



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 and experience to give professional advice to veterinary colleagues not similarly qualified on problems or procedures often encountered or used in general practice in the area of large animal (LA) veterinary radiology. For these guidelines large animal refers to equid, (horse and donkey) and production animals (bovine, ovine, caprine 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

¹Knowledge levels:

Detailed knowledge - candidates must have an in-depth understanding of the topic, including differing points of view and the published literature. The highest level of knowledge.

Sound knowledge - candidate must know the principles and some of the finer detail of the topic, 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.

- 1.2. Generation of x-ray photons:
 - 1.2.1. components of the x-ray tube, types of anodes: rotation 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. Formation of the radiographic image for film-screen radiography:
 - 1.5.1. formation of an image due to differential absorption
 - 1.5.2. film construction, types and speeds
 - 1.5.3. photographic density and contrast
 - 1.5.4. intensifying screens, phosphors, construction, rare earth Vs Ca tungstate, speeds
 - 1.5.5. cassettes
- 1.6. The principles and practice of film processing:
 - 1.6.1. development, wash, fixation, wash, dry
 - 1.6.2. darkroom design and requirements
 - 1.6.3. film identification

- 1.7. Factors affecting image quality:
 - 1.7.1. density, contrast, sharpness
 - 1.7.2. the origin and control of scatter – grids/collimators
 - 1.7.3. film and screen speed
 - 1.7.4. unsharpness – geometric (magnification, distortion, penumbra effect) and 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. formation of a technique chart
 - 2.1.4. patient positioning and problems in veterinary practice/limitations
 - 2.1.5. the need for restraint and suitable methods/advantages and disadvantages of anaesthesia
- 2.2. Radiographic faults and artefacts (film-screen radiography):
 - 2.2.1. the identification and explanation of radiographic faults / artefacts
 - 2.2.2. recognition of faults due to inadequate radiographic procedure
 - 2.2.3. the identification of darkroom artefacts
 - 2.2.4. the identification of processing artefacts.

3. Digital Radiography

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

- 3.1. differences in image formation between film-screen and digital systems (both computed radiography and direct digital radiography)
- 3.2. advantages and disadvantages of digital radiography
- 3.3. principles of computed radiography vs direct digital radiography, digital imaging and communication in medicine (DICOM), picture archiving and communications systems (PACS)
- 3.4. common artefacts associated with digital radiography

- 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. principles of ultrasound image formation including frequency, acoustic impedance, resolution, artefacts and transducers
- 4.2. the indications for use of diagnostic ultrasound in practice
- 4.3. functions of the ultrasound machine used in image optimisation: depth, focal zone, gain, Time Gain Control (TGC), dynamic range, persistence/frame averaging

5. Radiation safety

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

- 5.1. radiation monitoring and safety equipment and regulations, and should be able to convey this information in a coherent matter to other veterinarians
- 5.2. relevant Australian and New Zealand laws and Codes of Practice as they apply to the use of ionising radiation
- 5.3. principles of radiation protection: risks involved in the use of radiographic procedures/methods to minimise this risk
- 5.4. basic radiation protection rules for a large animal practice
- 5.5. stochastic and non-stochastic effects
- 5.6. MPD, ALARA
- 5.7. somatic and genetic effects
- 5.8. units: Gray, Sievert.

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 should have a **sound** knowledge of:

- 7.1. Iodinated contrast agents and its formations including the difference between ionic and non-ionic formations.

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

- 7.2. Barium sulphate in its different formulations
- 7.3. the pharmacology of radiographic contrast agents including: mechanism of action, indications, contraindication, common side effects and dose rates
- 7.4. the use of myelography in the investigation of spinal disease in horses.
- 7.5. other contrast procedures performed in large animal practice, including arthrography and fistulography.

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

The candidate will be able to with **sound**² expertise:

- 8.4. recognise, describe and list differential diagnoses for the changes in structure and function of the various body systems as related to disease which occurs in horses
- 8.5. select and interpret an appropriate imaging modality (radiography or ultrasound)
- 8.6. determine which radiographic projection is presented from the radiographic anatomy.

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

- 8.7. indications for advanced imaging (including nuclear medicine, MRI and CT).

² Skill levels:

Detailed expertise — the candidate must be able to perform the technique with a high degree of skill, and have extensive experience in its application. The highest level of proficiency.

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.

