



**ACPSEM**

Australasian College of Physical Scientists & Engineers in Medicine

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# RADIATION ONCOLOGY MEDICAL PHYSICS

## CLINICAL TRAINING GUIDE

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*The ACPSEM mission is to advance services and professional standards in medical physics  
and biomedical engineering for the benefit and protection of the community*

## ACKNOWLEDGEMENTS

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Version 1 of the ACPSEM Radiation Oncology Medical Physics Clinical Training Guide (CTG) was based on the Regional Cooperative Agreement (RCA) guide. The RCA is an intergovernmental agreement for East Asia & Pacific region, under the auspices of the International Atomic Energy Agency (IAEA), in which the Government Parties undertake, in co-operation with each other and with the IAEA to promote and co-ordinate co-operative research, development (R&D) and training projects in nuclear science and technology through their appropriate national institutions. More detail can be found at <http://www.rca.iaea.org>.

The RCA Radiation Oncology Medical Physics Clinical Training Programme was developed with the support of the International Atomic Energy Agency. The RCA authors acknowledged the input of the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) in providing documents from their Training, Education and Accreditation Programme (TEAP) for Radiation Oncology Medical Physicists. Those documents were used to develop the framework of the RCA programme. The ACPSEM in turn, gratefully acknowledged the approval of the RCA for the use of their guide in the further development of the TEAP documentation.

Version 2 of the CTG was released in 2009. The content was essentially the same as that in Version 1, but Competencies 4.3, 4.4 and 4.5 were expanded to allow separate assessment of acceptance testing, commissioning and quality assurance of kilovoltage equipment, linear accelerators and CTs/simulators. A core module points system was introduced in this version and implemented by the release of a spreadsheet for monitoring progress through the allocation of points for each completed competency level. Some updated references were also included.

Version 3 of the CTG was developed by the Progressive Assessment Working Group (PAG), a subcommittee of the ACPSEM's Radiation Oncology Certification Panel. The key aim of this revision was to provide specific guidance about assessment requirements for each competency and requirement, in addition to the more general guidance provided in Version 2. Secondary aims were to update content to reflect changes in radiotherapy physics practice since 2008 and to simplify the competencies, reducing duplication of content between different modules. During the revision process, PAG developed initial drafts for each module in a progressive assessment framework. The drafts for each module were then reviewed by an Expert Review Group consisting of invited ROMPs with expertise in training and assessment of the module.

Version 3.0 included a complete revision of the introductory pages and a new version of Module 2.

Version 3.1 includes a new version of Module 3.

Version 3.2 includes a new version of the introductory pages to include the ancillary modules in the progressive assessment framework and a new version of Module 4.

Version 3.3 includes a new version of Module 5.

Version 3.4 includes a new version of the "Training and assessment" section of the introductory pages to include changes in the assessment requirements for brachytherapy and a new version of Module 6.

Version 3.5 includes new versions of Modules 1 and 7.

Version 3.6 includes a new version of Module 8.

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- TEAP Coordination Group

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## INTRODUCTION

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This Clinical Training Guide (CTG) for Radiation Oncology Medical Physics (ROMP) forms the basis of clinical training for ROMP registrars in the ACPSEM's Training, Education and Assessment Program (TEAP). Registrars enrolled in the ACPSEM TEAP must follow this guide to attain the required competencies.

The CTG is divided into eight modules. Module 1 is an ancillary module covering clinical introduction which should be completed early in the training period. There are five core modules (numbers 2 to 6) each of which covers the core clinical knowledge and skills required of a ROMP. There are two additional ancillary modules (numbers 7 to 8) which provide the professional skills and education necessary for a qualified ROMP to work effectively in the multi-disciplinary field of radiation oncology with knowledge of the wider medical physics field.

The core and ancillary modules differ both in the level of competence that registrars are expected to attain and in the mode of assessment. Competency in the core modules is assessed during clinical training, in the written exam and in the final Part A and Part B examinations. The ancillary modules are assessed during the clinical training period.

The eight modules are:

- Module 1: Clinical Introduction
- Module 2: Radiation safety and Protection
- Module 3: External Beam Radiation Dosimetry
- Module 4: External Beam Radiation Therapy Equipment
- Module 5: External Beam Treatment Planning
- Module 6: Brachytherapy
- Module 7: Professional Awareness, Management and Training
- Module 8: Diagnostic Imaging Medical Physics

Each module contains a number of competencies to be attained. . The modules can be undertaken in any order and with more than one module undertaken at a time.

The basic syllabus for TEAP is the textbook:

Podgorsak E.B (Ed). (2005) *Radiation Oncology Physics: A Handbook for Teachers and Students*, International Atomic Energy Agency, Vienna.

Note that while this text gives an overview of the course content, it doesn't cover the depth required for the training program. Registrars should also consult the references listed in the CTG for each module to ensure they cover the material required to meet the assessment criteria for each competency learning outcome.

## TRAINING AND ASSESSMENT

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### COMPETENCY LEVELS IN THE CORE AND ANCILLARY MODULES

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There are three competency levels recognized in the CTG.

- At **Level 1**, the registrar understands basic physics principles, and is able to describe, list or identify the key components of theory or practical tasks. The registrar works under close supervision.
- At **Level 2**, the registrar understands the details of relevant theory and can apply it to clinical physics situations. The registrar is also able to perform practical tasks competently working under general supervision, with the exception of Module 6 Brachytherapy where close supervision is still required.<sup>1</sup>
- At **Level 3**, one of the learning outcomes is identical to the wording of the competency itself, reflecting the registrar's ability to demonstrate the skills and knowledge required for the competency as a whole. At Level 3, the registrar should be able to take responsibility for managing a process, assess compliance with regulatory requirements and perform quality management. The registrar is capable of working under minimal supervision.<sup>2</sup>

Please refer to the [Quality Management](#) section of this document for further explanation of how the term "quality management" is used in the CTG.

Registrars must achieve Levels 1, 2 and 3 in the core modules, starting from Level 1 and building up to Level 3 by the end of training, except in Module 6 Brachytherapy, where Level 3 is optional.

The same three competency levels are recognized in the ancillary modules, but most competencies only require registrars to achieve Level 1. A small number of competencies in the ancillary modules also have a Level 2 component. Registrars must achieve all the competency levels specified for a given ancillary module.

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<sup>1</sup>For Module 6 Brachytherapy, it is recognized that access to brachytherapy services is limited for many registrars, and that working under direct, close supervision will be expected, especially when handling radioactive sources. At level 2, the registrar will therefore not necessarily have acquired the same level of skills and experience expected in the other core modules. The registrar will provide evidence of performing practical tasks competently whilst working under close supervision. Most registrars will achieve this level through attending workshops, training sessions and mock scenarios/ treatment planning sessions. This is considered the **basic** level of competence in brachytherapy required for a registrar seeking Certification as a Medical Physics Specialist in Radiation Oncology with Level 2 Proficiency in Brachytherapy.

<sup>2</sup>For Module 6 Brachytherapy, Level 3 is **optional**. It is expected that registrars involved with routine clinical practice over a range of brachytherapy services for an extended period of time (generally more than 6 months depending on the brachytherapy case load) will complete this level. This is considered the **advanced** level of competence in brachytherapy required for a registrar seeking Certification as a Medical Physics Specialist in Radiation Oncology with Level 3 Proficiency in Brachytherapy.

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## TRAINING AND ASSESSMENT REQUIREMENTS

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The training and assessment requirements for each competency in the core and ancillary modules are set out in tabular form. The elements of the table are:

- [Learning Outcomes](#)
- [Recommended Items of Training \(RIOTs\)](#)
- [Suggested Evidence for RIOTs](#)
- [Suggested Assessment Method](#)
- [Assessment Criteria](#)

**The learning outcomes and assessment criteria are mandatory. Each registrar must achieve all the learning outcomes and must meet the assessment criteria, except in Module 6 Brachytherapy, where the Level 3 learning outcomes are optional.** This ensures consistency in interpretation of competency levels throughout all training centres, with the result that all registrars completing TEAP have achieved a similar base level of competency. Learning outcomes are audited by ROCP Examiners/Assessors during annual progress reviews.

The RIOTs, suggested evidence and suggested assessment methods are intended to provide guidance for registrars and supervisors. Alternatives may be used, provided the learning outcomes are achieved and the assessment criteria are met. This allows departments to customize training programs to suit local requirements.

Each of the five elements is further explained in the subsequent sections of this document, and illustrated with an [example](#).

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### LEARNING OUTCOMES

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A learning outcome specifies an ability that a registrar must achieve through acquired skills and/or knowledge. Learning outcomes are assessed against the assessment criteria. Achieving the learning outcomes defines competency in TEAP.

For each TEAP competency, there are learning outcomes listed in the table for each of Level 1, 2 and 3 in the core modules, and for Level 1 and 2 in the ancillary modules. In order to reach Level 1, a registrar must achieve all the learning outcomes listed for Level 1, and similarly for the other TEAP levels. **Learning outcomes are mandatory: every registrar must achieve all the learning outcomes for each competency, except in Module 6 Brachytherapy, where the Level 3 learning outcomes are optional.**

Learning outcomes define the outcome to be achieved at the end of training, not the training process itself. There are many ways to achieve a given learning outcome. Learning outcomes are written from the learner's perspective, and they should be specific, measurable and able to be assessed. The words "The registrar can...." or "The registrar is able to...." are understood to preface each learning outcome.

The learning outcomes become progressively more complex as training proceeds, reflecting the registrar's development as a ROMP. These may be seen in the characteristic verbs used to develop learning outcomes at each Level.

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### RECOMMENDED ITEMS OF TRAINING (RIOTS)

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Recommended Items of Training (RIOTs) are provided for each learning outcome. These are intended to provide guidance for registrars and supervisors, not as a mandatory list of tasks

that must be undertaken. There are many possible ways to achieve a given learning outcome. Registrars and supervisors may use some or all of the RIOTs, and/or they may use alternative learning activities that are relevant to the learning outcome. Alternative activities may be used in addition to, or as substitutes for, the RIOTs listed in the CTG.

Training plans should be developed and agreed upon by registrars and their supervisors, taking into account the registrar's previous experience and training needs. When developing training plans, registrars and supervisors should consider the list of RIOTs as well other learning opportunities that are available. Registrars are encouraged to participate in the routine clinical work of the department and in developmental projects as part of their training. Participation in the department's clinical activities helps registrars to see the relevance of ROMP work, and also contributes to competency achievement. Training efficiency can be improved by identifying relevant clinical projects that address more than one TEAP competency. Supervisors should use their discretion in selecting training activities relevant to a given learning outcome.

Master of Science (MSc) coursework is listed as a RIOT in some learning outcomes. This is a reference to the coursework undertaken by registrars as part of their ACPSEM accredited postgraduate degree. In some cases, registrars will have already covered aspects of basic theory as part of their coursework, and this should not need to be repeated. However supervisors need to review the work undertaken during the MSc to confirm that it was relevant to the learning outcome under consideration and that the assessment criteria have been achieved.

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## SUGGESTED EVIDENCE FOR RIOTS

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Registrars are required to keep records of their training activities and to produce this on request at their Annual Progress Review (APR). There are many types of evidence that are acceptable. There are some suggested types of evidence listed for each learning outcome in the CTG. These are intended to provide guidance to registrars and supervisors, not as mandatory requirements. The supervisor may suggest that the registrar presents their training evidence in a format not listed in the CTG. For example, an oral presentation to the department, a graph, a table, a flowchart or an annotated diagram summarizing results might be appropriate for some learning activities. Using a variety of forms of training evidence is encouraged. Supervisors and registrars should agree on what evidence is required for each learning outcome as part of developing the training plan for each competency.

