such as how packages should be marked, labelled, and stowed in vehicles) and details of who is authorised to transport the unsealed radioactive material and of security arrangements away from base.
Radiation management plan: security procedures	For X-ray units, this section of the plan will set out procedures in place to prevent theft or unauthorised use of equipment; for example, keeping an X-ray unit in a locked cupboard when not in use. For radioactive materials, this section of the plan should state the security level for the facility (typically security level D[6]) and the transport security level (basic security packages[7]). It should also give details of access controls for the radioactive materials and the areas they are used or being stored in and security systems for the facility. This section should also set out procedures for checking that radiation sources not in regular use have not been removed or tampered with at least three-monthly and after extended shutdowns or holiday periods.
Annual protection and safety management system reviews	Managing entities must perform protection and safety management system reviews at least once per year, and keep records of this. Managing entities should use a checklist to ensure records of what was checked, and the date of the review. Appendix 5 gives an example checklist identifying some common issues that managing entities may need to consider in their annual reviews.

[6] Refer to clause 4 and appendix 1 of the Code of Practice for the Security of Radioactive Material: ORS C5.

[7] Refer to clause 6 and appendix 2 of the Code of Practice for the Security of Radioactive Material: ORS C5.

4 Safety assessment

(Clause 2 of ORS C9)

All radiation sources (X-ray units and/or radioactive materials), whether in use or in storage	A safety assessment is required for all radiation sources. Managing entities must update these following any changes that may affect radiation safety, such as a significant change in workload, new radiation sources, a change in procedures, a change to the radiation use area or a change to occupancy levels in surrounding areas. The purpose of the safety assessment is to assess exposure risks to workers and members of the public from radiation sources. A safety assessment aims to identify specific safety measures that may be required, such as shielding and monitoring; identify potential incidents before they occur; and assess provisions for protection and safety to reduce the likelihood of incidents happening. Staff who are not radiation workers are considered members of the public. Appendices 1–4 contain example safety assessments for the main types of veterinary facilities (small animal X-ray, equine X-ray, I-131 cat and equine scintigraphy).

5 Facilities

Room shielding

(clauses 3–4 of ORS C9)

All radiation sources (X-ray units and/or radioactive materials), whether in use or in storage	Managing entities must formally verify and document the adequacy of the shielding they use to protect surrounding occupied areas. This is usually done by undertaking workplace monitoring: • after construction or renovation • after changes or upgrades to equipment or the introduction of new techniques • after an increase in workload. See also 'Workplace dose monitoring' in section 9 below. Clause 3(c) of ORS C9 specifies that no person in surrounding occupied areas outside the controlled area can receive a dose exceeding 0.3 mSv per year, and the dose rate must be less than 10 µSv per hour. If a managing entity is uncertain whether it will meet the requirements of the code, it should seek advice from a qualified expert, who can advise on a shielding plan to use in support of an application for a source licence (see section 10 of the Act).
X-ray units – traditional radiography	Extra shielding is seldom required to protect persons outside the room where a traditional portable X-ray unit is used on a stand if it is several metres away from surrounding occupied areas and the beam is never pointed in these directions. However, managing entities of clinics with high workloads, or with high occupancy areas close by, should seek advice on this matter from a qualified expert. A permanent operator barrier in the X-ray room is not normally required for veterinary radiography. However, clinics with high workloads or small rooms may need such a barrier. In this case, managing entities should seek advice from a qualified expert. ORS C9 requires the presence of primary barriers to intercept the primary beam for routine orientations. If radiography is always performed vertically downwards in a room on the ground floor with no basement, this requirement is met as a matter of course. If the X-ray beam is occasionally pointed towards an occupied area, the default requirement is room shielding of 2 mm of lead or equivalent. In the case of an X-ray beam directed downwards towards an X-ray couch, even if there are no occupied areas below, 2 mm of lead or equivalent built into the X-ray couch will be useful to help protect holders legs and feet in case they accidentally stray close to the beam in the X-ray.

	The room's ambient light level, to assist in positioning and collimation will need to be low enough so that the light field from the light beam diaphragm is clearly visible.
X-ray units – equine field radiography	In horse stables or large open areas, X-rays should be taken as far away as possible from routinely occupied areas. No one should be in the horizontal beam direction. Whenever possible, all horizontal beams should be directed towards a brick or concrete wall.
X-ray units – interventional radiography	A dedicated room and room shielding of 1 mm of lead or equivalent is required, including for the operator barrier.
X-ray units – computed tomography	A dedicated room and room shielding of 1.5 mm of lead or equivalent is required, including for the operator barrier.
I-131 cat and Tc-99m equine scintigraphy radioactive materials facilities	Unless there is a significant barrier, such as a solid thick concrete wall, it is usually more practicable to use distance, rather than extra shielding, to protect surrounding occupied areas. The dose will fall off approximately as the inverse square of distance. For example, if the distance is trebled, the dose will be 1/32 = 1/9th of what it was. For a similar reduction using shielding, approximately 1 mm of lead for Tc-99m or 10 mm of lead for I-131 would be required. There is an inhalation risk as well, especially for I-131. For this reason, it is important that the rooms where animals are treated and housed and where waste is accumulated are well ventilated. All areas where radioactive materials are used should be designed to be easily decontaminated, and should not be in a high-thoroughfare area; alternatively, access to them should be restricted during their use (eg by designating the area to be a controlled area and putting up warning signage at the entrances).

Controlled areas

A controlled area is 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.

(clauses 2, 3 and 10 of ORS C9)

X-ray units – at a veterinary facility	The room in which an X-ray unit is being used is usually the most practicable choice of controlled area, assuming the room shielding is adequate (see above). This decision will be informed by a safety assessment and dose monitoring, and needs to be periodically reviewed. Ideally, X-rays should be carried out in a room from which all persons whose presence is unnecessary can be excluded while X-rays are being produced. The room may be a dedicated X-ray room or a

	theatre. The room should not be used for other purposes when X-ray procedures are in progress. In the case of interventional radiology and computed tomography, a dedicated room is required, and for computed tomography nobody can be present in the room during a procedure. All entrances to the controlled area must have warning signs, and at any entrances which that the operator is unable to observe, extra physical barriers (such as locked doors and chained-off areas) should be used to prevent access. Ideally, the room layout should be such that persons entering the room are not able to gain immediate access to the area where X-rays are being used. Where additional controls such as a locked door are used when X-rays are being taken, they must be recorded as written local rules (see clause 8(a) of ORS C9).
X-ray units – equine field radiography	The most practicable choice of a temporary controlled area is usually as large an area as possible in the horse stables, or a large open area as far away as possible from routinely occupied areas. Any horizontal beams should be directed towards non-occupied areas, or towards a brick or concrete wall. This decision will be informed by a safety assessment and dose monitoring, and needs to be periodically reviewed. Portable warning signs, cones or barrier tape should be used to mark temporary controlled areas, especially at entrances to the controlled area that the operator is unable to observe.
I-131 cat administration facilities	The treatment room, the I-131 cat housing cage(s) and contaminated waste decay-storage drum areas are the commonly designated controlled areas in a I-131 cat administration facility, assuming the shielding or distances to surrounding occupied areas in these areas are adequate (see above). This decision will be informed by a safety assessment and dose monitoring, and needs to be periodically reviewed. Cages adjacent to those housing the treated cats should be left empty, to reduce the risk of contamination of untreated cats. Extra items such as blankets should not be kept in the cage, as they will become contaminated. All entrances to the controlled areas must have warning signs, including on or near the cage, and at any entrances that the operator is unable to observe, extra physical barriers (such as locked doors and chained-off areas) should be used. Where these additional controls are needed, they must be recorded as written local rules (see clause 8(a) of ORS C9). Controlled areas remain so until cleared by contamination monitoring, at which stage the warning signage can be removed. If a cage is not needed immediately after the cat is released back to the owner, it is preferable to leave the contamination to time decay, rather than having staff unnecessarily handling it and its contents during decontamination.

Tc-99m equine scintigraphy facilities	The Tc-99m horse stall and the gamma scanner room are commonly designated controlled areas in a Tc-99m equine scintigraphy facility, assuming the shielding in these areas is adequate (see above). This decision will be informed by a safety assessment and dose monitoring, and needs to be periodically reviewed. Adjacent stalls to theTc-99m horse stall are usually left empty to reduce the risk of contamination of other horses. All entrances to the controlled areas must have warning signs, and at any entrances that the operator is unable to observe, extra physical barriers (such as locked doors and chained-off areas) should be used to prevent access. Where these additional controls are needed, they must be recorded as written local rules (see clause 8(a) of ORS C9). All controlled areas remain so until cleared by contamination monitoring, at which stage the warning signage can be removed. If a stall is not needed immediately after the horse is released back to the owner, and the gamma scanner room is not needed immediately, it is preferable to leave the contamination to time decay away, rather than having staff unnecessarily handling it and its contents during decontamination.

Controlled area warning signs

(clause 3(i) of ORS C9)

All radiation sources (X-ray units and/or radioactive materials)	There must be prominently displayed radiation warning signs at the entrances to controlled areas. Appendix 6 contains examples of such warning signs. For field radiography, portable radiation warning signs are required.

6 Radiation sources and equipment

Buying, selling, shifting, or disposing of radiation sources

(section 31 of the Act)

X-ray units	Any facility that has management or control of X-ray units must have a current and appropriate source licence (see section 1 of this Guide). X-ray units must be registered with the Director before they are used. The Director must also be notified when there is any change in the location or possession of an X-ray unit, or it is disposed of. To access forms to register an X-ray unit or notify a change, see the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/managing-entities-radiation-sources/register-radiation-sources.** Managing entities must render X-ray units permanently inoperable before disposing of them. This typically involves puncturing the X-ray tube, destroying the generator and removing any X-ray signage. It is good practice to send pictures and protocols of disposal to ORS with the notice of disposal. See the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/managing-entities-radiation-sources/storage-and-disposal-irradiating-apparatus.**
I-131 and Tc-99m unsealed radioactive materials	Any veterinary facility that has management or control of unsealed radioactive materials must make sure it has an appropriate source licence (see section 1 of this Guide). Veterinary facilities may not dispense radioactive material (that is, split up a stock solution into individual patient doses). Radioactive material is usually ordered in pre-dispensed syringes ready for administration to an animal. Each dose comes in an appropriately shielded type-A radioactive material package along with a dangerous goods declaration from a local agent or local hospital nuclear medicine department. If a source is being imported directly from overseas, an import consent is required from ORS: see the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/buy-sell-and-import-export-radiation-sources/import-or-export-radioactive-material.**

	Veterinary facilities must maintain complete cradle-to-grave records of radioactive material, from ordering to waste decay storage (see clause 15(d) of ORS C9). Unsealed I-131 and Tc-99m sources do not need to be registered with ORS.
For sealed radioactive sources	Sealed radioactive sources must be registered with the Director if their activity is equal to or more than the acceptable level of activity for the radionuclide type (for example, a Cs-137 sealed check source above the Cs-137 acceptable activity level of 10 kBq: see section 4 of the Act). Any veterinary facility that has management or control of registerable sealed radioactive sources must make sure it has an appropriate source licence (see Section 1 of this Guide). Managing entities must also notify the Director when there is any change in the location or possession of such a source, or it is disposed of. To access forms to register a source or to notify a change, see the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/managing-entities-radiation-sources/register-radiation-sources.** If a source is being imported directly from overseas, an import consent is required from the Director: see the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/buy-sell-and-import-export-radiation-sources/import-or-export-radioactive-material**. An export consent from The Director is required when disposing of a source back to the manufacturer at the end of its useful lifetime. Before purchasing a source, managing entities should ensure that return arrangements are in place.

