



**AUSTRALIAN AND NEW ZEALAND
COLLEGE OF VETERINARY SCIENTISTS**

MEMBERSHIP GUIDELINES

Veterinary Radiology (Large Animal)

INTRODUCTION

These Membership Guidelines should be read in conjunction with the *Membership Candidate Handbook*.

ELIGIBILITY

Refer to the *Membership Candidate Handbook*.

OBJECTIVES

To demonstrate that the candidate has sufficient knowledge of and experience in large animal veterinary radiology to be recognised as an advanced practitioner. Successful completion of Membership exam represents a middle-tier of knowledge, competence and experience in large animal veterinary radiology.

For these guidelines large animal refers to equid, (horse and donkey) and production animals (bovine, ovine, caprine, porcine and alpaca).

LEARNING OUTCOMES

1. Radiation physics as it applies to veterinary diagnostic imaging

The candidate should have a **basic**¹ knowledge of:

- 1.1. Electromagnetic spectrum:
 - 1.1.1. elementary general physics as it pertains to radiology
 - 1.1.2. the electro-magnetic spectrum: definition, wave and particle theories
- 1.2. Generation of x-ray photons:
 - 1.2.1. components of the x-ray tube, types of anodes: rotating and stationary, cathode
 - 1.2.2. thermionic emission, line focus principle, heel effect, heat dissipation, structure of the atom, binding forces
 - 1.2.3. basic generator circuits, rectification, transformers, capacitor discharge equipment
- 1.3. Production of the x-ray photon:
 - 1.3.1. interactions at the anode: general radiation / Bremsstrahlung and characteristic radiation
 - 1.3.2. the effect of kV, mA and time on x-ray photon production
- 1.4. The interaction of x-ray photons with matter:
 - 1.4.1. coherent scatter, the photoelectric effect, Compton and the relative frequencies of these interactions
 - 1.4.2. factors affecting attenuation / the inverse square law
 - 1.4.3. scatter radiation – factors affecting the production of and methods to reduce the effects of scatter - grids (types, cut-off), air gap techniques, beam collimation
- 1.5. Factors affecting image quality:
 - 1.5.1. density, contrast, sharpness
 - 1.5.2. the origin and control of scatter:
 - 1.5.2.1. control of scatter production
 - 1.5.2.2. reduction of the negative impact of scatter on image quality

¹ **Knowledge levels:**

Sound knowledge — candidate must know all of the principles of the topic and some of the finer detail, including differing points of view and the core literature. A middle level of knowledge.

Basic knowledge — candidate must know the principles of the topic and the core literature.

1.5.3. unsharpness

1.5.3.1. geometric (magnification, distortion, penumbra effect)

1.5.3.2. motion

2. Practice of veterinary radiography

The candidate should have a **basic** knowledge of:

2.1. Practical radiography:

2.1.1. exposure assessment

2.1.2. factors influencing the choice of kV, mA, time, films and grids

2.1.3. patient positioning and problems in veterinary practice/limitations

2.1.4. the need for restraint and suitable methods/advantages and disadvantages of anaesthesia

2.1.5. the legal requirements for imaging study identification and image storage, including radiographs and ultrasound images

3. Digital Radiography

The candidate should have a **basic** knowledge of:

3.1. differences in image formation between computed radiography and digital systems (both direct and indirect digital radiography)

3.2. advantages and disadvantages of digital radiography including but not limited to latitude, exposure, speed, mobility, portability, workflow.

3.3. principles of:

3.3.1. digital imaging and communication in medicine (DICOM)

3.3.2. picture archiving and communications systems (PACS)

3.4. common artefacts associated with digital radiography including but not restricted to storage scatter, cracks of imaging plate, phantom image, quantum mottle, planking, grid cut-off, Moire, double exposure, dead pixels, dirty light guide, faulty data transfer, Überschwinger, clipping/image saturation

3.5. factors affecting image quality specific to digital imaging (including system resolution, exposure index, use of grids, algorithms, look-up table)

4. Diagnostic ultrasound

The candidate should have a **basic** knowledge of:

4.1. generation of the ultrasound image

- 4.2. production of ultrasound – transducer, piezoelectric crystal, frequency, pulse repetition frequency (PRF), power, focal zone
- 4.3. interactions of sound within the patient – acoustic impedance, transmission, absorption, reflection, refraction, scatter
- 4.4. processing the returning signal to generate an image - gain, time gain compensation (TGC), dynamic range.
- 4.5. factors that influence ultrasound image quality, including but not limited to:
 - 4.5.1. resolution – spatial resolution (axial, lateral, and slice thickness/elevational), and temporal resolution
 - 4.5.2. ultrasound artefacts
- 4.6. functions of the ultrasound machine used in image optimisation, including but not limited to depth, focal zone, gain, time gain compensation (TGC), dynamic range, persistence/frame averaging
- 4.7. Colour and Power Doppler