As a general rule, higher quality evidence is required at the higher levels of competency. Some suggestions for suitable training evidence for each competency level in the core and ancillary modules are included in Table 1.

TABLE 1: EXAMPLES OF TRAINING EVIDENCE FOR LEVELS 1-3 OF THE CORE AND ANCILLARY MODULES

Level 1	Level 2	Level 3
<ul style="list-style-type: none"> <li>• Logbook notes, showing registrar participation in an activity</li> <li>• Observation by the supervisor of registrar participation</li> <li>• Tutorial notes</li> <li>• MSc course notes</li> <li>• Dot point summaries of theory</li> <li>• Evidence of attendance at</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment tasks</li> <li>• Observation by supervisor of a registrar carrying out a task under general supervision.</li> <li>• Experimental records showing registrar completion of a task.</li> <li>• Q&amp;A session with supervisor covering level 2 theory.</li> <li>• Internal reports on minor</li> </ul>	<ul style="list-style-type: none"> <li>• Practical tasks carried out under mock exam conditions, including Q&amp;A.</li> <li>• Internal reports on major projects carried out by registrar (e.g. commissioning a new item of equipment, performing full absorbed dose calibration or radiation</li> </ul>

- |  |  |  |
|--|--|--|
| <ul style="list-style-type: none"> <li>TEAP training days, workshops and seminars</li> <li>• Reports (verbal or written) from others about what they have done with the registrar</li> <li>• Experimental records showing registrar participation</li> <li>• Minutes showing attendance at meetings</li> <li>• CPD records</li> <li>• Evidence of professional contributions by the registrar</li> <li>• Patient case study reports</li> </ul> | <ul style="list-style-type: none"> <li>projects carried out by the registrar (e.g. measurement of factors).</li> <li>• Written answers to             <ul style="list-style-type: none"> <li>○ assignments</li> <li>○ training day questions</li> <li>○ past exam questions</li> </ul> </li> <li>• Summaries of key protocols or physics principles</li> <li>• Moodle quiz results</li> <li>• Registrar trains other staff in routine tasks</li> </ul> | <ul style="list-style-type: none"> <li>survey).</li> <li>• Critical reviews of departmental procedures in comparison with published protocols.</li> <li>• Procedures developed or substantially revised by the registrar</li> <li>• Registrar trains other registrars or non-physics staff.</li> <li>• Registrar is rostered to work under minimal supervision.</li> </ul> |
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## SUGGESTED ASSESSMENT METHODS

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Each learning outcome must be assessed to see whether the registrar meets the assessment criteria. It is not enough for the registrar just to complete the training activities. The assessor must make a summative decision as to whether the registrar has met the assessment criteria and achieved the learning outcome.

In the CTG, the term “assessor” is used to indicate the person carrying out the assessment. In practice, the “assessor” may be the registrar’s clinical supervisor or another suitably qualified person as assigned by the clinical supervisor, such as a designated clinical trainer for a particular module, a TEAP coordinator/preceptor, an ACPSEM examiner or assessor, a qualified ROMP from another department or an expert from another discipline.

The CTG suggests methods for assessing each learning outcome for guidance, but the assessor may substitute alternative methods at their discretion. The critical requirement is that the assessor must determine whether the registrar meets the assessment criteria.

There are four key assessment methods used in the CTG:

- [Assessment by observation.](#)
- [Assessment of written evidence.](#)
- [Question and answer sessions](#) and
- [Recognition of prior learning \(RPL\).](#)

Assessors are encouraged to use a mix of these assessment methods.

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### ASSESSMENT BY OBSERVATION

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Assessment by observation is the ideal way to assess practical skills. The assessor observes the registrar carrying out a practical task, which may be either real work or a simulated task, such as a mock exam. Ideally the assessment by observation should be supplemented by some questions to test registrar comprehension.

Regular practice with performing practical tasks under observation and answering questions is essential to help registrars prepare for their final Part A Practical/Oral examination.

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### ASSESSMENT OF WRITTEN EVIDENCE

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Assessment of written evidence is valuable for assessing high level analysis skills, such as the ability to carry out complex calculations, to critically evaluate a process or to make recommendations. Assessors may consider all kinds of written evidence, such as those listed

in Table 1. Looking at written evidence such as reports and experimental notes is helpful for assessing work carried out outside the assessor's direct observation. Ideally assessment of written evidence should be supplemented by questions to test registrar comprehension.

When assessing written evidence, assessors should consider the [General Criteria for Communication](#).

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### ASSESSMENT BY QUESTION AND ANSWER

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Assessment by questioning the registrar is very useful for testing the registrar's comprehension of theory and how it applies in practice, and for identifying gaps in knowledge. It has the advantage of being much faster than other assessment methods. Questioning allows the assessor to explore a range of scenarios that may not be achievable in routine clinical practice, such as what to do when accidents occur or results are out of tolerance.

When assessing oral answers to questions, assessors should consider the [General Criteria for Communication](#).

Regular practice with answering questions verbally is essential to help registrars prepare for their final Part B Oral Examination.

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### RECOGNITION OF PRIOR LEARNING (RPL)

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When assessing competency, assessors can take a registrar's prior learning into account. The registrar may have evidence of competency gained prior to starting their clinical training in TEAP. Examples include:

- University coursework or research
- Participation in other medical physics training programs
- Prior work experience in radiation oncology medical physics
- Prior work experience in other disciplines

TEAP is a competency based learning program. It doesn't matter how or when the registrar achieved a particular learning outcome, provided that they have achieved it. This means that TEAP does not require registrars to repeat training that has been undertaken elsewhere. Assessors should recognize relevant prior learning when assessing competencies. However, the assessor must decide whether the prior learning is relevant to the learning outcome under consideration, and whether the work undertaken was sufficient for the registrar to meet the assessment criteria. The assessor should require the registrar to provide evidence of their prior learning, and should ask questions to test whether the registrar's knowledge is at the level expected for TEAP, and that the registrar has retained and understood the material previously learnt.

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### ASSESSMENT CRITERIA

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Assessment criteria are explicit statements that define what the registrar must demonstrate to achieve the learning outcome. They may describe knowledge that the registrar must obtain, or skills that they must acquire and demonstrate. **The assessment criteria are mandatory – every registrar should meet all the assessment criteria.** Whichever assessment method is used, the assessor should consider all the assessment criteria in deciding whether the registrar has achieved the learning outcome.



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## EXAMPLE OF V3 FORMAT FOR CTG

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An extract from Competency 2.3 *Perform radiation safety and protection procedures for radiation emitting devices according to legislated requirements* is shown in Table 2. This example is a Level 1 knowledge based learning outcome, which requires the registrar to demonstrate an understanding of basic physics principles. In this case, the knowledge required is an understanding of principles of survey meters.

Three RIOTs are suggested. The registrar and supervisor should review the list of RIOTs and decide which one(s) the registrar will undertake. If the registrar had gained adequate knowledge of the principles of survey meters from their MSc coursework, then they could provide evidence of this via their MSc course notes and/or assessment tasks for the assessor to consider. The assessor should recognize the registrar's prior learning (RPL), assessing the previous work to decide whether the work undertaken is adequate to meet the assessment criteria. The assessor may decide to ask the registrar some questions to test whether they have remembered and understood the material covered in the coursework.

TABLE 2: EXTRACT FROM COMPETENCY 2.3

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.3.1.1 Demonstrate an understanding of the principles of survey meters	<ul style="list-style-type: none"><li>• MSc coursework</li><li>• Read and summarize references</li><li>• Attend training day / tutorial</li></ul>	<ul style="list-style-type: none"><li>• MSc course notes</li><li>• Report</li></ul>	<ul style="list-style-type: none"><li>• RPL</li><li>• Q&amp;A session with assessor</li></ul>	<ul style="list-style-type: none"><li>• Explains principles of:<ul style="list-style-type: none"><li>○ Geiger counter</li><li>○ proportional counter</li><li>○ ion chamber survey meter</li><li>○ neutron meter</li><li>○ environmental survey dosimeters e.g. TLD, film</li></ul></li><li>• Identifies<ul style="list-style-type: none"><li>○ fault modes</li><li>○ limitations of each device for surveys of different equipment</li></ul></li><li>• Sketches and explains key features of signal vs. voltage graph for gas filled detector</li></ul>

If the coursework had not yet been undertaken, or there were some gaps in the material covered in the MSc, the registrar might undertake the additional RIOTs, such as attending a training day or reading and summarizing relevant references. The supervisor could request training evidence in the form of a brief report, and then carry out a final assessment by questioning the registrar to test their understanding.

Whichever assessment method was used, the assessor would need to ensure that the registrar's training covers all the points listed in the assessment criteria.

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## QUALITY MANAGEMENT

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Some competencies in V3 of the Clinical Training Guide contain the wording "Perform quality management of...." This wording reflects the expectation that by the end of their training, a registrar should have a broad understanding of quality management principles and be able to apply them to radiation oncology medical physics tasks. As outlined in the Australian/New

Zealand Standard *Quality management systems – Requirements* (2008), these key principles can be summarized as:

**Plan** – identify objectives and establish the processes required to deliver the required results

**Do** – implement the process

**Check** – monitor the process against the objectives and report the results

**Act** – take action to continually improve the process

It is expected that at Level 3, a TEAP registrar can not only perform routine quality assurance tasks, but they can:

- establish procedures to meet an identified medical physics or clinical quality objective, including developing documentation in an appropriate format
- implement quality assurance procedures, including training others
- monitor established quality assurance procedures to assess their effectiveness
- make recommendations for improvement

It is NOT expected that a registrar should take responsibility for a formal departmental quality management system, but they should be able to contribute to such a system as part of a multi-disciplinary team.

For further information on quality management principles and their application in radiation oncology, please consult the references listed below.

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### QUALITY MANAGEMENT REFERENCES

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Leer, H. McKenzie, A. Scalliet, P. Thwaites, D.I. (1998) *Practical Guidelines for the Implementation of a Quality System in Radiotherapy*. ESTRO. Accessed August 2012 <http://www.estro-education.org/publications/Pages/ESTROPhysicsBooklets.aspx>

Standards Australia Limited / Standards New Zealand (2008) *AS/NZS ISO 9001:2008 Quality management systems – Requirements*. SAI Global Limited, Sydney.

Standards Australia Limited / Standards New Zealand (2005) *AS/NZS ISO 9000:2005 Quality management systems — Fundamentals and vocabulary*. SAI Global Limited, Sydney.

Standards Australia Limited / Standards New Zealand (2009) *Managing for the sustained success of an organization — a quality management approach*. SAI Global Limited, Sydney.

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### DOCUMENTATION OF COMPETENCY ACHIEVEMENT

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Two options are available for documenting competency achievement:

- Recording progress in hard copy in the CTG.
- Recording progress electronically using the ACPSEM's e-learning software (preferred).

In either case, the requirements will be similar:

- Registrars are required to maintain records of training evidence and to provide them on request at their APR.



- The person carrying out the competency assessment must make notes explaining how the assessment was carried out and identifying the evidence used to make the assessment.

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## GENERAL ASSESSMENT CRITERIA

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Regardless of which competency or requirement is being assessed, it is expected that registrars demonstrate appropriate skills in communication, professionalism and practical work. In order to reduce the amount of repetition in the CTG, the assessment criteria which are common to all the core and ancillary modules have been listed separately as “General Assessment Criteria.” Registrars should refer to these during their training, and assessors should consider the General Assessment Criteria during assessment.

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### GENERAL ASSESSMENT CRITERIA FOR PROFESSIONALISM

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These general assessment criteria for professionalism outline the expectations at **Level 3**, where a registrar is expected to operate under minimal supervision and is ready for final assessment in this competency. The dot points should be used as assessment criteria by the assessor where relevant.