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

- 8.8. the normal sonographic appearance of the following structures in the horse:
 - 8.8.1. palmar/plantar structures of the carpus/tarsus, metacarpus/metatarsus and pastern
 - 8.8.2. soft tissue structures of the stifle
 - 8.8.3. biceps tendon
 - 8.8.4. pleural space and peripheral lung
 - 8.8.5. abdominal structures accessible to transcutaneous ultrasound in the adult
 - 8.8.6. foal umbilicus and abdomen

9. Radiographic features of disease in horses

9.1. Skeleton:

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

- 9.1.1. the reaction of bone to disease
- 9.1.2. radiographic anatomy of the different regions of the axial and appendicular skeleton
- 9.1.3. radiographic projections of the different regions of the axial and appendicular skeleton including the radiographic projections required for a complete study of the joints and bones of the limbs from the shoulder and stifle distally.
- 9.1.4. radiographic features that differentiate bony neoplasia from infection
- 9.1.5. classification of fractures, including descriptors of the fracture type (e.g. spiral, transverse, incomplete/complete etc), location, Salter-Harris types, other appropriate classification types (eg distal phalangeal fractures, sesamoid fractures), comminution, delayed unions.
- 9.1.6. radiographic signs of bone healing
- 9.1.7. radiographic signs of septic and degenerative arthritis.

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

- 9.1.8. position patients to obtain the views
- 9.1.9. identify and categorise lysis (e.g. geographic, moth-eaten, permeative) and periosteal new bone reaction (solid vs. interrupted categories)
- 9.1.10. classify bony lesions in the spectrum of benign or aggressive

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

9.2. Osteoarthritis

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

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

9.3. Osteochondrosis

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

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

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

- 9.3.2. pathophysiology of osteochondrosis

9.4. Juvenile bone disease

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

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

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

- 9.4.2. the radiographic signs of these diseases.

9.5. Tendons/ligaments

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

- 9.5.1. sonographic signs of soft tissue injury in the following regions:
 - 9.5.1.1. palmar/plantar metacarpus/metatarsus
 - 9.5.1.2. pastern
 - 9.5.1.3. stifle
 - 9.5.1.4. biceps tendon

9.6. Stifle

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

- 9.6.1. osteochondrosis, including the various morphologies

9.7. Tarsus

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

- 9.7.1. osteochondrosis, including the various morphologies
- 9.7.2. osteoarthritis

9.8. Shoulder

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

- 9.8.1. osteochondrosis
- 9.8.2. osteoarthritis
- 9.8.3. fractures

9.9. Carpus

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

- 9.9.1. osteoarthritis, including third carpal bone sclerosis
- 9.9.2. carpal fracture disease, including typical locations of fractures.

9.10. Metacarpus, metatarsus, fetlock

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

- 9.10.1. fractures of these regions, typical causes and locations
- 9.10.2. common sites and radiographic appearance of osseous fragments associated with the fetlock joint, and their clinical significance.
- 9.10.3. periostitis (splints)
- 9.10.4. osteoarthritis, including synovitis, of the fetlock
- 9.10.5. palmar osteochondral disease
- 9.10.6. osteomyelitis +/- sequestration in this and other locations
- 9.10.7. fractures and inflammatory conditions of the proximal sesamoid bones.

9.11. Phalanges

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

- 9.11.1. typical locations of fractures; descriptions for fractures
- 9.11.2. osteoarthritis
- 9.11.3. laminitis, pedal osteitis and infectious osteitis

9.11.4. hypertrophic osteopathy

9.11.5. navicular syndrome

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

9.11.6 pathophysiology of laminitis, hypertrophic osteopathy and navicular syndrome.

9.12. Vertebrae

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

9.12.1. cervical vertebral malformation, including vertebral sagittal ratios and minimum sagittal diameters (MSDs)

9.12.2. fractures and osteomyelitis of the dorsal spinous process

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

9.12.3. congenital anomalies, and appreciation of the breed incidence

9.12.4. myelographic procedure

9.13. Head

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

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

9.13.2. patient positioning and be able to position patients to obtain these views with **sound** expertise

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

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

9.13.4. dental disease;

9.13.5. fractures and neoplasia of the mandible

9.14. Lungs

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

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

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

9.14.3. 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.

9.14.4. 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.

9.14.5. 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.