Quality assurance

(Clauses 1 and 4 and Appendix 3 of ORS C9)

Overview	Managing entities need to establish a quality assurance programme as part of their protection and safety management system, to ensure that radiation sources, protective equipment and ancillary equipment remains in compliance; that doses are optimised; that working procedures continue to be effective; and that authorisations, equipment registers, and training records are up to date. Managing entities must document their quality programme in writing, noting protocols and frequencies for each check and test and including records of when the tests were performed and the results. Appendix 8 gives an example of a documented quality assurance programme for a small animal X-ray facility.
Image quality checks – X-ray units	Managing entities should carry out regular image quality checks; this is commonly done by six-monthly or annual in-house image repeat analysis.

	The repeat rate should be less than 10% of all images taken. For digital imaging systems, repeats due to processing errors will be much less likely, but repeats will be necessary for other reasons, such as positioning, exposure error, grid error, system error, artifacts, and animal motion. Managing entities should document repeats in the animal exposure book for the X-ray unit. In the case of a digital imaging system, the system itself may allow an operator to enter repeats against pre-defined repeat reasons and automate the analysis. All images produced should be individually rated with regard to their diagnostic image quality; for example, using the following 1 to 3 scale: 1. excellent; no errors in animal positioning, X-ray exposure or processing 2. diagnostically acceptable; some errors in animal positioning, X-ray exposure or processing, but not sufficient to detract from the diagnostic usefulness of the radiograph 3. unacceptable; errors in animal positioning, X-ray exposure or processing that render the radiograph diagnostically unacceptable (repeat). Managing entities should assign and record image quality ratings for all radiographs at the time they are being viewed. Managing entities should set image quality performance targets for the facility, and an analysis of image quality ratings should occur at regular intervals (say, every six months), including comparison with the facility's performance targets. Where performance targets are not being met, managing entities should take corrective actions. Appropriate corrective actions can be determined by having in place a systematic means of analysing the causes of unacceptable radiographs. Eliminating the occurrence of unacceptable radiographs will result in lower staff doses. It is useful to have available good quality reference radiographs, to remind operators what good-quality images look like. If the current day's images do not meet this standard, managing entities should seek reasons for the discrepancy.
Equipment performance	Managing entities need to regularly maintain and check the performance of all radiation sources and ancillary equipment. For example, they should undertake regular consistency testing of X-ray unit output and image processing and beam collimation, and ensure that a service engineer carries out three-yearly compliance testing of X-ray units. Managing entities need to ensure that operators carry out regular checks that images are being processed satisfactorily, including regular checks for any signs of damage on the receptor. Images should also be visually checked for the presence of artefacts or blemishes.

	Managing entities need to ensure that operators carry out regular checks that ancillary and personal protective equipment is performing satisfactorily. Lead aprons, lead gloves and other protective clothing need to be thoroughly checked visually for any signs of wear or damage. Where they appear to be suspect, they need to be tested further using X-ray (or a fluoroscopy machine). Survey meters require in-service checks and calibration. Gamma cameras need regular uniformity and energy resolution testing.
Working procedures review	Managing entities need to carry out regular checks to verify that working procedures continue to be effective in minimising occupational and public doses. An example of this (eg, by undertaking additional monitoring of surrounding occupied areas when there has been a significant increase in workload) and periodically review the designation and delineations of controlled areas. This process should include input from relevant staff on the appropriateness and effectiveness of written procedures, and a review of monitoring records.
Exposure chart review – X-ray units	The exposure chart for an X-ray unit should specify kVp, mA and time (or mAs), film/screen speed system if still using film and the source to image distance among other things. Managing entities need to regularly check that X-ray units' exposure charts continue to be effective in optimising doses. A user can carry out such a check for each image by checking that the exposure index (X-ray dose to the image receptor indicated after each exposure) for the technique chart exposure factors used falls within the manufacturer's recommended range. If it does not, the user should record this in the animal exposure book for the X-ray unit and the managing entity should review that book with a view to improving the technique chart during the annual review, or sooner if a given specific projection's current default settings prove routinely not to be effective in optimising dose. Different imaging systems call their exposure index by different names; the supplier should be able to advise what system is used, where it can be found among the image information and what range it should be in to check for over- or under-exposure. This is the modern equivalent of the user checking to see if a film image has come out too black or light.
Annual reviews of the protection and safety management system	Managing entities should undertake annual reviews of the protection and safety management system, including the results of quality assurance checks, and ensure that authorisations, equipment registers, and training records are up to date. Appendix 5 sets out an example review checklist.

X-ray unit periodic performance testing

Only an appropriately trained and licensed person can carry out the maintenance and servicing of veterinary X-ray equipment that involves the X-ray generator or tube, or production of X-rays.

(clause 4(a) and (b) of ORS C9)

X-ray units	Performance testing of X-ray units by X-ray service engineers against ORS C9 requirements needs to occur at commissioning, after repairs and at least every three years. The X-ray service engineer must provide a full written report for these tests (see clause 21(b) of ORS C9). ORS does not maintain a public list of X-ray service engineers.

X-ray unit maintenance logging

(clauses 15(g) and 21 of ORS C9)

Overview	Managing entities must keep records of maintenance, testing reports and repair work carried out on X-ray units and retain them for at least 10 years. For each entry, a maintenance and repair log should list the date, what was done and who performed the repair/maintenance. Service engineers must send the facility a written report verifying that the equipment is in compliance, describing the fault fixed, the tests and measurements carried out, the work done, and any adjustment made, including parts replaced and any changes that may affect protection and safety

Inventory of radiation sources

(clauses 4(j) and 15(e) of ORS C9)

Overview	Managing entities must keep an inventory of all radiation sources and retain these records for at least 10 years. For X-ray units, this inventory needs to include make, model, serial number, and location. Updates to this inventory must be communicated to ORS via email (**orsenquiries@health.govt.nz).** For unsealed radioactive material (I-131 for cats and Tc-99m for horses), managing entities should keep complete records of all the radioactive material they have ordered and received, including activity and batch number; which animals this radioactive material was administered to; and its subsequent associated waste disposal. For registerable sealed radioactive sources, the record needs to include make, model, serial number, radionuclide type, activity, activity date and location. Updates to this inventory must be communicated to ORS via email (**orsenquiries@health.govt.nz**).

Operating handheld X-ray equipment and optimising safety

(clauses 4(d)–(g) of ORS C9)

Overview	Operators of portable X-ray units must only hold them during radiography if the equipment is specially designed for this purpose and it is impracticable or medically unacceptable to use fixed X-ray equipment.[8] A suitable stand must always be readily available (including for handheld intra-oral dental X-ray units and for equine X-ray radiography), and operators should, whenever possible, in conjunction with the stand, use the full extent of the trigger cord to be as far as possible away from the X-ray unit and the animal. In cases where holding the portable X-ray unit by hand is necessary, a lead apron should be worn, and individual personal dose monitoring of the operator should occur. Holding an animal during an x-ray can only be done if it is medically unacceptable to immobilise the animal by sedation or general anaesthesia and/or mechanical restraint. The concept of not holding an animal or an X-ray machine without good reason reflects an established hierarchy of protective measures (engineered controls, personal protective equipment, local rules) that

[8] In this context, examples of fixed X-ray equipment are where the X-ray tube is mounted on a wall or a stand, so that the operator does not need to hold the tube during radiography. This includes handheld equipment used on a stand.

	has been poorly implemented in the past. This concept aims to break what had become a habit in the veterinary sector of relying on personal protective equipment alone (primarily lead gloves and gowns). X-ray units that can only be used in a handheld manner do not give the operator the option to step out of the controlled area during the exposure. Small animal veterinarians generally have a surgical space dedicated to dental treatments. The most appropriate type of X-ray unit for small animal dental X-rays in the majority of facilities is a wall-mounted unit of the type used by dentists. This arrangement has the X-ray head on a long arm that can reach around 2m, is completely manoeuvrable around the head of the animal and maintains a stable position to enable operators to leave the controlled area for the duration of the exposure. A wall-mounted unit is generally cheaper to purchase. An alternative would be a mobile unit on a stand. This could be useful if the facility wants to move the unit between different surgical spaces. There are situations in which a portable handheld dental X-ray machine can legitimately be held while in use; for example, where an animal needs to be imaged in the field, where an animal is too large to treat in the area where the fixed unit is installed or where an animal cannot be transported to a fixed X-ray unit without posing a serious risk to the health of the animal.
Assistant holding the animal	An assistant can only hold an animal during an X-ray if it is medically unacceptable to immobilise the animal by sedation and/or mechanical restraint. Mechanical restraint aids such as sandbags, tie-downs or stocks must be readily available. Where holding the animal is necessary, such as in the case of a temperamental horse, the assistant should wear a lead apron, along with lead gloves if they are close to the primary beam, and individual personal dose monitoring of the holder is required.
Assistant holding the X-ray image receptor cassette	Aids such as foot blocks, vice grips and long-handled X-ray cassette holders must be readily available, and should be used whenever possible to maximise the distance between the holder and the cassette. All holders should wear a lead apron, and individual personal dose monitoring is required. Also, on the rare occasion that the assistant needs to hold the cassette itself; for example, in the case of an X-ray for a horse's lateral (LAT) stifle joint, the assistant should also wear lead gloves and keep their hands out of the primary beam.