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#### PROFESSIONAL PARAMETERS: LEGAL AND ETHICS

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- Follows the [ACPSEM Code of Ethics](#)
- Maintains confidentiality, including patient privacy
- Understands scope of practice of a ROMP
- Maintains and encourages safe work practices including OHS and ALARA
- Demonstrates a risk management approach
- Practises and supports equal opportunity in the work place
- Works safely and under an appropriate level of supervision.
- Fulfils the regulatory and legal obligations required in the work.

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#### PROFESSIONAL BEHAVIOUR: KNOWLEDGE, SKILLS AND ATTITUDES, APPEARANCE AND INTERRELATIONSHIPS

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- Approaches work logically and carefully
- Prioritizes work and manages time effectively
- Displays a confident approach combined with the ability to recognize when assistance is required
- Possesses sufficient knowledge and skills to conduct the work
- Learns from experience and others.
- Accepts feedback positively and acts upon it.
- Able to identify and define a problem then formulate strategies to address the problem
- Evaluates outcomes and makes appropriate recommendations.
- Supports processes and decisions with evidence.
- Uses appropriate reference documents and guidelines to ensure best practice.
- Applies knowledge and skills to achieve best practice in the work.
- Understands lines of responsibility
- Understands the relationship between ROMPs and other professional groups
- Demonstrates quality management approach

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## PROFESSIONAL RESPONSIBILITY: RESPONSIBILITY TO SELF, PATIENTS, EMPLOYER AND PROFESSION

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- Participates in professional development activities to maintain competence
- Demonstrates a commitment to delivering the highest quality care
- Supports and encourages best practice by colleagues
- Takes appropriate responsibility for work undertaken.

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## REFERENCES FOR ASSESSING PROFESSIONALISM

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**Australasian Institute of Radiography (2007)** *Guidelines for professional conduct for Radiographers, Radiation Therapists and Sonographers* Australian Institute of Radiography. Accessed June 2012: [http://www.air.asn.au/cms\\_files/01\\_TheAir/07\\_Ethics/Professional\\_Conduct.pdf](http://www.air.asn.au/cms_files/01_TheAir/07_Ethics/Professional_Conduct.pdf)

**Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) (2009)** *Code of Ethics*. Accessed June 2012: [http://www.acpsem.org.au/images/stories/membership/ethics\\_code\\_2009.pdf](http://www.acpsem.org.au/images/stories/membership/ethics_code_2009.pdf)

**Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) (2009)** *Radiation Oncology Medical Physics Clinical Training Guide Version 2*. Accessed June 2012: <http://www.acpsem.org.au/index.php/radiation-concology-teap>

**Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) (2005)** *Accreditation in Radiotherapy Equipment and Quality Assurance Candidates Kit*. Accessed June 2012: [http://www.acpsem.org.au/index.php/rosigdocuments/cat\\_view/334-groups/187-specialty-groups/188-radiation-oncology/197-accreditation](http://www.acpsem.org.au/index.php/rosigdocuments/cat_view/334-groups/187-specialty-groups/188-radiation-oncology/197-accreditation)

**Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) (2012)** *Assessment of Registrars in Radiation Oncology Medical Physics*. Version 1.1. Accessed June 2012: <http://www.acpsem.org.au/index.php/radiation-concology-teap>

**Brehm, B. Breen, P. Brown, B. Long, L. Smith, R. Wall, A. Steinburg Warren, N. (2006)** *Instructional Design and Assessment: An interdisciplinary approach to introducing professionalism*. Am J Pharm Ed. 70 (4) Article 81.

**Institute of Physics and Engineering in Medicine (IPEM) (2010)**. *Training Prospectus for Medical Physicists and Clinical Engineers in Health Care*. Version 5. Accessed June 2012: <http://www.ipem.ac.uk/SiteCollectionDocuments/Training/Scientist/Prospectus%20v5.pdf>

**Serago, C.F. Adnani, N. Bank, M.I. BenComo, J.A. Duan, J., Fairbent, L., Freedman, D.J. Halvorsen, P.H. Hendee, W.R. Herman, M.G. Morse, R.K. Mower, H.W. Pfeiffer, D.E. Root, W.J. Sherouse, G.W. Vossler, M.K. Wallace, R.E. Walters, B. (2009)** *Code of Ethics for the American Association of Physicists in Medicine (AAPM): Report of Task Group 109*. Med. Phys. 36(1), 213-223.

**The Royal Australian and New Zealand College of Radiologists (RANZCR) (2008)** *Radiation Oncology Training Program: Curriculum*. Version 1. Accessed June 2012: <http://www.ranzcr.edu.au/training/radiation-oncology/current-training-program/curriculum>.

## GENERAL ASSESSMENT CRITERIA FOR PRACTICAL WORK

These general assessment criteria for practical work outline the expectations at **Level 2** competency, where a registrar should be able to work scientifically under general supervision. This is interpreted as meaning that they can competently carry out practical work according to established procedures without prompting. Similar criteria would apply at **Level 3**, but with the additional expectation that the registrar should be able to develop their own practical procedures appropriate for the purpose and should demonstrate the ability to interpret results and make appropriate clinical judgments.

These general assessment criteria are designed to assist in assessment of all Level 2 and Level 3 learning outcomes that require practical work. The assessor should consider each of the assessment criteria listed in the left column of Table 3. The check list in the right column gives specific suggestions about how the assessment criteria might be interpreted in practice. It is clearly impossible to cover all the possible practical scenarios in a generic list. The supervisor should come up with his/her own check list, deleting those that are not applicable, and adding others if necessary.

TABLE 3: CHECKLIST FOR ASSESSMENT OF PRACTICAL WORK

Assessment criterion	Check list (delete those that are not applicable)
Plans practical work	<ul style="list-style-type: none"> <li>• Explains purpose of work</li> <li>• Identifies and locates necessary equipment</li> <li>• Identifies and collates any necessary preparatory material (e.g. plans of department, previous commissioning results, reference values, protocols)</li> <li>• Prepares worksheets</li> <li>• Plans measurement sequence</li> <li>• Estimates time required</li> </ul>
Safety	<ul style="list-style-type: none"> <li>• Complies with departmental safety procedures, including OHS requirements</li> <li>• Ensures safety of self and others</li> <li>• Can identify and use safety features of equipment</li> <li>• Observes ALARA principle</li> <li>• Handles equipment with care</li> </ul>
Performs QA checks prior to carrying out experiment	<ul style="list-style-type: none"> <li>• Checks that calibration certificates are current</li> <li>• Confirms that routine QA results were within tolerance at last check</li> <li>• Checks critical parameters independently (e.g. confirm linac gantry angle independently if planning to check symmetry)</li> <li>• Identifies any assumptions made</li> </ul>
Equipment setup	<ul style="list-style-type: none"> <li>• Choice of phantom: <ul style="list-style-type: none"> <li>○ Complies with relevant protocol</li> <li>○ If no protocol, registrar can justify choice of phantom (considering issues such as tissue equivalence, ease of use, compatibility with detectors)</li> <li>○ Correction factors for non-tissue equivalence applied if necessary</li> </ul> </li> <li>• Choice of detector: <ul style="list-style-type: none"> <li>○ Complies with relevant protocol</li> <li>○ Registrar can justify choice of detector (considering issues such as spatial resolution, signal to noise ratio, energy dependence, water or air equivalence)</li> </ul> </li> <li>• Sets up equipment efficiently and considers all relevant setup parameters such as: <ul style="list-style-type: none"> <li>○ Levelling of water tank / phantom</li> <li>○ Modality /energy</li> <li>○ SSD / depth / distance</li> <li>○ Field size / applicator / cutouts</li> <li>○ Collimator / couch / gantry angles</li> <li>○ Beam modifying devices including wedges, blocks, MLCs, IMRT fields</li> </ul> </li> <li>• Correction for effective point of measurement</li> <li>• Image acquisition parameters</li> </ul>
Practical / experimental	<ul style="list-style-type: none"> <li>• Sets bias voltage, gain, range on electrometers</li> <li>• Corrects for leakage / background</li> </ul>

Assessment criterion	Check list (delete those that are not applicable)
technique	<ul style="list-style-type: none"> <li>• For water tank, selects appropriate scan speed / spacing</li> <li>• Takes adequate number of readings</li> <li>• Considers accuracy required &amp; signal to noise ratio in acquiring data</li> <li>• Critically observes experiment in progress and follows up unexpected results</li> </ul>
Analysis	<ul style="list-style-type: none"> <li>• Prepares data for analysis (e.g. smoothing, averaging &amp; normalization)</li> <li>• Corrects for influence quantities such as temp, press, humidity, polarity, recombination</li> <li>• Corrects from ionization to dose where required</li> <li>• Processes results as required for application (e.g. calculates beam quality, relative dose factors, absorbed dose, image noise)</li> <li>• Uses correct formulae and obtains numerically correct results</li> <li>• Uses appropriate number of significant figures</li> <li>• Estimates uncertainty</li> <li>• Compares results with expected values and calculates discrepancies</li> <li>• Knows tolerances</li> <li>• Identifies out of tolerance results and follows up according to departmental procedures</li> </ul>
Documentation (refer also to General Criteria for Communication)	<ul style="list-style-type: none"> <li>• Records raw data in permanent form</li> <li>• Data recording complies with departmental requirements (e.g. use of standard forms, practical log books, electronic data directories)</li> <li>• Details of practical setup and analysis are recorded in sufficient detail for a second person to reproduce the experiment</li> <li>• Handwritten documentation is legible</li> <li>• Results, analysis and conclusions are documented according to departmental requirements (e.g. on QA forms, internal reports, memoranda)</li> <li>• Meets incident and other formal reporting requirements</li> </ul>

## GENERAL ASSESSMENT CRITERIA FOR COMMUNICATION

These general communication assessment criteria are designed to assist in assessment of all TEAP Level learning outcomes that require communication. The assessor should consider each of the assessment criteria listed in the left column of Table 4. The check lists in the right columns give specific suggestions about how the assessment criteria might be interpreted for written, oral and interpersonal communication respectively. Further detail about assessment of interpersonal communication is included in Table 5. It is clearly impossible to cover all the possible scenarios in a generic list. The assessor should come up with his/her own check list, deleting those that are not applicable, and adding others if necessary.