5. Radiation safety

The candidate should have a **sound**² knowledge of:

- 5.1. Code of Practice and Legislation:
 - 5.1.1. radiation monitoring, safety equipment and regulations
 - 5.1.2. relevant Australian and New Zealand laws and Codes of Practice as they apply to the use of ionising radiation
- 5.2. biologic effects of radiation:
 - 5.2.1. direct and indirect effects
 - 5.2.2. stochastic and deterministic effects
- 5.3. practical applications of the principles of radiation safety, including:
 - 5.3.1. practical applications of a Radiation Management Plan (Australia) or Radiation Safety Plan (New Zealand)
 - 5.3.2. principles of radiation protection: risks involved in the use of radiographic procedures/methods to minimise this risk
 - 5.3.3. basic radiation protection rules for a large animal practice

² **Knowledge levels:**

Sound knowledge — candidate must know all of the principles of the topic and some of the finer detail, including differing points of view and the core literature. A middle level of knowledge.

Basic knowledge — candidate must know the principles of the topic and the core literature.

- 5.3.4. maximum permissible dose (MPD)
- 5.3.5. the ALARA principle (As Low As Reasonably Achievable)
- 5.4. monitoring radiation exposure:
 - 5.4.1. units of dose and exposure: Gray, Sievert
 - 5.4.2. devices, monitoring bodies

6. Other imaging

The candidate will have a **basic** knowledge of:

- 6.1. Computed tomography (CT), magnetic resonance imaging (MRI) and nuclear medicine and its application to large animal veterinary practice.

7. Contrast agents and radiographic contrast procedures (contrast studies)

The candidate will be able to with **sound**³ expertise:

- 7.1. describe how common radiographic contrast procedures in horses are performed: venogram, arthrography, fistulogram, bursography
- 7.2. The candidate should have a **sound** knowledge of:
 - 7.2.1. Barium sulphate in its different formulations
 - 7.2.2. Iodinated contrast agents and its formulations including the difference between ionic and non-ionic formations
- 7.3 The candidate should have a **basic** knowledge of:
 - 7.3.1 the pharmacology of radiographic contrast agents including: mechanism of action, indications, contraindication, common side effects and dose rates
 - 7.3.2 the myelographic procedure.

8. General radiological interpretation of horses

The candidate will have a **sound** knowledge of:

- 8.1. hanging protocols and labeling protocols for equine radiography, according to the international conventions as displayed in the major equine radiology texts (Thrall, Butler)
- 8.2. radiographic appearance of the appendicular skeleton, thorax, abdomen, skull and cervical spine

³ Skill levels:

Sound expertise — the candidate must be able to perform the technique with a moderate degree of skill, and have moderate experience in its application. A middle level of proficiency.

Basic expertise — the candidate must be able to perform the technique competently in uncomplicated circumstances.

- 8.3. radiographic pathology, and associated pathophysiology, of the various organ systems investigated in equine practice

The candidate will be able to with **sound**⁴ expertise:

- 8.4 demonstrate a systematic approach to radiographic interpretation
- 8.5 determine which radiographic projection is presented from the radiographic anatomy
- 8.6 recognise, describe and interpret, including formulation of ranked order list of differential diagnoses, radiographic and sonographic abnormalities in horses
- 8.7 construct a radiology report incorporating the above components
- 8.8 demonstrate a systematic approach to the radiographic interpretation of a yearling radiographic series

9. The candidate will have a sound knowledge of:

- 9.1. the normal sonographic appearance of the following structures in the horse:
- 9.2. Skeleton:
 - 9.2.1. soft tissue structures of the carpus/tarsus, the metacarpus/metatarsus and pastern
 - 9.2.2. soft tissue structures of the stifle
 - 9.2.3. pelvis
 - 9.2.4. pleural space and peripheral lung
 - 9.2.5. abdominal structures accessible to transcutaneous ultrasound in the adult
 - 9.2.6. foal umbilicus and abdomen

10. Radiographic features of disease in horses

The candidate will have a **sound** knowledge of:

- 10.1. the reaction of bone to disease
 - 10.1.1. bone lysis patterns (geographic, moth eaten, permeative)
 - 10.1.2. periosteal and endosteal new bone patterns
 - 10.1.3. exostosis

⁴ Skill levels:

Sound expertise — the candidate must be able to perform the technique with a moderate degree of skill, and have moderate experience in its application. A middle level of proficiency.