Use of personal protective equipment

(clauses 4(g)–(h) of ORS C9)

X-ray facilities	All staff should wear lead aprons inside the controlled area. Holders should also use additional protection equipment, such as lead gloves; however, hands should never be in the primary X-ray beam, even if the holder is wearing lead gloves. (Personal protective equipment still typically lets through about 10% of X-rays, and the primary X-ray beam dose rate can be more than 1000 times larger than the scatter dose rate at 1 metre from the animal.)
I-131 cat administration facilities	I-131 has a half-life[9] of eight days, and primarily emits two different types of radiation, which have different influences on the personal protective equipment needs of workers, as follows. I-131 beta particles I-131 emits beta particles that penetrate less than half a millimetre in tissue. When the iodine is taken up in the thyroid gland this radiation is all absorbed within the gland, making I-131 an effective treatment for hyperthyroidism. The beta radiation can only become a hazard if the I-131 is ingested or inhaled, or contaminates the skin or eyes. Therefore, when handling the I-131, dealing with the treated cat and dealing with any waste, disposable impermeable gloves and protective surgical gowns should be worn. As I-131 is volatile, there is also an inhalation risk in rooms where the vapour can build up over time. A good ventilation system to the exterior is therefore needed for the cat housing cage area and an exterior locked ventilated drum as far away as possible from occupied areas should be used for the time decay of waste. Surgical masks will not stop the I-131 vapour itself but are useful when handling and potentially disturbing contaminated biological waste particulates I-131 gamma rays I-131 also emits highly penetrating gamma radiation at approximately 365keV. 10% of the radiation will pass through a 1cm thickness of lead. Therefore, the lead aprons and other lead protective equipment designed for X-ray units, which typically have less than 0.05cm thickness of lead, are of very limited use in stopping I-131 gamma rays. They are therefore not recommended; due to their awkwardness, wearing them may cause the wearer to spend more time close to the cat. Maximising distance, shielding the room and limiting time close to the animal are more practical measures to take.

[9] Half-life is the amount of time it takes for the radionuclide to half in activity. After 10 half-lives the activity will decay away almost completely.

	As an example of the importance of distance at 10 cm distance from the neck of a treated cat the dose rate could be as high as 500 µSv/h, but at 2 metres it is just 1 µSv/h. In addition, to help address potential contamination issues, when handling I-131 and dealing with the administered cats or any waste, staff should wear disposable impermeable gloves and protective surgical gowns. Surgical masks will also be useful when handling and potentially disturbing contaminated biological waste particulates.
Tc-99m equine scintigraphy facilities	Tc-99m has a half-life of six hours, and it emits primarily gamma radiation at approximately 140keV. 10% of the Tc-99m radiation will penetrate a 0.1cm thickness of lead. Therefore, the lead aprons and other lead protective equipment designed for X-ray units, which typically have less than 0.05cm thickness of lead, may still be useful in some limited circumstances, such as in the scanning room, where staff spend some time close to the horse. Otherwise, that equipment does not tend to be used; due to their awkwardness, wearing them may cause the wearer to spend more time close to the horse. Maximising distance, shielding the room, and limiting time close to the horse are measures to take. In addition, to help address potential contamination issues, when handling Tc-99m and dealing with the administered horse or any waste, staff should wear disposable impermeable gloves and protective surgical gowns. Surgical masks will also be useful when handling and potentially disturbing contaminated biological waste particulates.

7 Protection and safety procedures for radioactive material

Radiation survey meter

(clauses 5(b), 10(e) and 16(e) and Appendix 3 of ORS C9)

Overview	A properly calibrated radiation survey meter is required, to allow operators to check radiation levels and to check for possible contamination in all areas where radioactive material could be present. Managing entities should carry out routine operational checks of the survey meter, such as checking the batteries and taking a constancy reading against a known source. An ideal check source for this purpose would be a sealed Cs-137 source with an activity of less than 10kBq (being the exemption level for Cs-137. See relevant information in section 6). Managing entities should regularly send the survey meter for calibration, typically at least every two years. The survey meter should: • be able to detect dose rate radiation levels down to natural background level and surface contamination down to 3Bq/cm^2 • display dose rate in terms of µSv/h and contamination counts per second or counts per minute[10] • have a near instantaneous detector response (this is to allow the presence of small spot contamination to be detected at a typical scanning speed of 2–3cm per second) • have an audible output and/or an analogue dial display.

[10] The user manual of the meter should have a table in it specifying radionuclide specific conversion factors to convert these count rate readings to the equivalent Bq/cm^2 surface contamination reading if required. In practice, if the count rate reading of a surface is more than three times the natural background reading taken in an area away from the surface, decontamination with a spill kit is indicated. However, ideally any surface above natural background should be decontaminated, if possible, down to natural background levels (see also 'Workplace dose monitoring' in section 9 below).

8 Training and authorisation

User authorisations list and regular refresher training

(clause 6 and Appendix 2 of ORS C9)

Overview	Managing entities must maintain a current list of all users with details of their qualifications, education, and suitable training records in accordance with the code requirements. They must also implement documented procedures for providing or ensuring all users receive regular refresher training, typically at least every three years. Managing entities should engage qualified experts to set up and provide training. For further advice on responsibilities, authorisations, and training procedures, see 'Protection and safety management system (radiation management plan)' in section 3 above. Appendix 7 sets out an example responsibilities and authorisations list for a small animal X-ray facility.

9 Monitoring and measurement

Monitoring and measurement of radiation levels ensures protection and safety, and minimises exposure for workers and members of the public.

There are two broad categories of radiation monitoring: monitoring of individuals and monitoring of areas of the workplace itself.

Individuals who routinely work in a controlled area or who could potentially receive a significant radiation dose are monitored individually.

Workplace monitoring involves monitoring of the surrounding areas, particularly in close by areas of high occupancy. It is particularly important for staff who are not covered by individual monitoring.

Managing entities must ensure that they do not exceed dose limits for members of the public. Under most circumstances, workplace monitoring will provide reassurance that this is the case.

When managing entities use unsealed radioactive sources, they need to monitor contamination as well as the usual dose levels, due to the potential for this contamination to become an internal hazard; for example, if radioactive sources are accidentally ingested.

Individual dose monitoring

(clauses 10(a), 11 and 12 of ORS C9)

Overview	Individual dose monitoring is required for any workers who need to be inside the controlled area during exposures or who could receive more than 10% of a dose limit. Continuous individual monitoring in controlled radiation areas is an essential principle in establishing and maintaining an organisational and sector-wide radiation safety culture. Exemptions only apply where it is not practicable to comply with the requirement and, at the same time, radiation safety can be achieved in another way. In practice, except for computed tomography rooms, for almost all uses workers will routinely need to be inside the controlled area, and so will need individual monitoring. If a worker's normal duties do not include being inside a controlled area, or they expect to be called upon only infrequently to assist in holding an animal for radiography (eg when another staff member is

	absent), they are not considered to usually work in a controlled area. As such, they are not expected to have their doses monitored individually; workplace monitoring records are enough to verify their levels of exposure. Sharing dose monitoring badges among individuals, for example by attaching them to lead aprons, is not individual monitoring.
Dose records	Managing entities should take all reasonable steps to obtain the previous individual dose records of new workers as far back as possible. This documentation could be asked for as part of the human resource process for a new hire. Subsequent employers can ask for an employee's dose records; so can employees themselves. If no response can be elicited from a previous employer, managing entities should keep a record of this. Managing entities should hold dose records for workers until those workers are 75, and for not less than 30 years after they cease work. If a worker's dose badge goes missing, then the worker's dose record for the missing period should estimate the dose, based on the dose readings either side of that period. The record should indicate that this entry is an estimate for a missing badge. Workers need to have ready access to their own results. Ideally, staff should be informed of their dose readings for each wearing period.
Dose investigation level	Managing entities must set an investigation level for the facility, above which a worker dose reading must be investigated following a documented procedure and recorded (see clause 8(n) of ORS C9). This investigation level needs to be relevant to the facility and the type of work done. It is best set by reviewing workers' past dose results and setting a level comfortably above the maximum readings workers would normally be expected to receive. Alternatively, a default value of 0.5mSv for a three-month wearing period is a suitable starting point. There may need to be more than one facility-wide investigation level, if different groups are undertaking different types of work. For example, a facility that does both small animal and equine radiography, with different staff working in these two areas, will likely need different investigation levels. Reports provided by a personal dosimetry service may have a default dose level ranking system and indicate when an individual dose is considered 'high'. However, these are not suitable for specific facility investigation levels, as they have not been optimised for the particular facility and the type of work done there.

Workplace dose monitoring

(clauses 3(c) and (d) and 10(b) and (c) of ORS C9)

Overview	Workplace monitoring is required to verify that doses to workers and members of the public outside of controlled areas are acceptable (less than 0.3mSv/y); managing entities need to document this monitoring. This is usually done by dose surveys using a radiation survey meter or by dosimetry badges placed in surrounding occupied areas. Dose surveys must be performed at commissioning and again whenever circumstances change, such as after construction or renovation, changes or upgrades to radiation equipment, introduction of new techniques, major servicing, or a significant increase in workload. <u>Unsealed radioactive material</u> Workplace monitoring for unsealed radioactive materials facilities requires the use of a radiation survey meter to routinely check for contamination of staff when they leave a controlled area and to check for any contamination left in the controlled area itself. Workers caring for an animal after administration should, at the end of each visit, check for contamination on themselves and record the reading in a room log. Workers should check for contamination on areas that are most likely to be contaminated, such as hands, soles of feet and the thyroid, in the case of I-131 (see clauses 3(d) and 12(b) and (c) of ORS C9). Worker decontamination should be performed in a designated low background area away from any potential sources of radiation. Workers should decontaminate their skin by gently washing the area in warm soapy water. For any contamination left in the controlled area, decontamination should entail using the spill kit[11] until readings are background, or at least no more than three times background. If this is not possible, operators should cordon off the area and allow the spill to time decay away. Contamination checks should be performed using the contamination mode (cpm/cps) of the survey meter and with the audible output speaker turned on.

[11] A spill kit needs to be put together and kept ready to aid staff in responding to any accidental spillage of radioactive sources or radioactive contamination. The expected contents of such a kit are given in the Ancillary Equipment section of Appendix 3 of the Code of Practice for Veterinary Radiation ORS C9.