TABLE 4: CHECKLIST FOR ASSESSMENT OF COMMUNICATION SKILLS

Assessment Criterion	Written	Oral	Interpersonal (see Table 5)
<b>Content</b>	<ul style="list-style-type: none"> <li>• Scientific</li> <li>• Appropriate structure, e.g. for a scientific report or communication: <ul style="list-style-type: none"> <li>○ Introduction</li> <li>○ Material/Methods</li> <li>○ Results</li> <li>○ Analysis</li> <li>○ Discussion</li> <li>○ Recommendations</li> <li>○ Conclusions.</li> </ul> </li> <li>• For an assignment a list of dot points may be sufficient.</li> <li>• Appropriate, clearly labelled, figures and diagrams</li> <li>• Appropriate referencing/ acknowledgement</li> <li>• Originality</li> <li>• Relevance</li> </ul>	<ul style="list-style-type: none"> <li>• Scientific</li> <li>• Appropriate structure, e.g. for a scientific report or communication: <ul style="list-style-type: none"> <li>○ Introduction</li> <li>○ Material/Methods</li> <li>○ Results</li> <li>○ Analysis</li> <li>○ Discussion</li> <li>○ Recommendations</li> <li>○ Conclusions</li> </ul> </li> <li>• For an assignment a simpler structure may be sufficient.</li> <li>• Appropriate, clearly labelled, figures and diagrams</li> <li>• Appropriate referencing / acknowledgement</li> <li>• Originality</li> <li>• Relevance</li> </ul>	<ul style="list-style-type: none"> <li>• Opens discussion</li> <li>• Gathers information</li> <li>• Understands</li> <li>• Shares Info</li> <li>• Reaches agreement</li> <li>• Closure</li> </ul>
<b>Style</b>	<ul style="list-style-type: none"> <li>• Scientific</li> <li>• Coherent / Cohesive</li> <li>• Concise</li> <li>• Appropriate format</li> <li>• Appropriate length</li> </ul>	<ul style="list-style-type: none"> <li>• Scientific</li> <li>• Coherent/Cohesive</li> <li>• Concise</li> <li>• Alternating tone (not monotonous)</li> <li>• Correct Pronunciation</li> <li>• Confident</li> <li>• Appropriate pace</li> <li>• Appropriate volume</li> <li>• Appropriate format</li> <li>• Appropriate length</li> </ul>	<ul style="list-style-type: none"> <li>• Scientific</li> <li>• Coherent / cohesive</li> <li>• Concise</li> <li>• Assertive</li> <li>• Empathetic / considerate</li> <li>• Confident</li> <li>• Appropriate volume</li> </ul>
<b>Language</b>	<ul style="list-style-type: none"> <li>• Paragraphing</li> <li>• Syntax, Grammar, Sentence fluency</li> <li>• Vocabulary</li> <li>• Spelling conventions</li> <li>• Punctuation conventions</li> <li>• Equation formatting and numbering</li> </ul>	<ul style="list-style-type: none"> <li>• Appropriate vocabulary for audience</li> </ul>	<ul style="list-style-type: none"> <li>• Appropriate vocabulary</li> </ul>
<b>Behaviour</b>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>• Open body language</li> <li>• Use of gestures</li> <li>• Eye contact</li> </ul>	<ul style="list-style-type: none"> <li>• Appropriate behavioural cues</li> <li>• Eye contact</li> </ul>

TABLE 5: ELEMENTS OF INTERPERSONAL COMMUNICATION

Essential Element	Tasks
<b>Establishes Rapport</b>	<ul style="list-style-type: none"> <li>• Encourages participation in discussion</li> <li>• Respects others' participation</li> </ul>
<b>Opens Discussion</b>	<ul style="list-style-type: none"> <li>• Allows other party to completely outline issue before speaking</li> </ul>
<b>Gathers Information</b>	<ul style="list-style-type: none"> <li>• Active non-verbal listening (body language, eye contact)</li> <li>• Active verbal listening (verbal indicators and encouragement)</li> <li>• Clarifies and summarises information to ensure full understanding</li> </ul>
<b>Understands other party's perspective</b>	<ul style="list-style-type: none"> <li>• Shows consideration for other party's role, responsibilities</li> <li>• Shows consideration of contextual issues such as workplace, age, gender, culture</li> <li>• Acknowledges feelings, ideas and values of other party</li> </ul>
<b>Shares information</b>	<ul style="list-style-type: none"> <li>• Uses appropriate level of language (jargon, acronyms etc.)</li> <li>• Checks for understanding (verbal &amp; non-verbal cues)</li> <li>• Encourages questions</li> </ul>
<b>Reaches agreement on problems and plans</b>	<ul style="list-style-type: none"> <li>• Negotiates with party for agreement</li> <li>• Identifies willingness to support and participate in plan</li> <li>• Identifies resources and support required</li> </ul>
<b>Provides closure</b>	<ul style="list-style-type: none"> <li>• Ensures all issues have been addressed</li> <li>• Summarises discussion</li> <li>• Clarifies action plan and follow-up</li> </ul>

Kalmazoo Consensus Statement essential elements modified for generalised healthcare professional communication *Adapted from Schirmer et al.*

## REFERENCES FOR ASSESSING COMMUNICATION

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**Calhoun, A.Q. Rider, EA. Meyer, EC. Lamiani, GL. Truog, RD. (2009)** *Assessment of communication skills and self-appraisal in the simulated environment: Feasibility of Multirater feedback with gap analysis*. *Simulation in Healthcare*. 4 (1) 22-29.

Australian Council for Education Research (ACER) (2011). *Tertiary Writing Assessment*. Accessed October 2011: <http://www.acer.edu.au/tests/twa/assessment-criteria>.

IELTSonTrack (2011) *How is IELTS Scored?* Accessed October 2011: [http://www.ieltsontack.com/content\\_desc.php?content=20](http://www.ieltsontack.com/content_desc.php?content=20).

**Schirmer, J.M. Mauksch, L. Lang, F. Marvel, M.K. Zoppi, K. Epstein, R.M. Brock, D. Pryzbylski, M. (2005)** *Assessing communication competence: a review of current tools*. *Fam Med*. 37 (3) 184-192.

## TRANSITION FROM VERSION 2 TO VERSION 3 OF THE CTG

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### IMPLEMENTATION PLAN

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Version 3 of the CTG incorporates revisions to all the modules in a new progressive assessment framework. It is planned to release revised modules progressively, with a new module being released every two months, from November 2012 to November 2013. Use of the new modules is optional for registrars currently enrolled in TEAP and mandatory for registrars enrolling after each module is released.

### USE OF NEW MODULES (V3) WITH EXISTING (V2) SYSTEM

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**Currently enrolled registrars:** Use of the new version 3 modules (v3) is optional for registrars currently enrolled in TEAP. However it is recommended that currently enrolled registrars who have not yet made significant progress should use the v3 modules. Registrars who opt to use v3 for a particular module must use only competencies in v3. It is not possible to use a mix of competencies from v2 and v3 for any module. However registrars may choose to use v2 for one module and v3 for another.

It is recommended that all registrars review v3 modules for guidance on assessment criteria, even if they opt to remain with v2 for the purposes of recording competency achievement.

**New registrars:** Registrars enrolling in TEAP after the release of new modules (v3) must use v3 and cannot use v2.

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### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 1

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The revised version of Module 1 (v3) was released on 18 October 2013.

Table 7 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 1.

TABLE 6: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 1

New v3 competency number	Existing v2 competency number(s)
1.1	1.2 & 1.3
1.2	1.1
1.3	1.3

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### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 2

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The revised version of Module 2 (v3) was released on 20 December 2012

Table 7 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 2.

TABLE 7: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 2

New v3 competency number	Existing v2 competency number(s)
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2.1	2.1 & 2.2
2.2	2.5
2.3	2.3
2.4	2.4
2.5	2.6
2.6	2.7

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#### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 3

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The revised version of Module 3 (v3) was released on 31 January 2013

Table 8 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 3. Competency 3.5 in v2 will be covered in Module 5 in v3.

TABLE 8: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 3

<b>New v3 competency number</b>	<b>Existing v2 competency number(s)</b>
3.1	3.1, 3.2, 3.7
3.2	3.4, 3.7
3.3	3.3
3.4	3.4
3.5	3.6

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#### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 4

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The revised version of Module 4 (v3) was released on 24<sup>th</sup> June 2013.

Table 9 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 4. The “external beam treatment techniques” component of Competency 4.7 in v2 will be covered in Module 5 in v3. Competency 4.2 from V2 (Prepare specifications and advice for new equipment in association with other professional and technical staff) is covered in Module 7 in V3.

TABLE 9: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 4

<b>New v3 competency number</b>	<b>Existing v2 competency number(s)</b>
4.1	4.1, 4.2, 4.3II, 4.4II, 4.5II, 4.6
4.2	4.1, 4.2, 4.7
4.3	4.1, 4.2, 4.7, 4.8
4.4	4.1, 4.2, 4.7, 4.8
4.5	4.1, 4.2, 4.3III, 4.4III, 4.5III
4.6	4.1, 4.2, 4.3I, 4.4I, 4.5I
4.7	Requirement 7.4

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#### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 5

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The revised version of Module 5 (v3) was released on 7<sup>th</sup> August 2013.

Table 10 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 5. Competency 5.1 of v2 (Participate in the process of and provide



scientific advice for the procurement of a suitable radiotherapy treatment planning system) is covered in Module 7 in v3.

TABLE 10: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 5

New v3 competency number	Existing v2 competency number(s)
5.1	5.2, 5.3, 5.4
5.2	5.5
5.3	4.7, 5.6
5.4	4.7, 5.7
5.5	3.5, 5.8

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#### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 6

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The revised version of Module 6 (v3) was released on 4 October 2013.

Table 10 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 6. Competency 6.1 of v2 (Participate in the process of procurement including provision of scientific advice, for a brachytherapy treatment unit with ancillary equipment and associated brachytherapy planning system) is partially covered in Module 7 of CTG v3.

TABLE 11: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 6

New v3 competency number	Existing v2 competency number(s)
6.1	6.2, 6.3, 6.4
6.2	6.5
6.3	6.2, 6.3, 6.4
6.4	6.6
6.5	6.4, 6.7, 6.8
6.6	6.2, 6.3, 6.4, 6.7, 6.8
6.7	Level 3 aspects of all Module 6 competencies

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#### RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 7

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The revised version of Module 7 (v3) was released on 18 October 2013.

Table 12 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 7. The v3 Module 7 combines aspects of v2 Modules 7 and 8. Competency 7.2 of v2 (Oral and written communication skills) is assessed in v3 as part of each module using the General Assessment Criteria for Communication. Competency 7.4 of v2 (Information Technology Basics) is assessed where relevant in the core modules. Competency 8.1 of v2 (Conduct research and development in Radiation Oncology Physics) is assessed through the postgraduate research, publication and presentation requirements of TEAP.

TABLE 12: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 7

New v3 competency number	Existing v2 competency number(s)
7.1	7.1

7.2	7.3
7.3	4.2, 5.1, 6.2
7.4	8.2
General Assessment Criteria for Communication in all modules	7.2
Part of core modules	7.4

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## RELATIONSHIP BETWEEN EXISTING AND NEW COMPETENCIES FOR MODULE 8

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The revised version of Module 8 (v3) was released on 11 December 2013.

Table 13 summarises the relationship between the competencies for the existing (v2) and new (v3) versions of module 8. The v3 Module 8 combines v2 Modules 9 and 10. Competency 10.6 of v2 (Research review) is assessed through the postgraduate research, publication and presentation requirements of TEAP.

TABLE 13: RELATIONSHIP BETWEEN V2 AND V3 COMPETENCIES IN MODULE 8

<b>New v3 competency number</b>	<b>Existing v2 competency number(s)</b>
8.1	9.1, 9.3, 10.4
8.2	9.1, 9.2, 9.3, 9.4, 9.5
8.3	9.1, 9.2, 9.3, 9.4, 9.5
8.4	10.1, 10.2, 10.3, 10.4, 10.5
8.5	9.1, 9.2, 9.3, 9.4, 9.5
8.6	9.1, 9.2, 9.3, 9.4, 9.5
8.7	10.1, 10.2, 10.3, 10.4, 10.5

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## CTG PROGRESSION MONITOR TOOL (POINTS WORKBOOK)

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The CTG progression monitor tool (points workbook) has been updated to include the new v3 competencies. The 'Your Points' worksheet has a new table for entry of CTG v3 competencies to the left of the old table for entry of CTG v2 competencies.

As each module is released, current registrars will need to decide whether to use v2 or v3 for that module. If they decide to continue with v2, they should copy points from their existing points workbook into the table for CTG v2 module competencies on the right hand side of the new workbook. If they decide to use v3, they should enter points in the left hand column of the new workbook.

The worksheet will total a mix of v2 and v3 modules but not a mix v2 and v3 competencies within a module. Only the larger of the v2 or v3 sub-total points for a module count towards the total number of points accrued.

Ancillary requirements for v2 are also recorded in the sheet, in the area below the competency tables.