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

9.15. Pleural space

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

9.15.1. pathophysiology of pleuropneumonia

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

9.15.2. radiographic and sonographic anatomy of the pleural space

9.15.3. radiographic and sonographic signs of pleural space disease

10. Abdomen

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

10.1.1. radiographic and sonographic signs of abdominal diseases in the foal including: intestinal obstruction, retained meconium, sand enteritis, ruptured bladder, omphalophlebitis

10.1.2. the use of sonography to investigate colic in the adult horse

10.1.3. sonographic evaluation of the foal umbilicus

11. Radiographic features of disease in production animals

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

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

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

11.2. determine which radiographic projection is presented from the radiographic anatomy.

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

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

11.3.1. Cattle/calves

11.3.1.1. osteochondrosis

11.3.1.2. septic pododermatitis and septic arthritis

11.3.1.3. pneumonia

11.3.1.4. osteoarthritis

11.3.1.5. fractures

11.3.2. Sheep/goats

11.3.2.1. osteoarthritis

11.3.2.2. osteomyelitis

11.3.2.3. fractures

11.3.2.4. septic arthritis

11.3.2.5. pneumonia

11.3.2.6. dental disease

11.3.3. Alpacas

11.3.3.1. dental disease

11.3.3.2. osteomyelitis and sequestration

11.3.3.3. angular limb deformities

11.3.3.4. vitamin D deficiency (rickets)

11.3.3.5. 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 and Oral Examination** (*Component 2*)
Practical (two hours forty minutes)
Oral (one hour)

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 on the examination paper 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:

Two (2) essay-type questions of 30 marks each. Questions may be broken into multiple sub-parts. TOTAL SUGGESTED TIME: 60 minutes

Four (4) short-answer questions 10 marks each TOTAL SUGGESTED TIME: 40 minutes

Ten (10) multiple choice questions 2 marks each TOTAL SUGGESTED TIME: 20 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 and alpaca).

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 and alpaca).

Practical Examination:

The practical examination will be 160 minutes in duration and will require written reports on the radiographic films or digital images of ten (10) 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 fifteen (15) minutes allowing ten (10) minutes at the end for review, however candidates are free to move through the cases at their own pace. Each case is of equal value equating to a total of 200 marks. 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 techniques 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.

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.

Oral Examination:

This examination further tests the candidate's achievement of the above-mentioned Learning Outcomes. It will be approximately one (1) hour duration and will include further description and interpretation of digital images (both radiographs and ultrasound), or other objects as pertains to radiology (inclusive of ultrasound). Six (6) cases are presented with supporting questions asked verbally in a face-to-face setting. The oral examination has a total of 120 marks with each case allocated 20 marks.

Questions will be provided in Power Point format.

These questions aim to test how the candidate arrives at their radiographic conclusions.

Candidates will be provided with information about the study such as, signalment and limited history.

Candidates may request additional imaging studies; these may or may not be available.

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

Marks will be awarded for:

- demonstration of a systematic approach
- the candidate's description of imaging abnormalities
- the candidate's ability to draw logical conclusions from the imaging findings
- the candidate's ability to make appropriate patient management recommendations, including both imaging-related diagnostics and other pertinent diagnostic testing.

Candidates should not comment on artefacts unless they are pertinent to interpretation of the study.

Normal findings may be described, but avoid spending excessive time on describing normal findings.

Examples of questions:

“Describe the artefact you see and discuss how this occurred”

An image depicting a brand of contrast medium. “What is this chemical? What are the indications and contraindications for its use?”

Standing lateral radiographs of a horse's thorax, with pleuropneumonia and pulmonary abscesses. The candidate must be able to describe the radiographic features present that are consistent with pleural effusion and pulmonary abscess formation (eg. increased opacity with border effacement of the cardiac silhouette and leafing of lung lobes, and horizontal linear gas-fluid interfaces).

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 Textbooks:

Bushong, SC (2012) 10th ed. “Radiologic Science for Technologists: Physics, Biology, and Protection” Elsevier

Thrall, DE (2012) 6th ed. “Textbook of Veterinary Radiology”, Saunders Elsevier, Missouri.

Butler, JA, Colles, CM, Dyson, SJ, Kold, SE, Poulos, PW, (2008), “Clinical Radiology of the Horse”, 3rd Ed. Blackwell Science, Malden, Mass.

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

Additional reading materials:

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

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

Stashak, TS, (1998), “Adam’s lameness in horses”, 5th Ed, Williams and Wilkins, Baltimore.

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” Vet Comp Orthop Traumatol. 2006;19(3):123-32.

FURTHER INFORMATION

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