10 Security

Use, storage, and transport of radiation sources

(sections 11 and 12 of the Act and clauses 4, 5 and 6 of ORS C5)

All radiation sources (X-ray units and/or radioactive materials)	Every person who deals with a radiation source must ensure that there are appropriate security measures in place to prevent: • unauthorised access to the radiation source or to the place where the radiation source is stored or used • loss or theft of the radiation source • sabotage of the radiation source • unauthorised transfer or unauthorised removal of the radiation source • any unauthorised act through the use of the radiation source. Every person who transports, stores, or disposes of a radiation source must do so safely and securely.
I-131 cat and Tc-99m equine scintigraphy radioactive materials facilities	When using or storing radioactive materials, managing entities must secure the material: • in accordance with prudent management practice • in a manner that impedes unauthorised removal of the material. An example of how this can be achieved is by ensuring that radioactive material is kept in a locked cupboard with appropriate labelling until it is ready to be used, and never left unattended when taken out for use. If the veterinary facility is transporting the unsealed radioactive material itself from the local hospital nuclear medicine department (see clause 2 of ORS C6), the following guidelines apply. • The vehicle used to transport the package needs front and rear radiation transport placards on substantially vertical surfaces. Suitable placard holders may need to be fitted to the vehicle, as there is often insufficient surface area to display a magnetic placard on to a substantially vertical surface. The placards cannot be inside the vehicle (that is, behind the windscreen or rear window). • The dangerous goods declaration needs to be kept in the driver's door pocket. Hospital nuclear medicine department staff should be consulted over the technical details when filling out this form. • The driver needs to be an appropriately authorised user, or be carrying the package as 'tools of trade' as described in the Land Transport Rule: Dangerous Goods Rule2005, and there needs to

	be a procedure for how the package should be tied down inside the vehicle. • The transportation must fully comply with applicable transport regulations (such as International Atomic Energy Agency transport regulations and the Land Transport Rule: Dangerous Goods 2005) • For further details on transport, including suitable placards and links to the applicable transport regulations, see the ORS website: **health.govt.nz/our-work/ionising-radiation-safety/transporters-radioactive-material/road-transport-radioactive-material**
I-131 cat and Tc-99m equine scintigraphy radioactive materials facilities – transport	When transporting radioactive material, the managing entity must secure the package by: • securing and storing the package in a manner that impedes unauthorised removal • not leaving packages or conveyances unattended for any longer than is necessary • using carriers with package tracking systems, if applicable • using closed vehicles to keep packages out of sight • providing people involved in transporting with written details of emergency contacts • checking the backgrounds of authorised individuals to ensure that they are correctly identified, trustworthy and reliable • providing basic security awareness training that includes the need for transport security, the nature of security-related threats, methods to address security concerns and actions to take if there is a security event • identifying and protecting sensitive information if any • providing adequate resources • evaluating compliance • ensuring capability to respond to security events establishing capability for timely reporting of security events.

11 Incidents, accidents, and emergencies

(clauses 13 and 14 of ORS C9)

Emergencies	Managing entities should follow written procedures in emergencies, and these procedures must consider all foreseeable accident and emergency situations.
Postulated incident and emergency scenarios	Scenarios to be considered include: • lost/stolen/missing radiation sources • fire • earthquakes/flooding • transport accidents • suspected overexposure of a worker or a member of the public • damaged and/or leaking sources.
Emergency plans	Where a safety assessment indicates a reasonable likelihood of an emergency occurring, managing entities must prepare an emergency plan. The emergency plan should include arrangements to promptly identify an emergency, determine the correct level of response, provide individual and workplace monitoring, arrange medical treatment if necessary, and assess and mitigate the consequences of the emergency. Managing entities should perform drills and emergency exercises to practise actions required in response to an emergency. If emergency plans involve third parties (eg, Fire and Emergency New Zealand or the police) those parties should be actively engaged in emergency planning and encouraged to participate in emergency exercises.
Incidents	Any accident or unintended event, including near misses and unauthorised or malicious acts, that could potentially result in a significant exposure is considered an 'incident'. Incidents must be reported to the RSO and promptly investigated. Managing entities should take timely action to mitigate the consequences of any accident and restore radiation equipment to a safe condition. The investigation should include the cause or suspected cause of the event, calculations or estimates of doses for any person who was exposed to radiation, corrective actions to prevent a recurrence of the incident and details of the implementation of identified corrective actions. Managing entities must keep a record of the investigation.

Reportable incidents	Managing entities must report incidents to the Director as soon as practicable and within 48 hours if a dose limit has been exceeded, or if a source is lost, missing or beyond regulatory control.
Emergency response procedures	Managing entities should develop emergency response procedures to effectively respond to postulated scenarios. In all cases, life-saving actions should take precedence over the radiological hazard. Managing entities can seek 24/7 expert advice from the ORS duty officer (021 393 632). Once emergency response actions have been taken, the area in the case of radioactive sources should be cordoned and contained until a full radiological assessment is carried out. To enable such an assessment, appropriately trained personnel with radiological monitoring equipment (including a survey meter to measure gamma dose rate and perform basic contamination monitoring) must be readily available. An example emergency procedure for a lost, stolen, or missing source is as follows: as soon as it is known that the location of a source cannot be accounted for (after making initial inquiries with operators or any other relevant persons), the managing entity will notify the RSO. If the source is suspected to have been stolen, the managing entity will immediately notify the police. The managing entity will notify the incident to the Director as soon as possible and within 48 hours.

Appendices

Appendix 1: Example safety assessment for a typical small animal veterinary X-ray facility

Purpose and scope

The managing entity must conduct, document, and keep up to date a safety assessment to:

- identify the ways in which occupational and public exposures could be incurred
- 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 exposures
- assess the adequacy of provisions for protection and safety in respect of siting, design, and operation.

Example

This example safety assessment is for a dedicated small animal X-ray room next to the reception area and public waiting area with a single doorway, where there are no other occupied areas above or below. The examples given are for illustrative purposes only and do not provide a comprehensive list of all possible exposures that could occur at a specific veterinary facility.

The veterinary X-ray unit used in this example is assumed to be a small portable radiography X-ray unit mounted over an X-ray couch that has tie-down points, where X-rays are only taken in the downwards direction, with an average weekly workload of 50 X-rays.

Because of the proximity of the reception area to the X-ray unit at this facility, and given the high occupancy of reception areas, the default precautionary approach used for interventional radiology walls has been followed, with 1 mm of lead or equivalent additional shielding being fitted to the wall between the X-ray room and reception.

We have also assumed that workplace monitoring using extra personal dosimetry badges placed on the outside of all four walls of the X-ray room, at the operator position, in the reception and in the waiting area all confirmed that at the current workload the dose rates outside the controlled area (the X-ray room) are all below the required dose constraint of 0.3 mSv per year. (If this dose constraint was exceeded in any area, then additional shielding would be indicated in that area.)

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Member of the public or workers walking into the X-ray room during an exposure	• Likelihood: low • Magnitude: low, less than 1 mSv	• Designation of X-ray room as a controlled area whenever equipment is switched on • Warning signs • Only one entrance to X-ray room, with the operator positioned outside entranceway able to monitor access • Local rules that forbid visitor access to the X-ray room when in use
Exposure to operator during routine use	• Likelihood: high • Magnitude: low, less than 2 mSv per year or 10% of the dose limit	• Individual monitoring • Workplace monitoring to verify adequate X-ray room shielding: – after construction or renovation, and before X-ray unit is used clinically – after changes or upgrades to X-ray equipment or the introduction of new techniques – after an increase in workload – after major servicing • Positioning of operator behind room wall (but still able to see animal, any animal holders in the room and the exposure lights on the X-ray unit by using a mirror positioned on the back left wall of the room) • Requirement that operator wears a lead apron • Optimised exposure chart (informed by the operator monitoring and recording any over/under exposed images by comparing them to the manufacturer's recommended exposure index range for the digital imaging systems) • Quality assurance programme (including repeat analysis and an annual review of the whole protection and management system) • Regular refresher training

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to animal holder assistants when they are occasionally required	• Likelihood: low • Magnitude: medium, less than 20 mSv per year	• Policy to only hold animals when they cannot safely be anesthetised • Policy to use tie-downs etc to restrain animals • Policy that holders wear a lead apron, gloves, and thyroid shield • Policy that holders' hands are never in the primary beam even when they are wearing lead gloves • 2 mm of lead built into the X-ray couch (as on the ground floor there is no occupied spaces below, however still fitted to help protect holder's legs and feet in case they accidentally stray close to the primary beam under the couch) • Individual monitoring
Exposure to staff in surrounding occupied areas and public in the waiting area	• Likelihood: high • Magnitude: low, less than 0.3 mSv per year	• Shielding of wall between X-ray room and reception • Adequate distances to other adjacent rooms in all other directions • Verification of adequate room shielding/distances using workplace monitoring • Extra dose monitoring badge placed on wall by reception area to continuously monitor that doses remain negligible in this area • Policy that X-rays are only taken in a downwards direction, not towards any walls
X-ray unit malfunction or suspected damage (eg, X-ray unit dropped)	• Likelihood: low • Magnitude: medium, less than 20 mSv effective dose	• Ability of operator to terminate exposure immediately using a trigger • X-ray unit switchboard circuit breaker close by and labelled • Quality assurance programme • Regular three-yearly performance testing of the X-ray unit • Visibility of exposure lights on Xray unit plus audible exposure warning • Policy that RSO approval is required before the X-ray unit can be used again
X-ray unit lost or stolen	• Likelihood: low • Magnitude: potentially high	• Location of X-ray unit in a secure and alarmed area • Policy that X-ray unit is under constant supervision or locked away when off site • Policy that, in case of theft, the RSO and police are notified without delay

Appendix 2: Example safety assessment for typical equine veterinary X-ray facility

Purpose and scope

The managing entity must conduct, document, and keep up to date a safety assessment to:

- identify the ways in which occupational and public exposures could be incurred
- 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 exposures

  assess the adequacy of provisions for protection and safety in respect of siting, design, and operation.

Example

This example safety assessment is for equine radiography. The examples given are for illustrative purposes only and do not provide a comprehensive list of all possible exposures that could occur at a specific premise.

The veterinary X-ray unit used in this example is assumed to be a small portable radiography X-ray unit held on a stand whenever possible. The X-rays occur mostly in a single-storied large barn area 'equine X-ray room' at the facility, which has a stock to aid in holding the horse, and positioned to line up with a section of the barn wall where all horizontal beams are pointed towards during X-raying, which is shielded with 2 mm of lead. This shielded area has a large sign on it that says, 'X-ray against this section of the wall'.

X-rays are also assumed to occasionally occur at client premises in horse stables or large open areas.