## MODULE 1: CLINICAL INTRODUCTION

### COMPETENCY 1.1: UNDERSTAND BASICS OF CANCER AND ONCOLOGY TREATMENTS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	1.1.1.1 Understand the basics of cancer and its diagnosis	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise references, for example <a href="http://www.eviq.org.au/">http://www.eviq.org.au/</a></li> <li>• Patient case studies</li> <li>• Problem Based Learning scenarios – small group discussion</li> <li>• Attend ward rounds, new patient clinics and multidisciplinary clinics</li> <li>• Read and summarise references, including UICC TNM Atlas</li> <li>• Review clinical imaging for cancer diagnosis and staging</li> <li>• Attend Basic Sciences of Oncology course</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Short report</li> <li>• Case study reports</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the biological basis of cancer, including an understanding of the nature and effects of a tumour on an organ and its function.</li> <li>• Describes the effects and symptoms of cancer for common cancer sites, such as, breast, prostate, lung, head and neck, CNS, gastrointestinal, skin, blood, gynaecological</li> <li>• Demonstrates competence through focusing on one clinical site and               <ul style="list-style-type: none"> <li>○ Identifies the main routes of spread of disease</li> <li>○ Explains basic terms used in oncology, such as grade, stage, type (e.g., carcinoma, sarcoma, lymphoma), primary, secondary, metastatic</li> <li>○ Explains the process and tools used for cancer diagnosis, grading and staging, such as patient history, clinical examination, imaging, pathology</li> </ul> </li> </ul>
	1.1.1.2 Understand the decision making process for cancer management	<ul style="list-style-type: none"> <li>• Read and summarise references, for example, <a href="http://www.eviq.org.au/">http://www.eviq.org.au/</a></li> <li>• Patient case studies</li> <li>• Problem Based Learning scenarios – small group discussion</li> <li>• Attend ward rounds and multidisciplinary clinics</li> <li>• Attend Basic Sciences of Oncology course</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Short report</li> <li>• Case study reports</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Discusses the utility, pros and cons of the major methods in the management of cancer, such as:               <ul style="list-style-type: none"> <li>○ surgery</li> <li>○ chemotherapy</li> <li>○ radiotherapy</li> </ul> </li> <li>• Defines terms commonly used to describe management intent, including palliative, radical, curative, prophylactic, adjuvant and neo-adjuvant.</li> <li>• Discusses cost of treatment in regards to decision making for cancer management</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	1.1.1.3 Understand the aims and effects of radiotherapy in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise references, for example, Handbook of Evidence Based Radiation Oncology, <a href="http://www.eviq.org.au/">http://www.eviq.org.au/</a></li> <li>• Read planning protocols</li> <li>• Patient case studies</li> <li>• Attend planning audit meetings</li> <li>• Problem Based Learning scenarios – small group discussion</li> <li>• Trials protocols (e.g. RTOG)</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Short report</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the radiobiological basis for radiotherapy, for example, using a sketch of a typical TCP, NTCP graph</li> <li>• Explains aims of radical and palliative radiotherapy treatment, including <ul style="list-style-type: none"> <li>○ Adequate dose to target</li> <li>○ Sparing OARs</li> <li>○ Maximising therapeutic gain</li> <li>○ Required accuracy.</li> </ul> </li> <li>• Explains the anatomical and physiological changes to the cancer and healthy tissue due to radiotherapy treatment.</li> <li>• Describes common early and late side effects of radiotherapy</li> <li>• Discusses factors to be considered when choosing external beam, brachytherapy and combined therapies, including <ul style="list-style-type: none"> <li>○ Radiation Type</li> <li>○ Radiobiology</li> <li>○ Timing of each</li> <li>○ Adequate dose to target whilst sparing OARs</li> <li>○ Dose localisation</li> <li>○ Patient comfort</li> <li>○ Resource requirements (including costs)</li> <li>○ radiation safety and protection</li> </ul> </li> </ul>
	1.1.1.4 Understand the patient journey in radiation oncology	<ul style="list-style-type: none"> <li>• Compile a short report reflecting on attendance at a <b>representative sample</b> of patient-related clinical experiences, such as: <ul style="list-style-type: none"> <li>○ New patient/review/follow up clinics</li> <li>○ Imaging (CT, MRI, x-ray, ultrasound, nuclear medicine)</li> <li>○ Treatment planning and mould room</li> <li>○ Radiation treatment</li> <li>○ Operating theatre</li> <li>○ Ward rounds</li> <li>○ Nursing</li> <li>○ Dietician, social worker, physiotherapist and/or other allied health professionals</li> <li>○ Attendance at chemotherapy</li> </ul> </li> <li>• Patient case studies</li> <li>• Read literature supplied for patients</li> <li>• Attend patient support and education sessions</li> <li>• Observe the impact of machine breakdown on staff and patients</li> </ul>	<ul style="list-style-type: none"> <li>• Short reflective report</li> </ul>	<ul style="list-style-type: none"> <li>• Review of evidence</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the key components and timeframes of the patient journey in radiation oncology</li> <li>• Describes the purpose, procedures and outcomes of a representative sample of patient-related clinical experiences.</li> <li>• Explains the effects of treatment on quality of life.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	1.1.2.1 Compare the decision making process for cancer management	<ul style="list-style-type: none"> <li>As for 1.1.1.2</li> </ul>	<ul style="list-style-type: none"> <li>As for 1.1.1.2</li> </ul>	<ul style="list-style-type: none"> <li>As for 1.1.1.2</li> </ul>	<ul style="list-style-type: none"> <li>Discusses the utility, pros and cons of the major methods (surgery, chemotherapy, radiation therapy) in the management of cancer, and other therapy approaches such as:               <ul style="list-style-type: none"> <li>hormonal therapy</li> <li>immunotherapy</li> <li>watchful waiting</li> <li>palliative care</li> <li>combined therapies</li> <li>targeted therapies</li> </ul> </li> </ul>

## COMPETENCY 1.2 APPLY RADIOBIOLOGICAL PRINCIPLES TO PATIENT TREATMENT

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	1.2.1.1 Understand the basics of clinical radiobiology	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarise relevant chapters from references, such as <i>Basic Clinical Radiobiology 4th Ed, 2009</i>  <a href="http://www.estro.org/school/articles/publications/basic-clinical-radiobiology">http://www.estro.org/school/articles/publications/basic-clinical-radiobiology</a>  or <i>Biomedical Physics in Radiotherapy for Cancer, Marcu et al. 2012</i>,</li> <li>Attend ESTRO or other radiobiology course</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes the role of radiobiology, in terms of conceptual basis, treatment strategies and protocols</li> <li>Describes the time-scale effects in radiobiology, including physical, chemical and biological phases.</li> <li>Describes the response of normal and malignant tissues to radiation</li> <li>Sketches and describes curves of <ul style="list-style-type: none"> <li>radiation damage to tissue as a function of time after irradiation</li> <li>typical dose response curves for tumours and normal tissues</li> <li>isoeffect plots for fixed levels of normal tissue damage and tumour response</li> </ul> </li> <li>Describes the concept of therapeutic index.</li> <li>Explains effects of radiation on cells and DNA, activation of programmed cell death process and DNA repair pathways</li> <li>Understands the rationale for combination therapies, e.g., chemotherapy and radiotherapy</li> <li>Demonstrates an appreciation of radiobiological differences between ablative and conventional treatments</li> </ul>
	1.2.1.2 Demonstrate awareness of modelling in clinical radiobiology	<ul style="list-style-type: none"> <li>As for 1.2.1.1</li> <li>Review QUANTEC.</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the basics of the linear-quadratic model and related concepts such as alpha-beta ratios, BED, EUD</li> <li>Describes rationale behind treatment options with respect to LET and RBE, such as the use of protons, neutrons and heavy ions</li> <li>Explains basis of fractionation in terms of radiosensitivity, repair, repopulation, redistribution and reoxygenation.</li> <li>Explains effect of hypoxia on radiotherapy treatment</li> <li>Explains impact of fractionation on tumour and normal tissue response, for example by sketching typical cell survival curves for early and late responding tissues, for both single dose and fractionated treatments</li> </ul>
	1.2.1.3 Understand the tools used to obtain radiobiological information	<ul style="list-style-type: none"> <li>As for 1.2.1.1</li> <li>Review of selected clinical trials protocols (e.g. CHART, START, CHISEL)</li> <li>Review tools such as laboratory and imaging (Examples including awareness of clonogenic assays, functional imaging - PET tracers, genetic testing)</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Understands importance of radiosensitivities for customisation of treatments</li> <li>Demonstrates basic appreciation of molecular oncology</li> </ul>

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	1.2.1.4 Understand the need to apply radiation protection principles to patients	<ul style="list-style-type: none"> <li>As for 1.2.1.1</li> <li>Review of literature on second primary cancers due to treatment and imaging</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explain the impact of out of field doses on stochastic effects in patients (e.g. secondary primary cancers, cardiac toxicity)</li> <li>Demonstrate understanding of time cause of 'low dose' effects in patients</li> </ul>
Level 2	1.2.2.1 Apply radiobiological principles to patient care	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Perform calculations to account for gaps between fractions</li> <li>Perform calculations to convert dose between brachytherapy LDR/HDR and external beam radiation therapy</li> <li>Perform retreatment calculation examples</li> <li>Participate in treatment planning using biological indices for optimization</li> <li>Patient case studies</li> <li>Read and summarise references</li> <li>Investigate the radiobiological rationale for a patient's treatment regime, including:               <ul style="list-style-type: none"> <li>Choice of fractionation scheme</li> <li>Awareness of other fractionation schemes used in clinical practice and why, with reference to <math>\alpha/\beta</math> ratio</li> <li>Organs at risk and dose constraints (including beam arrangement, organ volume and/or DVHs)</li> <li>Radiobiological rationale for dose constraints</li> <li>Radiobiological rationale for combined modality treatment</li> <li>Identify key references</li> <li>What evidence it is based on, e.g. empirical, clinical trials, in vitro studies</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report</li> <li>Radiobiological calculations</li> <li>Clinical case study report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> <li>Clinical case study assignment</li> </ul>	<ul style="list-style-type: none"> <li>Performs correct radiobiological calculations for:               <ul style="list-style-type: none"> <li>Changing the dose per fraction (including boosts)</li> <li>Changing the overall treatment time</li> <li>Accounting for gaps in fractionated treatments</li> <li>Combination brachytherapy LDR/HDR and EBRT treatments</li> <li>Errors in dose delivery</li> <li>Re-treatments</li> <li>Uncertainties in biological effect estimates</li> <li>Individual differences or variations from patient to patient in biological effects</li> </ul> </li> <li>Understands limitations of using radiobiological calculations in the clinic</li> <li>Demonstrates an understanding of biological treatment planning, parameters for different tumour types and the potential for individualized treatments</li> <li>Interprets decision making in RT based on radiobiology principles (e.g. priority of different patients on a waiting list, rationale for an individual patient's treatment regime, strategies to deal with gaps in patient treatment).</li> <li>Understands the impact of organ architecture on dose prescription and constraints</li> </ul>

## COMPETENCY 1.3: DEMONSTRATES PROFESSIONAL BEHAVIOUR IN A CLINICAL ENVIRONMENT

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	1.3.1.1 Demonstrate professional behaviour in a clinical environment	<ul style="list-style-type: none"> <li>Attend hospital education sessions on infection control, confidentiality and patient interactions</li> <li>Review patient and staff support</li> <li>Attend clinics and learn appropriate interactions with patients and other health professionals</li> <li>Summarise the roles and responsibilities of the members of the multidisciplinary team in a clinical department, e.g. ARPANSA RPS 14.3</li> </ul>	<ul style="list-style-type: none"> <li>Attendance records at mandatory training for hospital/department</li> <li>Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>Assessment by observation</li> <li>Review of evidence</li> </ul>	<ul style="list-style-type: none"> <li>Demonstrates patient care and rapport</li> <li>Explains legal requirements for patient privacy and confidentiality.</li> <li>Demonstrates correct hygiene/infection control procedures.</li> <li>Responds appropriately to reactions of patients and their carers.</li> <li>Defines the roles and responsibilities of the members of the multidisciplinary team within their department.</li> <li>Meets general criteria for interpersonal communication</li> <li>Meets general criteria for professionalism</li> </ul>