Basic expertise — the candidate must be able to perform the technique competently in uncomplicated circumstances.

10.1.4. classification of fractures

10.1.4.1. location

10.1.4.2. descriptors of the fracture type (e.g. chip, slab, spiral, transverse, incomplete/complete, etc.)

10.1.4.3. Salter-Harris types, other appropriate classification types (e.g. distal phalangeal fractures, sesamoid fractures)

10.1.5. Bone healing

10.1.5.1. radiographic signs of bone healing: primary and secondary intention bone healing

10.1.5.2. radiographic signs of complications of bone healing: delayed union, malunion, non-union, fibrous union

10.1.6. Septic arthritis

10.1.6.1. radiographic signs of septic arthritis in all joints

The candidate will be able to, with **sound** expertise:

10.1.7. identify and classify bony lesions in the spectrum of benign or aggressive

10.1.8. recognize changes in the soft tissues adjacent to bony lesions; for example the signs of joint effusion

10.2. Osteoarthritis

The candidate will have a **sound** knowledge of:

10.2.1. radiographic signs of osteoarthritis in all joints, but in particular, the carpus (including third carpal bone sclerosis), stifle, tarsus, fetlock and interphalangeal joints.

10.3. Osteochondrosis

The candidate will have a **sound** knowledge of:

10.3.1. radiographic signs, common locations and clinical significance of this disease in its various locations.

The candidate will have a **basic** knowledge of:

10.3.2. pathophysiology of osteochondrosis

10.4. Juvenile bone disease

The candidate will have a **basic** knowledge of:

- 10.4.1. pathophysiology of physitis, (septic and non-septic), delayed ossification of carpal and tarsal bones and angular limb deformity

10.5. Stifle

The candidate will have a **sound** knowledge of the radiographic features of:

- 10.5.1. osteochondrosis, including the various morphologies
- 10.5.2. osseous cyst like lesions
- 10.5.3. osteoarthritis

10.6. Tarsus

The candidate will have a **sound** knowledge of the radiographic features of:

- 10.6.1. osteochondrosis, including the various morphologies
- 10.6.2. osteoarthritis

10.7. Shoulder

The candidate will have a **sound** knowledge of the radiographic features of:

- 10.7.1. Osteochondrosis including the various morphologies
- 10.7.2. Osteoarthritis

10.8. Carpus

The candidate will have a **sound** knowledge of the radiographic features of:

- 10.8.1. osteoarthritis, including third carpal bone sclerosis
- 10.8.2. carpal fracture disease, including typical locations of fractures

10.9. Metacarpus, metatarsus, fetlock

The candidate will have a **sound** knowledge of the radiographic features of:

- 10.9.1. fractures of these regions, typical causes and locations
- 10.9.2. common sites and radiographic appearance of osteochondral fragments associated with the fetlock joint, and their clinical significance.
- 10.9.3. periostitis (splints)
- 10.9.4. osteochondrosis including the various morphologies

- 10.9.5. osteoarthritis, including synovitis, of the fetlock
- 10.9.6. palmar osteochondral disease
- 10.9.7. osteomyelitis +/- sequestration in this and other locations
- 10.9.8. fractures and inflammatory conditions of the proximal sesamoid bones.
- 10.9.9. hypertrophic osteopathy

10.10. Phalanges

The candidate will have a **sound** knowledge of the radiographic features of:

- 10.10.1. typical locations of fractures; descriptions for fractures
- 10.10.2. osteoarthritis
- 10.10.3. laminitis, pedal osteitis and infectious osteitis
- 10.10.4. navicular syndrome

The candidate will have a **basic** knowledge of:

- 10.10.5. pathophysiology of laminitis, hypertrophic osteopathy and navicular syndrome

10.11. Vertebrae

The candidate will have a **basic** knowledge of the radiographic signs of:

- 10.11.1. cervical vertebral malformation, including vertebral sagittal ratios and minimum sagittal diameters (MSDs)
- 10.11.2. fractures and osteomyelitis of the dorsal spinous process
- 10.11.3. impingement and overriding dorsal spinous processes
- 10.11.4. osteoarthritis of the cervical facet joints

The candidate will have a **basic** knowledge of:

- 10.11.5. congenital anomalies, and appreciation of the breed incidence
- 10.11.6. myelographic procedure, technique, indications and interpretation

10.12. Head

The candidate will have a **sound** knowledge of:

- 10.12.1. the radiographic projections required for a complete study of the equine paranasal sinuses and a basic study of the dental arcades and mandible.