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Member of the public or workers walking into the equine X-ray room during an exposure	• Likelihood: low • Magnitude: low, less than 1 mSv	• Designation of area where X-rays are to be performed as a controlled area whenever equipment is switched on • Portable warning signs at all access points into the controlled area • Positioning of operator and/or assistants to be able to monitor access to the X-ray room

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to operator during routine use	• Likelihood: high • Magnitude: low, less than 2 mSv per year	• Individual monitoring • Policy that operator uses the stand to hold the X-ray unit and stands at least 2 metres away from the horse and X-ray unit whenever possible • Policy that operator wears a lead apron and thyroid shield • Optimised exposure chart (informed by the operator monitoring and recording any over/under exposed images by comparing them to the manufacturer's recommended exposure index range for the digital imaging system) • Quality assurance programme (including repeat analysis and a yearly review of the whole protection and management system) • Regular refresher training
Exposure to animal and X-ray cassette holder assistants	• Likelihood: high • Magnitude: low, less than 2 mSv per year	• Policy that foot blocks, vice grips and long-handled X-ray cassette holders are used whenever possible • Policy that holders wear a lead apron, gloves, and thyroid shield • Policy that operators use a stock and tie horses whenever possible • Policy that holders' hands are never in the primary beam even when they are wearing lead gloves • Individual monitoring • Regular refresher training • Radiation safety briefing (for client's premises assistants) • Policy that assistant duty is shared around to minimise exposure to any individual
Exposure to workers in surrounding occupied areas and public (at the vet's facility)	• Likelihood: high • Magnitude: low, less than 0.3 mSv per year	• Workplace monitoring to verify adequate X-ray room shielding: – after construction or renovation, and before X-ray unit is used clinically – after changes or upgrades to X-ray equipment or the introduction of new techniques – after an increase in workload – after major servicing • Shielding of the section of the barn wall where all horizontal beams are pointed

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
		at with 2 mm of lead, with signage on the shielded area to remind the operator for horizontal beams to aim at this section of the wall
Exposure to workers in surrounding occupied areas and public (at the client's premises)	• Likelihood: high • Magnitude: low, less than 0.3 mSv per year	• Controlled area set up in horse stables or in a large open area as far away as possible from routinely occupied areas, so that no one can be in the horizontal beam direction • Policy that horizontal beams are directed towards a brick or concrete wall whenever possible • Portable warning signs at all access points into the controlled area • Positioning of operator and/or assistants to be able to monitor access to the controlled area
X-ray unit malfunction or suspected damage (eg, X-ray unit dropped)	• Likelihood: low • Magnitude: medium, less than 20 mSv effective dose	• Ability of operator to terminate exposure immediately • Quality assurance programme • Regular three-yearly performance testing of the X-ray unit • Visibility of exposure lights on X-ray unit plus audible exposure warning • Policy that RSO approval is required before the X-ray unit can be used again
X-ray unit lost or stolen	• Likelihood: low • Magnitude: potentially high	• Location of X-ray unit in a secure and alarmed area at the facility • Policy that X-ray unit is under constant supervision or locked away when off site • Policy that, in case of theft, the RSO and police are notified without delay

Appendix 3: Example safety assessment for a facility treating cats with I-131

Purpose and scope

The managing entity must conduct, document and keep up to date a safety assessment to:

- identify the ways in which occupational and public exposures could be incurred
- 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 exposures
- assess the adequacy of provisions for protection and safety in respect of siting, design and operation.

Example

This example safety assessment is for a veterinary facility where staff transport the I-131 themselves from a local hospital nuclear medicine department that supplies it in the form of a Type A package with the lead pot containing a pre-dispensed syringe; the veterinarian administers the I-131 by injection in the surgery adjacent to the cage area; and the treated cat is subsequently housed in a cage dedicated for this use for seven days. The maximum workload is three cats per month.

The contaminated housing waste is time decayed in a locked ventilated drum in a secure area on the premises but outside. The examples given are for illustrative purposes only and do not provide a comprehensive list of all possible exposures that could occur at a specific veterinary facility.

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to 87a worker and/or members of the public due to an accident during transport of the I-131 to the facility	• Likelihood: low • Magnitude: low, less than 1 mSv	• Transport of I-131 pre-dispensed syringe in a lead pot in a Type A package • Warning placards front and rear of the vehicle on exterior holders outside the cab • Copy of dangerous goods declaration for the package kept in the cab • Secure positioning of package using tie-downs in the boot of the vehicle • Written emergency procedures • Regular worker refresher training

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
		• Storage of package in locked cupboard in the controlled area upon arrival • Policy that package is never left unattended during transport
Member of the public or workers walking into the treatment room during administration or walking past where the I-131 cats are housed after treatment	• Likelihood: low • Magnitude: low, less than 1 mSv	• Designation of treatment room as a controlled area during administration • Designation of I-131 cat housing cages as a controlled area until decontaminated after release of the cat • Warning signs • Ability of workers to monitor access during the administration • Policy forbidding loitering close to the I-131 cat housing cages • Adequate ventilation of cage area, which vents directly to outside
Exposure to veterinarian and theatre staff during administration, ingestion of contamination or needle stick injury	• Likelihood: high • Magnitude: low–medium	• Individual monitoring • Standardised doses • No dispensing • Well-ventilated room, which vents directly to outside • Impermeable surfaces • Policy that staff wear surgical gloves and gowns • Policy that empty syringe and swabs etc are returned in the Type A package to the hospital for disposal • Contamination monitoring of staff and administration area • Availability of spill kit • Written emergency procedures • Regular refresher training • Contingency arrangements in place with the local hospital nuclear medicine department in case of major accidental administration to staff, for that department to provide medical advice and supply potassium iodide tablets if needed (if medically indicated, such tablets must be taken within four hours to be effective. They are prescription only, so no stock is held on site)

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to workers caring for the I-131 cat while being housed for a week	• Likelihood: high • Magnitude: low, less than 2 mSv per year	• Individual monitoring • Well-ventilated room • Warning sign on I-131 cat cage • Impermeable surfaces • Disposable waterproof cage base lining • Policy that adjacent cages are kept empty • Policy that workers wear surgical gloves and gowns • Suitably labelled waste container for used gloves and gowns etc • Contamination monitoring of workers with the survey meter after each visit • Decontamination of cage area after cat release (but not until it is needed) • Policy that contaminated housing waste from cage and the waste container are bagged, a warning sign is added, and the bag is dated and that this is then transferred to an exterior locked ventilated drum as far away as possible from occupied areas for time decay • Policy that drum waste bags are kept for six weeks, and that staff check that they are no longer radioactive with the survey meter and remove labels before disposal • Availability of spill kit available • Regular refresher training
Exposure to staff and public in surrounding occupied areas	• Likelihood: high • Magnitude: low, less than 1 mSv per year	• Location of I-131 cat cage in a well-ventilated room and away from any routinely occupied areas • Location of exterior locked ventilated drum for time decay of waste far from any routinely occupied area; regular monitoring of dose rate from drum • Workplace monitoring to verify adequate distances to surrounding occupied areas: – after construction or renovation – after changes or upgrades to equipment or the introduction of new techniques – after an increase in workload

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to the owner and members of the public after the cat is released back to the owner	• Likelihood: high • Magnitude: low, less than 0.3 mSv	• Policy that cat is housed at facility for one week before release (and to check with the survey meter that the maximum dose rate at 1 metre from the cat is less than 5 μSv/h before release (NCRP 148 recommendation[12]) • Provision of written safety instructions for the subsequent handling of the cat to the owner at time of release (see Appendix 10 for example safety instructions)
Lost or stolen I-131	• Likelihood: low • Magnitude: high, potentially over the dose limit	• Storage of package in a locked cupboard in the controlled area upon arrival, and removal only at the time of administration • Proper marking and labelling of packages, with trefoil radiation warning and contact details • Policy that packages are never left unattended during transport • Emergency procedures in place for contacting police, hospitals, and ORS duty officers

[12] NCRP Report No. 148 – Radiation Protection in Veterinary Medicine (2004), section 8.1

Appendix 4: Example safety assessment Tc-99m equine scintigraphy facility

Purpose and scope

The managing entity must conduct, document, and keep up to date a safety assessment to:

- identify the ways in which occupational and public exposures could be incurred
- 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 exposures
- assess the adequacy of provisions for protection and safety in respect of siting, design, and operation.

Example

This example safety assessment is for a veterinary facility where staff transport the Tc-99m themselves from a local hospital that supplies it in the form of a Type A package with the lead pot containing a pre-dispensed syringe; the veterinarian administers the Tc-99m in the horse's controlled area stall, where there are no untreated horses in the adjacent stalls; when ready for the scan the horse is led to a dedicated controlled area gamma camera scanner room and then led back to the stall afterwards; the horse is subsequently housed in this controlled area, typically for 60 hours; and the waste is time decayed until nothing can be detected with the contamination meter. The average workload is two or three horses per month. The examples given are for illustrative purposes only and do not provide a comprehensive list of all possible exposures that could occur at a specific veterinary facility.

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to the worker and/or members of the public due to an accident during transport of the Tc-99m to the facility	• Likelihood: low • Magnitude: low, less than 1 mSv	• Transport of Tc-99m pre-dispensed syringe transported in a lead pot in a Type A package • Warning placards front and rear of the vehicle on exterior holders outside the cab • Copy of dangerous goods declaration for the package kept in the cab • Secure positioning of package using tie-downs in the boot of the vehicle • Written emergency procedures

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
		• Regular worker refresher training • Storage of package in locked cupboard in the controlled area upon arrival
Member of the public or workers walking into the scanner room during the scan or past where the stall where the horse is housed	• Likelihood: low • Magnitude: low, less than 1 mSv	• Designation of horse stall and scanner room as a controlled area until no remaining contamination detectable • Warning signs • Ability of workers to monitor access during the administration and during the scan • Policy forbidding loitering close to the Tc-99m horse stall • Policy that adjacent stalls are left empty
Exposure to veterinarian and staff during administration in the horse stall and in the scanner room	• Likelihood: high • Magnitude: low, less than 2 mSv per year	• Individual monitoring • Standardised doses • No dispensing • Impermeable surfaces • Use of wood shavings as bedding in the horse stall • Use of bandages/tape for horse leg and feet coverings to reduce contamination of legs by urine, removed before transit to scanner room • Use of plastic bags over horses' feet during transit between stable and scanner room • Use of labelled bucket on long handles to catch any urine during transit between stable and scanner room, and during the scan • Policy that staff wear lead aprons, surgical gloves and gowns • Use of suitably labelled waste containers for used gloves and gowns etc, left to time decay for 60 hours until the survey meter confirms no remaining activity. Disposal of waste thereafter as ordinary biological waste • Policy that empty syringe and swabs etc are returned to the Type A package and left to time decay for 60 hours in a controlled area, then, after the survey meter confirms no remaining activity, labels are removed from the Type A package, and it is returned to hospital