## MODULE 2: RADIATION SAFETY AND PROTECTION

### COMPETENCY 2.1 APPLY THE PRINCIPAL REQUIREMENTS OF RADIATION PROTECTION MANAGEMENT

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.1.1.1 Interpret local regulations and how they relate to national and international recommendations	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarize international, national (and state if relevant) protocols &amp; legislation.</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Informal oral presentation to assessor</li> </ul>	<ul style="list-style-type: none"> <li>Lists international documents</li> <li>Lists national documents and legislation</li> <li>Lists state legislation (if applicable)</li> <li>Describes linkages between local/national and international documents</li> <li>Describes key recommendations and concepts for each document</li> </ul>
	2.1.1.2 Outline the key concepts of international reference documents for radiation protection	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarize references</li> <li>Attend training day / tutorial</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Informal oral presentation to assessor</li> </ul>	<ul style="list-style-type: none"> <li>Key concepts should include: <ul style="list-style-type: none"> <li>Risk/benefit analysis</li> <li>Justification</li> <li>Optimization (ALARA)</li> <li>Limits</li> <li>Authorization</li> <li>Sources / controls</li> <li>Protection in relation to medical, occupational, public and environmental exposure to ionizing radiation</li> </ul> </li> </ul>
	2.1.1.3 Identify how national (and state) legislation is implemented in department through local radiation management procedures	<ul style="list-style-type: none"> <li>Compile an index of radiation protection documents in the department, noting their purpose and location.</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes</li> <li>List of documents</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with assessor on local radiation safety management</li> </ul>	<ul style="list-style-type: none"> <li>Identifies correspondence between local management procedures and <ul style="list-style-type: none"> <li>the legislative requirements listed in the first learning outcome</li> <li>the key concepts listed in second learning outcome.</li> </ul> </li> </ul>
	2.1.1.4 Understand the role of the radiation safety committee	<ul style="list-style-type: none"> <li>Participate in local Radiation Safety committee meetings.</li> <li>Read the Radiation Safety Committee meeting minutes.</li> <li>Assist the RSO with his/her duties for a period of time.</li> </ul>	<ul style="list-style-type: none"> <li>Written logbook</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Outlines the role and authority of the Radiation Safety Committee.</li> <li>Explains reporting lines of the Radiation Safety Committee.</li> <li>Outlines the role of the Radiation Safety Officer.</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	2.1.2.1 Compare and contrast the various licenses / registrations / approvals in the department for staff and equipment (as applicable)	<ul style="list-style-type: none"> <li>Compare the RO, RT and physicist licenses.</li> <li>Compare licenses for the range of treatment devices in the department (if such licenses exist).</li> </ul>	<ul style="list-style-type: none"> <li>Written logbook</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>For different professional groups (including ROMPs, RTs &amp; ROs): <ul style="list-style-type: none"> <li>Explains eligibility requirements to be licensed</li> <li>Explains license conditions</li> <li>Identifies what activities are permitted under each license.</li> <li>Explains licensing requirements for supervised/unsupervised practice</li> </ul> </li> <li>Explains licensing/registration/approval conditions (if any) for different types of equipment, including therapeutic, imaging and research equipment</li> <li>Identifies radiation emitting equipment that is exempt from licensing requirements.</li> <li>Identifies requirements for notification of purchase/disposal of equipment</li> </ul>
	2.1.2.2 Audit a department's compliance with regulatory requirements	<ul style="list-style-type: none"> <li>Locate an audit procedure from within the department (or from another department). Perform an audit using that procedure. Make recommendations to the department on how to improve compliance with legislation, to cover identified risks or reflect recently published data.</li> <li>Review an audit report from a regulator.</li> <li>Analyse instructions on radiation protection provided to staff and patients.</li> </ul>	<ul style="list-style-type: none"> <li>Audit report</li> <li>Summary of recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of audit report plus Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>Departmental compliance audit shows: <ul style="list-style-type: none"> <li>All previous outcomes of audits addressed</li> <li>All audit criteria addressed</li> <li>Non-compliance identified (if any)</li> <li>Non-compliance is reported and followed up according to departmental protocols</li> </ul> </li> <li>Meets general criteria for communication</li> </ul>
Level 3	2.1.3.1 Apply the principal requirements of radiation protection management	<ul style="list-style-type: none"> <li>Complete Competencies 2.2 -2.6 to Level 3.</li> <li>Manage the local implementation of new legislation or recommendations.</li> <li>Explore mock scenarios and problem based learning exercises.</li> </ul>	<ul style="list-style-type: none"> <li>CTG showing Competencies 2.2-2.6 signed off.</li> <li>Documentation of local implementation.</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with trainer.</li> <li>Oral presentation</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication.</li> <li>Meets general criteria for professionalism.</li> <li>On completion of 2.2-2.6, discusses linkages and hierarchy of local/national and international documents and how they relate to the local management system.</li> <li>Competent judgment in mock scenarios.</li> <li>Discusses risks described in local management plans.</li> <li>Discusses how to convey risk assessments to relevant patient/personnel/public.</li> </ul>

## COMPETENCY 2.2 DETERMINE ROOM SHIELDING SPECIFICATIONS AND PROTECTION MEASURES FOR RADIATION ONCOLOGY EQUIPMENT

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.2.1.1 Outline the key concepts for shielding construction and identify reference documents	<ul style="list-style-type: none"> <li>• MSc</li> <li>• Read and summarize shielding construction references</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary notes</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Oral presentation, followed by Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• From relevant reports (i.e. NCRP 151, IAEA TECDOC 40, IAEA Safety report 47, IPEM Report 75), define: <ul style="list-style-type: none"> <li>○ IDR</li> <li>○ TADR</li> <li>○ Use</li> <li>○ Occupancy</li> <li>○ Workload</li> <li>○ Dose limits and design constraints</li> <li>○ TVL</li> </ul> </li> </ul>
	2.2.1.2 Identify the principles and features of shielding construction and protection measures for different equipment.	<ul style="list-style-type: none"> <li>• MSc</li> <li>• Review shielding construction plans for a range of rooms, including rooms that house: <ul style="list-style-type: none"> <li>○ a HDR afterloader</li> <li>○ linac (low and high energy)</li> <li>○ kV unit</li> <li>○ CT scanner.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A with assessor.</li> <li>• Past examination questions</li> </ul>	<ul style="list-style-type: none"> <li>• Principles include: <ul style="list-style-type: none"> <li>○ Primary and secondary barriers</li> <li>○ Doors/gates</li> <li>○ Interlocks</li> <li>○ Alarms/lights/signs</li> <li>○ Limits</li> <li>○ Time, distance, shielding</li> <li>○ Material selection</li> <li>○ Typical wall thickness/construction</li> <li>○ Maze calculations and baffle design</li> <li>○ Skyshine/Groundshine</li> <li>○ Neutrons</li> <li>○ Activation</li> </ul> </li> </ul>
Level 2	2.2.2.1 Differentiate shielding requirements for different equipment	<ul style="list-style-type: none"> <li>• Compare and contrast shielding requirements for: linac, HDR unit, kV unit, CT scanner.</li> </ul>	<ul style="list-style-type: none"> <li>• Comparison table</li> </ul>	<ul style="list-style-type: none"> <li>• Table reviewed by assessor plus Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>• For linac, CT, HDR &amp; kV unit, registrar identifies: <ul style="list-style-type: none"> <li>○ Isotropic vs. directed source and its implications for barrier thickness (primary, secondary)</li> <li>○ Energy and its impact on penetration, scatter, single vs. dual energy</li> <li>○ Use factors</li> <li>○ Workload</li> <li>○ Technical specifications – upper limit of leakage</li> <li>○ Neutrons or not?</li> </ul> </li> <li>• Implications of special techniques such as IMRT, VMAT, TBI on workload and use factors.</li> <li>• Explains two source rule (NCRP 151)</li> </ul>
	2.2.2.2 Calculate barrier thickness and dose levels	<ul style="list-style-type: none"> <li>• Detailed calculations for high energy linac (&gt;10MV) and CT and at least one other type of equipment (e.g. kV, HDR brachy, tomotherapy).</li> </ul>	<ul style="list-style-type: none"> <li>• Shielding calculations</li> </ul>	<ul style="list-style-type: none"> <li>• Calculations reviewed by assessor plus Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies common elements of shielding calculations for all equipment.</li> <li>• Correct calculation</li> <li>• Makes appropriate assumptions</li> <li>• Identifies areas of concern</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	2.2.2.3 Understand potential sources of weakness in shielding construction specifications	<ul style="list-style-type: none"> <li>Review literature and local experiences of case studies of shielding defects.</li> <li>Perform a risk assessment of shielding construction specifications.</li> </ul>	<ul style="list-style-type: none"> <li>Log book</li> <li>Reflective journal</li> <li>Risk assessment</li> </ul>	<ul style="list-style-type: none"> <li>Oral presentation or Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Communicates with colleagues and utilizes resources</li> <li>Nominates multiple examples of shielding design pitfalls related to linac, kV, brachy and CT shielding design and explains how these are avoided or overcome.</li> <li>Considers: <ul style="list-style-type: none"> <li>Incorrect assumptions e.g. Workload</li> <li>Communication breakdown with builder on shielding construction specifications e.g. Density of concrete</li> <li>Other Construction faults e.g. hollow walls, window</li> <li>Change in machine position</li> <li>Design faults (e.g. not calculating max divergence of primary)</li> <li>Hospital renovations changing occupancy</li> <li>Change in energy</li> <li>Window flashing missing</li> <li>Utilities access – cables, power points, etc.</li> <li>Primary beam limitations due to windows in orthovoltage</li> <li>Skyshine</li> </ul> </li> </ul>
Level 3	2.2.3.1 Determination of room shielding specifications and protection measures for radiation oncology equipment.	<ul style="list-style-type: none"> <li>Provide shielding details for linac bunker, HDR unit, CT scanner etc.</li> <li>Analyse an existing therapy room for a proposed change to equipment type or usage.</li> <li>Mock scenarios based on calculations, e.g. change in workload or IMRT</li> </ul>	<ul style="list-style-type: none"> <li>Completed one shielding report including mock scenarios.</li> </ul>	<ul style="list-style-type: none"> <li>Report reviewed by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for professionalism</li> <li>Meets general criteria for communication</li> <li>Evidence of design which: <ul style="list-style-type: none"> <li>Meets dose constraints</li> <li>Meets equipment constraints</li> <li>Correct identification of any errors</li> <li>Efficient use of space and construction materials</li> <li>Assumptions used in calculation clearly documented</li> <li>Considers design principles from Level 1 learning outcome</li> <li>Addresses potential sources of weakness from Level 2 learning outcomes</li> <li>Other stakeholder requirements</li> <li>Use of appropriate references such as the NCRP 147 and RPI of Ireland “The design of diagnostic medical facilities where ionizing radiation is used”</li> </ul> </li> </ul>