The candidate will have a **sound** knowledge of the radiographic signs of:

10.12.2. paranasal sinus disease, including sinusitis, ethmoid haematomas, sinus cysts and neoplasia

10.12.3. dental disease;

10.12.4. fractures and neoplasia of the mandible

The candidate will have a **basic** knowledge of the sonographic signs of:

10.12.5. Ocular disease including but not limited to trauma, cataracts, retinal detachment, retrobulbar masses

10.13. Lungs

The candidate will have a **sound** knowledge of:

10.13.1. the radiographic projections required for a complete study of the equine adult and foal lung.

10.13.2. normal radiographic anatomy of the equine lung in both the adult and the foal.

10.13.3. radiographic classification of pulmonary disease via traditional paradigms of lung pattern (alveolar, bronchial and interstitial patterns) and be able to identify and describe the radiographic signs that constitute these patterns with **sound** expertise.

10.13.4. the radiographic differential diagnoses for pulmonary disease based on the distribution (eg cranioventral, caudodorsal locations, diffuse, focal or multifocal locations) and type of lung pattern.

10.13.5. differential diagnoses for pulmonary disease, and be able to provide differential diagnoses which are ranked in order based on the age, signalment and clinical history of the patient.

10.13.6. the sonographic signs of pneumonia in the adult and foal

10.14. Pleural space

The candidate will have a **basic** knowledge of:

10.14.1. pathophysiology of pleuropneumonia

The candidate will have a **sound** knowledge of

10.14.2. radiographic and sonographic anatomy of the pleural space

10.14.3. radiographic and sonographic signs of pleural space disease

11. Abdomen

The candidate will have a **basic** knowledge of:

- 11.1. radiographic and sonographic signs of abdominal diseases in the foal including: intestinal obstruction, retained meconium, ruptured bladder, omphalophlebitis
- 11.2. sonographic evaluation of the foal umbilicus
- 11.3. the role of radiology in investigation of abdominal disease in the adult
- 11.4. the use of sonography to investigate colic in the adult horse

12. Radiographic features of disease in production animals

The candidate will have a **basic** knowledge of:

- 12.1. radiographic anatomy of the skull and the limbs of the alpaca, cow, sheep goat and pig from the elbow and stifle distally.

The candidate will be able to with **basic** expertise:

- 12.2. determine which radiographic projection is presented from the radiographic anatomy.

The candidate will have a **basic** knowledge of:

- 12.3. radiographic features, and associated pathophysiology of diseases common to production animal practice including, but not restricted to the following:

12.3.1. Cattle/calves/pigs

12.3.1.1. osteochondrosis

12.3.1.2. septic pododermatitis and septic arthritis

12.3.1.3. pneumonia

12.3.1.4. osteoarthritis

8.3.1.1. fractures

12.3.2. Sheep/goats

12.3.2.1. osteoarthritis

12.3.2.2. osteomyelitis

12.3.2.3. fractures

12.3.2.4. septic arthritis

12.3.2.5. pneumonia

12.3.2.6. dental disease

12.3.2.7. urethral obstruction

12.3.3. Alpacas

12.3.3.1. dental disease

12.3.3.2. osteomyelitis and sequestration

12.3.3.3. angular limb deformities

12.3.3.4. vitamin D deficiency (rickets)

12.3.3.5. pneumonia

EXAMINATIONS

For information on both the standard and format of the Written and Practical/Oral examinations, candidates are referred to the *Membership Candidate Handbook*. The Member examination has **two separate components**:

- 1. Written Papers (Component 1)**
Written paper 1: Principles of Large Animal Imaging (two hours)
Written paper 2: Applied Aspects of Large Animal Imaging (two hours)
- 2. Practical Examination (Component 2)**
Practical (two hours forty minutes)

The written examination will comprise two separate two-hour written papers taken on the same day. There will be an additional 15 minutes perusal time for each paper, during which no writing in an answer booklet is permitted. There is no choice of questions. Marks allocated to each question and to each subsection of questions will be clearly indicated on the written paper.