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
		• Contamination monitoring of staff, administration area and scanner room • Availability of spill kit available • Written emergency procedures • Regular worker refresher training
Exposure to workers caring for the horse while being housed for 60 hours	• Likelihood: high • Magnitude: low, less than 2 mSv per year	• Individual monitoring • Warning sign on Tc-99m horse stall • Impermeable surfaces • Policy that wood shavings bedding is not changed and waste not removed from the stable until after the horse has left and the survey meter detects no remaining contamination meter, then disposed of as ordinary biological waste • Policy that adjacent stalls are kept empty • Policy that workers wear surgical gloves and gowns • Use of suitably labelled waste containers for used gloves and gowns etc, left to time decay for 60 hours until the survey meter confirms no remaining activity. Disposal of waste thereafter as ordinary biological waste • Contamination monitoring of staff after each visit • Availability of spill kit • Regular refresher training
Exposure to workers and public in surrounding occupied areas	• Likelihood: high • Magnitude: low, less than 0.3 mSv per year	• Location of Tc-99m horse stall and scanner room away from any routinely occupied areas • Policy that adjacent stalls are left empty • Controlled area warning signage • Workplace monitoring to verify adequate distances to surrounding occupied areas: – after construction or renovation – after changes or upgrades to equipment or the introduction of new techniques – after an increase in workload

Hazard or risk	Likelihood and magnitude of exposure with protection and safety measures in place	Provisions for protection and safety
Exposure to the owner and members of the public after the horse is released back to the owner	• Likelihood: high • Magnitude: low, less than 0.3 mSv	• Policy that horses are housed at the facility for 60 hours (10 half-lives) before release • Use of the survey meter to confirm before releasing the horse that it is no longer radioactive.
Lost or stolen Tc-99m	• Likelihood: low • Magnitude: high, potentially over the dose limit	• Storage of package in locked cupboard in the controlled area upon arrival, and removal only at time of administration • Proper marking and labelling of packages, with trefoil radiation warning and contact details • Policy that packages are never left unattended during transport • Emergency procedure in place for contacting police, hospitals, and ORS duty officers

Appendix 5: Example checklist for annual reviews of the protection and safety management system

Purpose and scope

Managing entities must perform safety reviews at least once per year, and keep records. They should use a checklist to ensure records, with dates, of what was checked. The sample checklist below identifies some of the issues that managing entities may need to consider in their annual reviews.

AC VETERINARY CLINIC LTD ANNUAL PROTECTION AND SAFETY MANAGEMENT SYSTEM AUDIT CHECKLIST

Name of person doing the audit:
Date of audit:

	Item	Yes/No
Responsibilities and authorisations	Source licence is current, with an appropriate scope	
	For X-ray unit users: • Veterinarian users: are on the facility authorisations list for X-ray use along with their current APC expiry date. • Veterinary nurses: are on the facility authorisations list, along with what type of use they are authorised for (eg, use under direct supervision of a veterinarian) and the date of their radiation safety training For I-131 and Tc-99m unsealed radioactive materials users: • Veterinarian users: are on the facility authorisations list for administration of radioactive material along with their current ORS administration licence number and expiry date • Veterinary nurses: are on the facility authorisations list, along with what type of use they are authorised for (eg, use under written instructions of a veterinary administration user for the care of the radioactive animals after administration) and the date of their radiation safety training.	
	X-ray service engineer is licensed	
	Letter of appointment of RSO is on file and signed	
Radiation safety training	Requirements and records are up to date, including copies of annual practising certificates and radiation safety training certificates	
	All users have undergone regular refresher training (such as in using equipment and interpreting images) within the last three years	

	Item	Yes/No
Source inventory	There are records of make, model, serial number and location for each X-ray unit	
	There are records of radionuclide, activity, serial number, date of measurement and form of the material for any sealed radioactive sources, if applicable	
	There are records of receipt, administration, and waste disposal for any unsealed radioactive material, if applicable	
	There are compliance reports for each X-ray unit within the previous three years from the servicing engineer	
	X-ray units' maintenance logs are up to date	
	There is a shielding report verifying that X-ray room shielding is adequate	
Safety assessment	A safety assessment has been completed and is up to date	
Local rules for radiation use	Rules for radiation use at the facility have been reviewed and are up to date (eg, rules on operator position, and controlling access to controlled areas)	
	Controlled areas have been reviewed and are up to date	
	There is an optimised technique chart for each X-ray unit	
Quality assurance programme	The quality assurance programme reviewed and is up to date	
	All quality assurance checks have been performed on time and records have been retained	
Emergency procedures	Procedures on what needs to be done to ensure radiation safety in the case of an emergency (such as fire or earthquake) have been reviewed and are up to date	
	Emergency contact details are up to date	
	Emergency procedures have been exercised recently	
Incidents and accidents	Procedures for investigating incidents and records of any incidents have been reviewed and are up to date	
	Investigation records up to date, including preventative actions that have been undertaken	
Individual and workplace monitoring	All users have individual dose monitoring badges	
	Workplace monitoring records have been reviewed and are up to date (eg, there have been no changes in facility, equipment, or workloads)	
	Individual monitoring records have been reviewed and are up to date	
	All readings above the investigation level during the year were investigated and findings documented	
Transport procedures (unsealed radioactive material)	Procedures on safe and secure transport are up to date	
	All transporting staff are appropriately trained and authorised	
	Staff use vehicle placards and attachment points for the front and rear of the vehicles	

	Item	Yes/No
	Secure tie-down points, straps etc are available on all vehicles used for transporting	
Security procedures	Appropriate security precautions are in place to prevent theft or unauthorised use	
	Three-monthly checks have been carried out to ensure any radiation sources not regularly in use have not been removed or tampered with	

(File checklists in the Radiation Management Plan)

Appendix 6: Warning signs

Purpose and scope

This appendix provides a suitable radiation warning sign for the entrances to an X-ray room-controlled area (Figure 1), and for the entrances to a place where radioactive materials are used or stored (Figure 2).

Figure 1: X-rays warning sign

Figure 2: Radioactive material warning sign

Appendix 7: Example of a radiation management plan for a small animal X-ray facility

Radiation safety policy

- AB Vet Clinic will ensure, as far as reasonably possible, the health and safety of its employees, contractors working on the premises, and members of the public who may be exposed to the hazards arising from the use of X-rays in veterinary diagnosis.
- AB Vet Clinic will ensure that every X-ray procedure is justified in terms of an expected beneficial outcome that outweighs the risk from exposure to radiation.
- AB Vet Clinic will ensure that all X-ray procedures are optimised in terms of the desired diagnostic information, while keeping the radiation dose to staff as low as is reasonably achievable.
- No member of AB Vet Clinic staff is permitted to use, or assist in the use of, X-rays unless he/she is so authorised in this *Radiation Management Plan* and has signed the relevant entry to indicate familiarity with and acceptance of the requirements and procedures in this *Radiation Management Plan*.

Responsibilities and authorisations

Facility: AB Veterinary Clinic
113 Main South Road
BERTSVILLE

Source licence: 1234 (expires 1 July 2024)

Radiation safety officer (RSO): The following person, competent in radiation protection and safety, has been appointed by AB Veterinary Clinic to oversee the application of regulatory requirements.

Name	Signature
Mr A J Smith	*A J Smith*

The formal letter of appointment for the RSO (signed by the manager on behalf of the facility and countersigned by the RSO to indicate acceptance of the role) is on file.

Veterinarians: The following registered veterinarians are authorised to use X-rays for veterinary diagnosis at AB VeterinaryClinic and are responsible for complying with the procedures at this facility.

Name	Practicing certificate expiry date	Signature of RSO
Mr V2	17 April 2023	A J Smith
Ms V3	23 September 23	A J Smith
Ms V4	5 May 2023	A J Smith

Copies of the practising certificates are on file.

Veterinary nurses: The following veterinary nurses are authorised to use X-rays in veterinary diagnosis at AB VeterinaryClinic under the direct supervision of an authorised veterinarian.

Name	Training date	Signature of RSO
Ms N1	5 April 2023	A J Smith

Veterinary assistants: The following veterinary assistants are authorised to use X-rays in veterinary diagnosis at AB VeterinaryClinic under the direct supervision of an authorised veterinarian.

Name	Training date	Signature of RSO
Mr VA1	5 April 2023	A J Smith
Ms VA2	5 April 2023	A J Smith

Refresher training of all staff was last performed on the following dates.

Date of training	Signature of RSO
17 April 2022	A J Smith

Training certificates are on file.

Signature of the RSO: A J Smith

Date: 1 January 2023

Training procedure and records

Veterinarians

- On commencing work at AB Veterinary Clinic, veterinarians will be given the ABVC Radiation Protection Induction Course, covering:
  - the *Radiation Management Plan* and its contents, to ensure that they understand how radiation protection is implemented at the clinic (the RSO will check understanding of this by observation)
  - the Radiation Protection Act, Radiation Protection Regulations, ORS C9 and the Guidance Notes
  - how to use the AtomRay X-ray unit and the image processing facilities safely and correctly (the RSO will check competence by observation).
- On completion of the training, an appropriate entry will be made in the AB Veterinary Clinic X-ray Training Record Book.
- The AB Veterinary Clinic Responsibilities and Authorisations schedule will be updated accordingly.

Non-veterinarians who will work under the direct supervision of a veterinarian

- On commencing work at AB Veterinary Clinic, staff will be given the ABVC Radiation Protection Induction Course, covering:
  - the *Radiation Management Plan* and its contents, to ensure that they understand how radiation protection is implemented at the clinic (the RSO will check understanding of this by observation)
  - the Radiation Protection Act, Radiation Protection Regulations, ORS C9 and the Guidance Notes
  - how to use the AtomRay X-ray unit and the image processing facilities safely and correctly (the RSO will check competence by observation).
- Staff will receive instruction from an appropriate person covering the basic radiation protection training requirements for a user (X-ray) given in Appendix 2 of ORS C9.
- On completion of the abovetraining, an appropriate entry will be made in the AB Veterinary Clinic X-ray Training Record Book.
- The AB Veterinary Clinic Responsibilities and Authorisations schedule will be updated accordingly.

Other staff not involved in the use of X-rays

- On commencing work at AB Veterinary Clinic, new staff members will be informed:
  - that X-rays are used in the facility
  - who the RSO is;
  - where X-rays are used
  - that the *Radiation Management Plan* contains all the local rules for ensuring safe practice.
- On completion of the above, an appropriate entry will be made in the AB Veterinary Clinic X-ray Training Record Book.