## COMPETENCY 2.3 PERFORM RADIATION SAFETY AND PROTECTION PROCEDURES FOR RADIATION EMITTING DEVICES ACCORDING TO LEGISLATED REQUIREMENTS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.3.1.1 Demonstrate an understanding of the principles of survey meters	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarize references</li> <li>Attend training day / tutorial</li> </ul>	<ul style="list-style-type: none"> <li>MSc course notes</li> <li>Report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains principles of: <ul style="list-style-type: none"> <li>Geiger counter</li> <li>proportional counter</li> <li>ion chamber survey meter</li> <li>neutron meter</li> <li>environmental survey dosimeters e.g. TLD, film</li> </ul> </li> <li>Identifies <ul style="list-style-type: none"> <li>fault modes</li> <li>limitations of each device for surveys of different equipment</li> </ul> </li> <li>Sketches and explains key features of signal vs. voltage graph for gas filled detector</li> </ul>
	2.3.1.2 Identify radiation detectors in the department	<ul style="list-style-type: none"> <li>Report on the available radiation detection devices in the department and the appropriate use of the devices</li> </ul>	<ul style="list-style-type: none"> <li>List of detectors</li> </ul>	<ul style="list-style-type: none"> <li>Review of list by assessor</li> </ul>	<ul style="list-style-type: none"> <li>List includes: <ul style="list-style-type: none"> <li>detector name &amp; model</li> <li>location of detector</li> <li>location of manuals/calibration certificates</li> <li>serial number</li> <li>type of detector (e.g. Geiger counter, ion chamber, neutron meter)</li> <li>uses (e.g. shielding survey, detection of radioactivity)</li> </ul> </li> </ul>
	2.3.1.3 Demonstrate an understanding of the calibration of survey meters	<ul style="list-style-type: none"> <li>Audit departmental meters for current calibration certificate</li> <li>Arrange for calibration of survey meter or review procedure for doing this</li> <li>Attend training day/tutorial</li> </ul>	<ul style="list-style-type: none"> <li>Audit results.</li> <li>Summary of calibration procedure.</li> <li>Training attendance records</li> </ul>	<ul style="list-style-type: none"> <li>Report</li> </ul>	<ul style="list-style-type: none"> <li>Report includes <ul style="list-style-type: none"> <li>Calibration methodology</li> <li>Calibration frequency</li> <li>Uncertainty analysis</li> <li>Range of validity of the calibration</li> </ul> </li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	2.3.2.1 Operate radiation detectors	<ul style="list-style-type: none"> <li>Read operation/user manuals</li> <li>Assist with radiation surveys (linac, source storage areas, HDR unit etc.)</li> <li>Search for brachy seeds (anything that uses meter)</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes</li> </ul>	<ul style="list-style-type: none"> <li>Practical demonstration to assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Selects appropriate meter</li> <li>Selects appropriate range/scale</li> <li>Notes units of calibration and conversions required</li> <li>Monitors and corrects for background</li> <li>Confirms calibration of meter and its QC history</li> <li>Applies correction factors if needed (e.g. energy or directional dependence)</li> <li>Orients meter correctly</li> <li>Allows time for reading to stabilize (taking into account time constant)</li> <li>Identifies limitations of detector</li> </ul>
	2.3.2.2 Identify and test protection measures for radiotherapy equipment	<ul style="list-style-type: none"> <li>Complete checklist for different types of equipment (e.g. linac, CT, kV unit – HDR covered in 2.4)</li> <li>Test functionality of protection measures</li> </ul>	<ul style="list-style-type: none"> <li>Checklist of conformance with requirements</li> </ul>	<ul style="list-style-type: none"> <li>Review of list and conformance by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Identifies conformance of interlocks with previously specified requirements (national or state regulations and/or manufacturer specifications).</li> <li>List should include and have functionality tests of <ul style="list-style-type: none"> <li>Audible and visual alerts to emitting radiation</li> <li>Door interlocks</li> <li>Emergency stops</li> </ul> </li> </ul>
	2.3.2.3 Perform radiation surveys using appropriate equipment under general supervision	<ul style="list-style-type: none"> <li>Survey of: <ul style="list-style-type: none"> <li>linac bunker</li> <li>CT scanner room</li> <li>kV unit room</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Logbook notes</li> <li>Survey report</li> </ul>	<ul style="list-style-type: none"> <li>Assessment by observation</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Selects appropriate meter</li> <li>Systematic survey of controlled and uncontrolled areas</li> <li>Sets up radiation emitting device to maximize reading for both primary and secondary barriers</li> <li>Identifies areas of likely higher readings</li> <li>Relates results to regulatory requirements and design limits</li> <li>Carries out the above steps without prompting or instruction, but seeks advice from a senior when required by departmental policy.</li> <li>Considers own and others' safety in preliminary survey</li> <li>Refers to relevant references (e.g. NCRP 151)</li> </ul>
Level 3	2.3.3.1 Perform radiation safety and protection procedures for radiation emitting devices according to legislated requirements	<ul style="list-style-type: none"> <li>Assess radiation emitting equipment compliance with legislation. Audit : <ul style="list-style-type: none"> <li>high energy treatment unit and CT</li> <li>And either kV unit or HDR</li> </ul> </li> <li>Perform radiation surveys using appropriate equipment under examination conditions</li> </ul>	<ul style="list-style-type: none"> <li>Audit report</li> <li>Examiner's report</li> </ul>	<ul style="list-style-type: none"> <li>Review of report by assessor</li> <li>Practical mock exam</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>References relevant legislation for jurisdiction</li> <li>Identifies all safety requirements and discusses significance of non-compliance</li> <li>Makes recommendations</li> <li>Identifies and addresses limitations of detector</li> <li>Interprets detector results</li> <li>Makes recommendations for long term assessment of areas e.g. environmental survey dosimeters</li> </ul>

## COMPETENCY 2.4 PERFORM RADIATION SAFETY AND PROTECTION PROCEDURES FOR RADIOACTIVE MATERIAL ACCORDING TO LEGISLATED REQUIREMENTS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.4.1.1 Identify all sources in the department	<ul style="list-style-type: none"> <li>Make an inventory of all sources in the department</li> </ul>	<ul style="list-style-type: none"> <li>Source inventory</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of inventory</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Identifies all sources defined in legislation.</li> <li>Inventory includes: <ul style="list-style-type: none"> <li>types of emitter</li> <li>energy</li> </ul> </li> </ul>
	2.4.1.2 Identify key legislative requirements for management of radioactive sources	<ul style="list-style-type: none"> <li>Read and summarize legislative requirements (including transport, security, custody and disposal of sources)</li> </ul>	<ul style="list-style-type: none"> <li>MSc</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Assessor review of report</li> </ul>	<ul style="list-style-type: none"> <li>Correctly identifies all key requirements</li> <li>Understands the need for legislative requirements</li> <li>Identifies risks associated with different types of radioactive sources with reference to IAEA safety report 47</li> </ul>
	2.4.1.3 Relate departmental procedures for management of radioactive sources to legislative requirements	<ul style="list-style-type: none"> <li>Compare departmental procedures with legislative requirements.</li> <li>Review spill procedures</li> <li>Review contingency procedures e.g. fire/flood/security breach</li> </ul>	<ul style="list-style-type: none"> <li>Table comparing departmental and legislative procedures</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Identifies all procedures</li> <li>Understands the purpose of the management procedures</li> <li>Identifies links between legislation and departmental procedures</li> </ul>
	2.4.1.4 Demonstrate an understanding of principles of contamination meters	<ul style="list-style-type: none"> <li>MSc</li> <li>Read and summarize references</li> <li>Attend training day / tutorial</li> </ul>	<ul style="list-style-type: none"> <li>MSc course notes</li> <li>Report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Understands how to determine type of emitter from an unknown radioactive source</li> <li>Identifies risks and hazards</li> </ul>
Level 2	2.4.2.1 Perform leak tests on radioactive sources	<ul style="list-style-type: none"> <li>Perform leak tests on sources (e.g. brachy sources or Sr-90 check sources) according to existing protocols.</li> <li>Perform a contamination survey of a potentially contaminated object or area.</li> <li>Perform appropriate source handling techniques.</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes or QA records</li> </ul>	<ul style="list-style-type: none"> <li>Demonstration to assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work.</li> <li>Chooses appropriate detector, considering: <ul style="list-style-type: none"> <li>sensitivity</li> <li>energy response</li> <li>particle</li> </ul> </li> <li>Uses correct procedure in determining a source in a contamination survey</li> <li>Takes appropriate action in response to findings.</li> <li>Demonstrates appropriate source handling techniques</li> </ul>
	2.4.2.2 Maintain a source inventory	<ul style="list-style-type: none"> <li>Update source inventory records according to existing protocols (including delivery of new sources and disposal of old sources)</li> <li>Perform an annual source audit</li> </ul>	<ul style="list-style-type: none"> <li>Source inventory records</li> </ul>	<ul style="list-style-type: none"> <li>Review of inventory by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Source inventory managed correctly: <ul style="list-style-type: none"> <li>all sources identified, and presence confirmed</li> <li>tracking of incoming and outgoing sources</li> </ul> </li> <li>Takes appropriate action to store, dispose and return sources.</li> <li>Follows up any discrepancies with the inventory.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	2.4.3.1 Perform radiation safety and protection procedures for radioactive materials according to legislated requirements	<ul style="list-style-type: none"> <li>Develop new procedures and/or analyse existing procedures for source storage and security and make recommendations</li> <li>Assess suitability of source storage security e.g. review protocols and signage</li> </ul>	<ul style="list-style-type: none"> <li>New procedure or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Review of procedure/ report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>References relevant legislation for jurisdiction</li> <li>Identifies all safety requirements and discusses significance of non-compliance</li> <li>Makes recommendations</li> </ul>