Each two hour written examination will comprise:

One (1) essay-type questions of 30 marks each. Questions may be broken into multiple sub-parts. TOTAL SUGGESTED TIME: 30 minutes

Six (6) short-answer questions 5 marks each TOTAL SUGGESTED TIME: 30 minutes

Thirty (30) multiple choice questions 2 marks each TOTAL SUGGESTED TIME: 60 minutes

Written Paper 1:

This paper is designed to test the Candidate's knowledge of the principles of Veterinary Radiology as described in the Learning Outcomes. Answers may cite specific examples where general principles apply, but should primarily address the theoretical bases underlying each example. Written Paper 1 will mainly cover the Learning Outcomes 1-7, however material from any learning outcome may be examined. The species examined will be equid, (horse and donkey) and production animals (bovine, ovine, caprine, porcine and camelid).

Written Paper 2:

This paper is designed to (a) test the Candidate's ability to apply the principles of Veterinary Radiology to particular cases/problems or tasks and (b) test the Candidate's familiarity with the current practices and current issues that arise from activities within the discipline of Veterinary Radiology in Australia and New Zealand. Written Paper 2 will mainly cover the Learning Outcomes 8-11, however material from any Learning Outcome may be examined. The species examined will be equid, (horse and donkey) and production animals (bovine, ovine, caprine, porcine and camelid).

Practical Examination:

The practical examination will be 160 minutes in duration and will require written reports on the radiographic films or digital images of eight (8) cases. Images will be provided in Power Point; no image manipulation will be required. Ultrasound images or clips may be included. Total suggested time for each case is twenty (20) minutes, however candidates are free to move through the cases at their own pace.

Each case is of equal value equating to a total of 160 marks (1 mark/minute). The cases will include horses and a small component of production animals.

Each answer might include the following:

- views included, any techniques used (i.e. contrast studies)
- comment on radiographic technique/quality (positioning/exposure/collimation)
- radiographic description
- conclusions, differential diagnosis list, recommendation of further imaging if appropriate

The practical examination may not necessarily be limited to these types of questions.

Examiners are looking for a systematic evaluation of the study. Marks will be awarded for the following areas:

- correct identification of radiographic views
- assessment of radiographic quality
- description of imaging abnormalities
- radiographic conclusions and differential diagnoses
- recommendations for further imaging procedures

The candidates must demonstrate to the examiners their thought processes, prioritisation and conclusions.

Normal findings need not be described unless important for the pathology present (eg, there is a megaesophagus identified but the lung is normal with no evidence of aspiration pneumonia).

Candidates should not comment on artefacts unless they are pertinent to interpretation of the study (i.e. they affect the study outcome).

Descriptive sentences, vs. dot points can both be valid answers for the observation of imaging abnormalities or conclusions.

Candidates must use correct radiographic terminology and avoid colloquial language.

RECOMMENDED READING LIST

The candidate is expected to read widely within the discipline, paying particular attention to areas not part of their normal work experiences. This list of books and journals is intended to guide the candidate to some core references, including comparative texts, and other source material. Candidates also should be guided by their mentor / supervisor. The list is not comprehensive and is not intended as an indicator of the content of the examination.

Recommended Textbooks⁵:

Bushong SC (2016) 11th ed. “Radiologic Science for Technologists: Physics, Biology, and Protection” Elsevier.

Thrall DE (2017) 7th ed. “Textbook of Veterinary Radiology”, Saunders Elsevier, Missouri.

Butler JA, Colles CM, Dyson SJ, Kold SE, Poulos PW, (2017), 4th ed. “Clinical Radiology of the Horse”, Blackwell Science, Malden, Mass.

Kidd, Lu, Frazer. (2014) “Atlas of Equine Ultrasonography”, Wiley-Blackwell.

Additional reading materials:

Wallis A. McCoubrie P. The radiology report, are we getting the message across? Clinical Radiology 2011. 66. 1015-1022

Denoix JM, (2000), “The equine distal limb: an atlas of clinical anatomy and comparative imaging”, Manson Publishing, London

Ross MW and Dyson SJ (2010) 2nd ed. “Diagnosis and Management of Lameness in the Horse”, Saunders, London

Stashak TS, (2020), 7th ed. “Adam’s lameness in horses”, Wiley.

Wallack ST, (2003), “The Handbook of Veterinary Contrast Radiography” San Diego Imaging Inc. CA, USA

Veterinary Radiology and Ultrasound : V49 Issue 1 supplement – digital radiography.

Mattoon JS. “Digital Radiography” Veterinary and Comparative Orthopaedics and Traumatology. 2006;19(3):123-32.

⁵ **Definitions of Textbooks**

Recommended textbook – candidates should own or have ready access to a copy of the book and have a sound knowledge of the contents.

Additional references – candidates should have access to the book and have a basic knowledge of the contents.

Veterinary Radiology (Large Animal) Membership Guidelines 2022

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FURTHER INFORMATION

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