Refresher training

- A qualified expert will give a radiation protection refresher course to all the staff invoved in the use of X-rays every three years.
- On completion of the above, an appropriate entry will be made in the AB Veterinary Clinic X-ray Training Record Book, including the date the course was presented and the names of all staff present.

Signature of the RSO: *A J Smith*

Date: *1 January 2023*

Source inventory (X-ray machine)

AB Veterinary clinic has one X-ray machine:

Manufacturer and model:	AtomRay 007
Serial no:	AB10089
Location:	Surgery
Purchased:	4 September 2017

Verified by : A J Smith, RSO

Signed: *A J Smith*

Date: *1 January 2023*

Three-yearly code compliance testing of the X-ray machine by a servicing engineer

A copy of the servicing engineer's report is kept in the *Radiation Management Plan*.

X-ray unit	Serial number	Date of test	Expiry date	Signature of RSO
AtomRay 007	AB10089	1 April 2021	1 April 2024	*A J Smith*

Safety assessment

See Appendix 1: Example safety assessment for a typical small animal veterinary X-ray facility.

Local rules

Justification of the use of X-rays

The decision to use X-rays in veterinary diagnosis for a given animal can be made by the following persons only:

- A J Smith
- V1
- V2
- V3

X-rays on animals are to be performed only if one of the above named persons considers:

- there is information to be gained from the X-ray procedure that will help in the management of the animal; and
- there are no equivalent alternative non-X-ray imaging modalities available in the facility; and
- the radiation risk to the staff that will be involved in performing the X-ray procedure is small.

Use of X-rays under supervision

- Only persons authorised by the RSO in the *Radiation Safety Management Plan* are permitted to use X-rays in veterinary diagnosis under supervision.
- A supervising veterinarian must be present during the procedure.

Optimisation of the use of X-rays

Personnel

- Only those persons involved in the X-ray procedure are to be present when X-rays are used.
- These persons must be authorised. (See elsewhere in the *Radiation Management Plan* for authorised persons.)
- All other persons must leave the surgery while the X-ray procedure is being performed

Clinical evaluation of images

The following information will be entered into the *AB Veterinary Clinic X-ray Use Logbook* by the person responsible for the X-ray procedure.

- person taking the X-ray
- name of X-ray procedure

- date
- clinical evaluation
- image quality assessment.

Working procedures – small animal radiography

- All small animal radiography must be performed in the surgery.
- X-ray warning signs must be placed at the two doors leading into the surgery whenever X-rays are being taken.
- All animals must be positioned on the X-ray table over the part of the table with the 1 mm lead layer beneath the surface.
- The X-ray tube must be positioned in its default position on the tube stand.
- A standard focus to image receptor distance of 75 cm must be used for all radiographs unless special circumstances dictate a different distance.
- The radiographic factors to be used must be based on the factors given in the *AB Veterinary Clinic Technique Chart* for the given projection.
- The light beam diaphragm must be used to collimate the X-ray beam to the region of clinical interest.
- The animal being radiographed must be tranquillised or anaesthetised whenever practicable.
- The facility's immobilising devices (kept in the cupboard next to the X-ray machine) must be used wherever practicable.
- The animal must be manually restrained only if for clinical reasons there are no other practicable means of restraint.
- If the animal needs to be manually restrained then:
  - the person holding the animal must wear a lead apron
  - the person holding the animal must wear either lead gloves or a lead-rubber tube
  - the light beam diaphragm must be used to ensure the X-ray beam is collimated so that the holder's hands are not in the primary beam.
- The role of restraining animals must be shared among the authorised staff.
- Pregnant staff are not permitted to restrain animals.
- No person under the age of 16 years is permitted to restrain animals.
- Persons required to be present must stand as far as possible from the animal being radiographed and make sure that their position is not in line with the exit primary beam in the case of any lateral projection.
- Persons required to be present must wear a lead apron and their personal dosimetry badge.
- The person making the X-ray exposure must observe the AtomRay's controls during the exposure to confirm that the exposure has terminated correctly.
- After the radiograph has been taken, the image must be processed according to the user instructions given in the image processor's user manual.
- An entry recording the X-ray procedure and results must be made in the *AB Veterinary Clinic X-ray Use Logbook*.

- An assessment of the image quality (excellent, diagnostically acceptable, or unacceptable) of each image must be made and recorded in the *AB Veterinary Clinic X-ray Use Logbook*. If an image is assessed as unacceptable, then an entry of the deficiency and possible cause must be made in the *Unacceptable image log* located at the back of the *AB Veterinary Clinic X-ray Use Logbook*.

Signature of the RSO: A J Smith

Date: 1 January 2023

Emergency preparedness and response

- If there is a fire or the fire alarm is sounding:
  - turn off the mains switch on the AtomRay X-ray unit
  - turn off the mains supply switch on the X-ray room wall.
- If there is an earthquake:
  - turn off the mains switch on the AtomRay X-ray unit
  - turn off the mains supply switch on the X-ray room wall
  - follow the procedures for earthquakes in the *AB Veterinary Clinic Safety Manual*.
- For any other emergency, such as flooding, storm or landslide:
  - turn off the mains switch on the AtomRay X-ray unit
  - turn off the mains supply switch on the X-ray room wall
  - follow the procedures for civil defense emergencies in the *AB Veterinary Clinic Safety Manual*.
- After any emergency where damage to the AB Veterinary Clinic has occurred, before the AtomRay X-ray unit is used for veterinary radiography:
  - check the unit to confirm that it functions correctly
  - ensure that the RSO (A J Smith) authorises the re-commencement of the use of the X-ray facilities following an 'all-clear' report or appropriate repair of any damage
  - make a record of the above in the *AB Veterinary Clinic X-ray Maintenance and Servicing Record Book*.

Signature of the RSO: A J Smith

Date: 1 January 2023

Incident reporting, investigation and records

- In the event of an incident or accident, the RSO (ph: 021 XXXXXX) must be contacted and informed as soon as possible. Timely action should be taken to mitigate the consequences of any accident and restore radiation equipment to a safe condition.
- The RSO must promptly lead an investigation of the incident.
- The investigation needs to cover:
  - the cause or suspected cause of the incident
  - with the aid of a qualified expert if required, calculations or estimates of doses for any person who was exposed to radiation
  - corrective actions to prevent a recurrence of the incident, and details of the implementation of identified corrective actions.
- A record of the investigation must be kept in the *Radiation Management Plan*. This should include reportable incidents, but other incidents and near misses should also be investigated.
- If the incident has resulted in a dose limit being exceed or the X-ray machine being lost, missing or beyond regulatory control, the incident must also be reported to the Director as soon as is practicable but within 48 hours.

Signature of the RSO: *A J Smith*

Date: *1 January 2023*

Individual monitoring and records

- All workers involved in an X-ray procedure must be continuously monitored by wearing a personal dose monitoring badge
- If, however, a worker's normal duties do not include being inside a controlled area during radiography or they expect to be called upon very infrequently to assist holding an animal for radiography (eg, due to another staff member's absence), they are not required to wear a personal dose monitoring badge.
- N1 will be responsible for issuing personal dosimeters at the start of each three-month monitoring cycle and the collecting and posting of the personal dosimeters at the end of each monitoring cycle.
- The dose monitoring badge must be worn outside the apron at collar level.
- N1 will post a copy of the Dose Report on the staff noticeboard in the tearoom as each report is received (every three months). After removal from the noticeboard, the Dose Report will be filed in the *Radiation Management Plan*.
- The RSO will review the Dose Report on its receipt. Any reading greater than 0.5 mSv will be investigated and a copy of the investigation and any corrective actions filed in the *Radiation Management Plan*.

Signature of the RSO: *A J Smith*

Date: *1 January 2023*

Workplace monitoring and records

- Two extra personal dose monitoring badges are used for workplace monitoring purposes. These are placed at the points where the highest readings outside the surgery might be expected, and at the nearest high occupancy area, as follows.
  - One is called 'corridor' and is put on the wall in the corridor outside the surgery at the closest point to the X-ray machine at chest height.
  - The other is called 'office' and is put on the office wall next to the surgery at the closest point to the X-ray machine at chest height.
- N1 will be responsible for putting up these dose monitoring badges at the start of each three-month monitoring cycle and the collecting and posting of these dose monitoring badges along with the others at the end of each monitoring cycle.
- The RSO will review the readings for these dose monitoring badges in the Dose Report on its receipt. Any reading greater than 0.3 mSv for a workplace monitoring dose monitoring badge will be investigated and a copy of the investigation and any corrective actions filed in the *Radiation Management Plan*.
- The Dose Report will be filed in the *Radiation Management Plan*.

Signature of the RSO: A J Smith

Date: 1 January 2023

Security procedures

The surgery in which the X-ray machine is kept and used is not in a public access area. After hours the surgery is locked and alarmed.

Signature of the RSO: A J Smith

Date: 1 January 2023

Annual protection and safety management system reviews

Appendix 5 gives an example checklist for these reviews. Further to this, the following guidelines apply.

- Reviews are performed each year in the last week of December.
- The review checklist used is based on the example in Appendix 5 and the template is kept in the *Radiation Management Plan*.
- Upon completion, annual checklists are kept in the *Radiation Management Plan*, along with the details of any corrective actions taken as a result of the review.

Annual review date	Expiry date	Issues found in review	Signature of RSO
21 December 2020	21 December 2021	Yes	A J Smith
17 December 2021	17 December 2021	None	A J Smith

Signature of the RSO: A J Smith

Date: 1 January 2023

Appendix 8: Example of a quality assurance programme for a small animal X-ray facility

Quality assurance programme overview

AB Vet Clinic's quality assurance programme has been established as part of the clinic's protection and safety management system to ensure that radiation sources, protective equipment and ancillary equipment performance remain in compliance; that doses are optimised; that working procedures continue to be effective; and that authorisations, equipment registers, and training records are up to date.

In addition to the normal preventative maintenance by the servicing engineers and staff, the following quality assurance procedures are performed at the stated frequencies.

In-house procedure/test	Frequency	Additional comments
Image quality – assigning an image quality rating (1–3) for all images produced.	At time of production of each image	Recorded in the *AB Veterinary Clinic X-ray Use Logbook*
Image quality – analysis of the image rating results (extended repeat anlysis)	Six-monthly (end of July and December)	Recorded in the *AB Veterinary Clinic QA Record Book*
Equipment performance – consistency of output and image processing	Quarterly (end of March, July, October and December)	Recorded in the *AB Veterinary Clinic QA Record Book*.
Equipment performance –X-ray unit compliance testing by service engineer	Three-yearly	Recorded in the *Radiation Management Plan*, along with a copy of the compliance report
Equipment preformance – image detector cassettes checks	Six-monthly as per manufacturer recommendation (end of July and December)	Recorded in the *AB Veterinary Clinic QA Record Book*
Equipment performance – beam collimation	Quarterly (end of March, July, October and December) or after any physical jarring of the tube head assembly	Recorded in the *AB Veterinary Clinic QA Record Book*
Equipment performance – protective clothing integrity check	Annually (end of December)	Recorded in the *AB Veterinary Clinic QA Record Book*
Working procedures review	Annually (end of December) or when there has been a significant increase in workload, change in layout or change in authorised staff.	Recorded in the *Radiation Management Plan*, along with a copy of the review report

In-house procedure/test	Frequency	Additional comments
Exposure chart review – recording the exposure index for all images produced	At time of production of each image	Recorded in the *AB Veterinary Clinic X-ray Use Logbook*
Exposure chart review – analysis of exposure index trends	Six-monthly (end of July and December)	Recorded in the *AB Veterinary Clinic QA Record Book*
Review of the protection and safety management system	Annually (end of December)	Recorded in the *Radiation Management Plan*, along with a copy of the review checklist

Quality assurance procedures for image quality

All images (including rejects and repeats) will be rated at the time of the production according to the categories given in the following table, and the ratings are to be recorded in the *AB Veterinary Clinic X-ray Use Logbook*.

Image quality rating

Rating	Quality	Basis
1	*Excellent*	No errors in animal positioning, X-ray exposure, or image processing
2	Diagnostically acceptable	Some errors in animal positioning, X-ray exposure or image processing, but not sufficient to detract from the diagnostic usefulness of the radiograph
3	Unacceptable	Errors in animal positioning, X-ray exposure or image processing, which render the radiograph diagnostically unacceptable

For any image assigned a rating of 3, a record will be made in the *Unacceptable image log* (located in the back of the *AB Veterinary Clinic X-ray Use Logbook)* at the time giving the:

- date
- nature of the deficiency
- known or suspected cause of this deficiency.

At the end of December and the end of June, the RSO (A J Smith) will analyse the image rating results for the previous six months and compare these with the target criteria in the table below. If target criteria are not being met, the RSO will call a meeting of all persons using X-rays at AB Veterinary Clinic to discuss appropriate corrective actions. The results of each six-month analysis will be recorded in the *AB Veterinary Clinic QA Record Book*.

At the end of January and the end of July, the RSO will analyse the *Unacceptable image log* with a view to appropriate corrective action if there are any trends evident. Any such corrective action will be recorded in the *AB Veterinary Clinic QA Record Book*.

Targets for image quality at AB Veterinary Clinic

Rating	Target percentage of radiographs taken
1	Not less than 70%
2	Not greater than 20%
3	Not greater than 10% (effectively the repeat rate)

Quality assurance procedures for equipment performance

AB Veterinarian Clinic will undertake the following quality assurance procedures for equipment performance.

- **Consistency of output and image processing** – quarterly (end of March, July, October and December)
  - The same image detector cassette (#4) will always be used and is placed on the X-ray table.
  - The light beam diaphragm (LBD) collimator is to be opened 5 cm beyond the edges of the cassette, so that it is well covered.
  - The 1 mm copper sheet (kept in the cupboard of the surgery) is to be taped to the bottom of the LBD collimator and with radiographed after every chemical change in the processing tanks (see below).
  - The radiographic technique factors to be used are 70 kVp and 3 mAs.
  - The focus to image detector cassette is to be the standard 75 cm.
  - The exposure Index of the resulting image is to be compared with the expected range worked out from the observed fluctuations of previous readings, which was found to be 1600 to 1700.
  - If the exposure index is outside this expected range, then:
    - the RSO (A J Smith) is to notified
    - the reason for the difference is to be sought and corrected before the X-ray machine is used
    - additional images are to be performed (as above) to confirm successful corrective action.
  - A record of the consistency test is to be made in the *AB Veterinary Clinic QA Record Book*.
- **Beam collimation** – quarterly (end of March, July, October and December) plus after any physical jarring of the tube head assembly
  - The collimation test object is irradiated as follows.
    - An image detector cassette is placed on the X-ray table.
    - The collimation test object (kept in the cupboard in the surgery) is placed centrally on top of the image detector cassette, and the LBD adjusted to the square marked out on the top of the test object.
    - The radiographic technique factors to be used are 70 kVp and 3 mAs.
    - The focus to image detector cassette is to be the standard 75 cm.

    - The exposure is made.
    - Without moving the test object but with the LBD collimators opened wide, a second exposure is made at the same settings.
  - From the image, the alignment of the light field with the X-ray field is determined.
  - If the misalignment is greater than 17 mm on any side, the service engineer must be called to adjust the collimators to give a coincidence better than 17 mm on all sides.
  - A record of the collimation test is to be made in the *AB Veterinary Clinic QA Record Book*.
- **X-ray unit compliance testing by service engineer** – three-yearly
  - The X-ray unit needs to be tested by the service engineer for compliance against ORS C9 requirements.
  - A full written compliance report is required from the service engineer.
  - The *Radiation Management Plan* must be updated with information on when the test was performed and when it is next due, and the report filed with the plan.
- **Image detector cassettes checks** six-monthly as per manufacturer recommendation (end of July and December)
  - A unique number and the date of entry into use is to be written on any new cassette.
  - All cassettes are to be inspected each year, checking for wear or damage that might affect light-tightness.
    - Any defective cassette is to be withdrawn from use and disposed of.
    - A record is to be made in the AB Veterinary Clinic QA Record Book that the cassette inspection has taken place, with any ensuing actions.
  - All intensifying screens are to be cleaned if needed using the appropriate cleaner and then inspected. Additionally:
    - any screens that are visibly damaged or blemished so that artefacts are present on the image are to be replaced
    - the date of entry into use of new intensifying screens is to be recorded on the cassette
    - a record is to be made in the AB Veterinary Clinic QA Record Book that all the screens have been cleaned and inspected, with any ensuing actions.
- **Protective clothing integrity check** – annually (end of December)
  - All lead aprons and lead gloves are to be visually inspected for physical damage or signs of internal de-lamination.
  - Any suspect items are to be radiographed to determine whether the protective properties of the item are compromised.
  - Any defective items are to be disposed of.
  - A record that the protective integrity check has taken place is to be made in the *AB Veterinary Clinic QA Record Book*, together with a note on any actions taken.

Quality assurance procedures for working procedures review

The working procedures in the *AB Veterinary Clinic Radiation Management Plan* are to be reviewed annually as part of the annual review of the protection and management system at the end of December (below), or when there has been a significant increase in workload, change in layout or change in authorised staff.

The review needs to include input from relevant staff on the appropriateness and effectiveness of written procedures, review of both the individual and workplace monitoring records and consideration of whether the current designation and delineation of the controlled areas are still adequate.

In the case of increased workload or change in layout, additional workplace monitoring may be needed at extra points to inform the review.

A record of review and changes made is to be recorded in the *AB Veterinary Radiation Management Plan*.

Quality Assurance procedures for exposure chart review

All images (including rejects and repeats) will have their exposure index (X-ray dose to the image receptor indicated after each exposure) recorded in the *AB Veterinary Clinic X-ray Use Logbook*.

For any image with an exposure index outside the 'adequate exposure' range of the table below, a record is to be also made in the *Over/under exposed image log* (located in the back of the *AB Veterinary Clinic X-ray Use Logbook)* at the time, giving the:

- date
- nature of the deficiency
- known or suspected cause of this deficiency (if the deficiency is obviously a problem with the exposure chart recommended settings for the projection taken, the RSO should consider getting the chart altered)

At the end of January and the end of July, the RSO will analyse the *Over/under exposed image log* with a view to appropriate corrective action to the X-ray machine exposure chart if there are any trends evident. Any such corrective action will be recorded in the *AB Veterinary Clinic QA Record Book*.

Targets for exposure index at AB Veterinary Clinic

(From the user manual for the ACME 400 CR image processing system used at our clinic)

	Value displayed on console image
Under-exposed	Less than 1500
Adequate exposure	1500 to 1800 (optimal = 1750)
Over-exposed	Greater than 1800

Quality assurance procedures for protection and safety management system review

A review of the protection and managements systems, the *Radiation Management Plan* and associated documentation is to be performed annually using the review checklist in Appendix 5.

The purpose of the review is to keep the documents current and to incorporate any changes or new recommendations in radiation protection as it applies to the use of X-rays in veterinary diagnosis.

A record of checklist and changes made is to be recorded in the *Radiation Management Plan*.

Signature of the RSO: A J Smith

Date: 1 January 2023

Appendix 9: Example radiation safety officer appointment letter

4 March 2023

AB Veterinary Clinic Ltd
113 Main South Road
BERTSVILLE

Dear Mr Alan J Smith

AB Veterinary Clinic Ltd appoints you to the role of radiation safety officer, as required by the radiation safety legislation, for our veterinary X-ray facility at AB Veterinary Clinic – Bertsville.

Kind regards

A JONES

Alice Jones
General Manger
Date: *4 March 2023*

I accept this role:

A J Smith

Alan J Smith
Veterinarian
Date: *5 March 2023*

Appendix 10: Example written safety instructions for owners upon release of their I-131 cat

For the next two weeks after the release of your cat:

- Avoid long periods (more than a few minutes) in close proximity to your cat, particularly during the first week. It is safe to pick your cat up for short periods, but your cat should not sit on anyone's lap for extended periods or sleep next to them on a bed.
- Avoid face-to-face contact. Don't allow your cat to lick you. If possible, wash your hands after handling your cat, especially before eating.
- If your cat urinates inside a dwelling, the urine should be cleaned up thoroughly with paper towels which are then placed in a rubbish bag. Use rubber gloves for this, and wash your hands very thoroughly afterwards. If the urine has soaked into garments or carpets, they should be washed thoroughly. Garments should be washed separately in a washing machine.
- If your cat uses a 'dirt box', keep this in an unoccupied area. Use a waterproof disposable lining. Wear rubber gloves when cleaning it out.
- Make sure your cat does not jump up onto the kitchen bench, or get onto anywhere that food is placed.
- Keep your cat away from other households and away from your vegetable or herb gardens. Also, as an extra precaution thoroughly wash any food or herbs from your garden.