## COMPETENCY 2.5 PROVIDE PROTECTION IN RELATION TO MEDICAL, OCCUPATIONAL AND PUBLIC EXPOSURE TO IONIZING RADIATION

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.5.1.1 Understands how the principles of radiation protection are applied in the department	<ul style="list-style-type: none"> <li>Read radiation safety manual.</li> <li>Attend radiation safety training sessions for different staff groups</li> <li>Review plan of department showing controlled areas</li> </ul>	<ul style="list-style-type: none"> <li>Logbook notes.</li> <li>Certificate of attendance</li> </ul>	<ul style="list-style-type: none"> <li>Question and answer</li> </ul>	<ul style="list-style-type: none"> <li>Clearly outlines application of key principles (justification, optimization, limits) and quantifies risk to target groups including: <ul style="list-style-type: none"> <li>Patients undergoing medical imaging</li> <li>Patients undergoing radiotherapy treatment</li> <li>Participants in clinical trials</li> <li>Public</li> <li>Staff</li> </ul> </li> <li>Identifies controlled areas in department</li> </ul>
Level 2	2.5.2.1 Identify risk of radiation damage during radiotherapy treatment and explain methods for minimizing damage	<ul style="list-style-type: none"> <li>Read and summarise relevant texts.</li> <li>Discuss with physicists, ROs and RTs.</li> <li>Read planning protocols and participate in treatment planning.</li> <li>Observe and advise on radiation protection in treatment delivery.</li> <li>Make dose estimates and risk assessments for treatment scenarios, including foetus, gonads, lens and pacemaker.</li> <li>Communicate radiation risks</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook notes.</li> <li>Summary of activities in planning / treatment.</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of evidence</li> <li>Q&amp;A session with assessor.</li> </ul>	<ul style="list-style-type: none"> <li>For given treatment scenario: <ul style="list-style-type: none"> <li>Recommends radiation constraints</li> <li>Identifies sources of dose and estimates magnitude, e.g. internal and external scatter, neutron activation, head leakage, imaging dose, additional dose in clinical trials.</li> <li>Suggests dose reduction methods, for example, shielding, beam directions, IMRT, physical removal of pacemaker.</li> <li>Communicates radiation risks effectively</li> </ul> </li> </ul>
	2.5.2.2 Understand principles and practice for personal monitoring	<ul style="list-style-type: none"> <li>Assist with management of staff monitoring program</li> <li>Compare current readings with historic results.</li> <li>Investigate sources of high readings.</li> <li>Communicate radiation risks</li> <li>Compare RT, RO, physics and nursing results with other occupationally exposed groups, e.g. nuclear medicine technicians, interventional radiologists and cardiologists</li> </ul>	<ul style="list-style-type: none"> <li>Logbook evidence.</li> <li>Reports of comparisons and individual investigations.</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of reports.</li> <li>Q&amp;A session with assessor.</li> <li></li> </ul>	<ul style="list-style-type: none"> <li>Understands need for personal monitoring.</li> <li>Knows procedure for personal monitoring, e.g., who changes badges, where results are stored, who views results.</li> <li>Knows types and applications of monitoring devices, e.g., TLD, OSL, ion chamber, finger monitors.</li> <li>Takes appropriate action in response to results.</li> <li>Covers all aspects in investigation.</li> <li>Interprets results from different professional groups, and different work areas in department.</li> <li>Identifies how staff deal with short term exposure of nuclear medicine patients</li> <li>Communicates radiation risks effectively</li> </ul>
	2.5.2.3 Understands principles and practice for protection of the public in radiotherapy practice	<ul style="list-style-type: none"> <li>Read and summarise information provided to the public</li> <li>Observe and participate in advising public of radiation safety requirements</li> <li>Communicate radiation risks</li> </ul>	<ul style="list-style-type: none"> <li>Logbook evidence.</li> <li>Summary report.</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with assessor.</li> <li>Assessor review of reports.</li> </ul>	<ul style="list-style-type: none"> <li>Knows appropriate information, for example <ul style="list-style-type: none"> <li>Information given to LDR patients</li> <li>Nuclear medicine patients</li> <li>Signage for controlled areas</li> <li>Imaging doses for carers</li> </ul> </li> <li>Communicates radiation risks effectively</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	2.5.3.1 Provide protection in relation to medical, occupational and public exposure to ionizing radiation	<ul style="list-style-type: none"> <li>Investigate mock scenarios such as: <ul style="list-style-type: none"> <li>Advise public groups, e.g. brachytherapy patients, pregnant women, carer in the CT room</li> <li>Advice to pregnant worker.</li> <li>Proposed change to an alternative monitoring method (e.g. OSL instead of TLD badges)</li> </ul> </li> <li>Advise on updates to radiation safety manual for radiation oncology</li> <li>Manage a personal dosimetry system</li> <li>Give a radiation safety in-service to another professional group</li> <li>Prepare a handout for staff on safety</li> </ul>	<ul style="list-style-type: none"> <li>Written report or oral presentation</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A session with assessor.</li> <li>Assessor review of report / presentation.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Provides appropriate advice to public groups</li> <li>Provides appropriate advice to occupationally exposed groups, e.g. pregnant staff, staff members with unusual personal monitoring readings</li> <li>Provides appropriate advice on optimisation of medically exposed groups, e.g. repeat CT scan of patients, imaging doses</li> </ul>

## COMPETENCY 2.6 MANAGE RADIATION INCIDENTS AND ACCIDENTS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	2.6.1.1 Identify risk factors and associated engineering and administrative controls with radiation exposure	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise relevant textbooks</li> <li>• Read and summarise IAEA incident reports</li> <li>• Talk with colleagues</li> <li>• Read radiation safety manual</li> <li>• Attend risk management discussion</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies risks that leads to incidents, e.g. understaffing, untrained staff, malfunction of equipment, human error</li> <li>• Identifies control methods for risks, e.g., safe practice policies, radiation management plan, correct procedure, correct patient, correct site, interlocks, building design, warning systems, quality control systems, redundant checking</li> <li>• Communicates risks and mitigations to relevant groups</li> </ul>
	2.6.1.2 Describe procedures to be followed in the event of common radiation incidents	<ul style="list-style-type: none"> <li>• Read departmental safety protocols.</li> <li>• Summarise step by step processes for common scenarios, e.g., mistreatment of patient, HDR emergency, spill of radio-nuclide, accidental exposure of staff member.</li> <li>• Participate in the local Radiation Safety Committee or review their minutes to understand the data management process.</li> </ul>	<ul style="list-style-type: none"> <li>• Short report with steps to be followed to address issue.</li> </ul>	<ul style="list-style-type: none"> <li>• Assessor review of reports.</li> <li>• Q&amp;A session with assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrates basic knowledge of managing the incident: <ul style="list-style-type: none"> <li>○ Ensure situation is safe, (e.g. beam off, secure HDR source, secure area)</li> <li>○ Communicate with those involved in the incident</li> <li>○ Perform investigation, e.g., root cause analysis</li> <li>○ Debriefing</li> <li>○ Dose estimation</li> <li>○ Reporting to authority.</li> <li>○ Knowledge of common accidents e.g. IAEA reports</li> </ul> </li> </ul>
Level 2	2.6.2.1 Perform emergency response procedures according to existing protocols	<ul style="list-style-type: none"> <li>• Participate in training drills, e.g., HDR emergency procedures, radioactive spills, loss of radioactive source during brachytherapy implantation.</li> </ul>	<ul style="list-style-type: none"> <li>• Log book notes</li> </ul>	<ul style="list-style-type: none"> <li>• Assessment by observation</li> </ul>	<ul style="list-style-type: none"> <li>• Follows protocol in managing the incident: <ul style="list-style-type: none"> <li>○ Performs activities in a timely manner</li> <li>○ Performs appropriate actions</li> <li>○ Ensures situation is safe, e.g., beam off, secure HDR source, secure area</li> <li>○ Communicates with those involved in the incident</li> <li>○ Reports to authority.</li> </ul> </li> </ul>
	2.6.2.2 Estimate dose to individuals in the event of accidental exposure to radiation	<ul style="list-style-type: none"> <li>• Mock scenarios, e.g., from contact with patients after a nuclear medicine procedure, staff member in bunker during treatment, HDR emergency, contact with a patient with a permanent brachytherapy implant</li> </ul>	<ul style="list-style-type: none"> <li>• Dose estimates</li> </ul>	<ul style="list-style-type: none"> <li>• Assessor review of measurements and calculations</li> </ul>	<ul style="list-style-type: none"> <li>• Determines correct calculation results</li> <li>• Makes appropriate judgments on results</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	2.6.3.1 Manage radiation incidents and accidents	<ul style="list-style-type: none"> <li>• Manage mock or real radiation incidents and accidents, e.g.:               <ul style="list-style-type: none"> <li>○ Develop emergency response procedures</li> <li>○ Theft of source, flood, earthquake or fire damage of radioactive source or hot laboratory or Nuclear Medicine laboratory</li> <li>○ Linac – RT in room, incorrect exposure incident</li> <li>○ Incorrect disposal of radioactive source</li> <li>○ Road accident with radiation involved (patient transported to hospital)</li> <li>○ Medical emergency with I-131 or I-125</li> <li>○ Patient mistreatment (under or overdose, incorrect site, incorrect patient).</li> <li>○ Comforter in CT scan</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Written procedure or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• Q&amp;A session with assessor.</li> <li>• Assessor review of written procedure / report</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> <li>• Recommends appropriate course of action</li> <li>• Suggests possible means to prevent recurrence of incident</li> <li>• Explains risk to staff, public e.g. internal letter to administration versus public</li> <li>• Understands reporting requirements both internal and external</li> <li>• Respects ethical considerations</li> <li>• Prioritizes appropriately</li> </ul>

## MODULE 3: EXTERNAL BEAM RADIATION DOSIMETRY

### COMPETENCY 3.1 PERFORM QUALITY MANAGEMENT FOR DOSIMETRY SYSTEMS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	3.1.1.1 Understand the physical principles and operation of ion chambers for MV and kV dosimetry	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Participate in dose measurements using the appropriate chamber type, including parallel plate, cylindrical and thin window parallel plate chambers.</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Defines the following terms and (where applicable) gives their units: Absorbed dose, Exposure, Kerma, Charged particle equilibrium</li> <li>Explains the physical principles of operation of ion chambers, including shape, size and construction for: <ul style="list-style-type: none"> <li>Free air chambers</li> <li>Extrapolation chambers</li> <li>Parallel plate chambers</li> <li>Cylindrical chambers</li> </ul> </li> <li>Explains polarizing voltage: typical value and why</li> <li>Explains the relationship between charge measured with the electrometer and dose delivered to the medium: <ul style="list-style-type: none"> <li>For MV photons and electrons (Bragg-Gray cavity theory)</li> <li>For kV photons</li> </ul> </li> <li>Lists influence effects and explains how they are accounted for using correction factors or procedures, including: <ul style="list-style-type: none"> <li>Air density</li> <li>Recombination (pulsed and continuous)</li> <li>Polarity (dependence on bias voltage)</li> <li>Warm-up</li> <li>Extracameral effects (stem and cable)</li> <li>Leakage (pre- and post- irradiation)</li> <li>Humidity</li> <li>Electrometer calibration</li> </ul> </li> <li>Estimates the order of magnitude of the above factors and discusses whether they can be above or below unity.</li> <li>Lists radiation quality and perturbation effects and explains how they are accounted for using correction factors or procedures, including: <ul style="list-style-type: none"> <li>chamber cavity</li> <li>chamber wall</li> <li>central electrode</li> <li>replacement of medium by chamber</li> <li>stopping power ratios</li> </ul> </li> <li>Identifies typical applications of different ion chambers.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	3.1.1.2 Understand the physical principles and operation of film for MV and kV dosimetry	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Participate in dose measurements.</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the physical principles of operation (including film structure) of: <ul style="list-style-type: none"> <li>radiographic film</li> <li>radiochromic film</li> </ul> </li> <li>Explains the processes used to relate optical density to the dose delivered to the medium (via film calibration)</li> <li>Aware of issues to be considered when using film such as: <ul style="list-style-type: none"> <li>storage requirements</li> <li>processing</li> <li>film calibration</li> <li>film scanner calibration</li> <li>geometrical scaling</li> <li>energy dependence</li> <li>film orientation</li> <li>film handling</li> <li>post-irradiation darkening</li> </ul> </li> </ul>
	3.1.1.3 Understand the physical principles and operation of diodes for MV and kV dosimetry	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarize references</li> <li>Participate in dose measurements using diodes</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the physical principles of operation of diodes.</li> <li>Explains the relationship between charge measured with the electrometer and dose delivered to the medium.</li> <li>Explains the process for obtaining reliable dosimetry results from diodes, accounting for factors such as: <ul style="list-style-type: none"> <li>Diode calibration</li> <li>Temperature dependence</li> <li>Directional dependence</li> <li>Dose dependence</li> <li>Energy dependence</li> </ul> </li> </ul>
	3.1.1.4 Understand the physical principles of specialised detectors for MV and kV dosimetry	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Participate in dose measurements using specialized detectors.</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the physical principles of operation of at least two of the following detectors: TLD, MOSFET, OSLD, EPIDs</li> <li>Explains the physical principles of operation of at least one of the following detectors: gels, diamonds, wire arrays, scintillators, fibre optic dosimeters or any other novel dosimeters</li> <li>Explains the relationship between the measured quantity and dose delivered to the medium for each detector.</li> <li>Explains the process for obtaining reliable dosimetry results from these detectors, accounting for relevant correction factors.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	3.1.2.1 Commission and perform QA for ion chambers for MV and kV dosimetry	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform commissioning and QA tests on ion chambers</li> <li>Audit QA worksheets to confirm factors current</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA records</li> <li>Commissioning reports</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. ACPSEM 1997 Table A1, AAPM TG40 Table IV, AAPM TG-106. If department uses alternative procedure, registrar should have an understanding of protocol recommendations, and explain any deviations.</li> <li>Draws conclusions from results</li> <li>Identifies limitations and tolerances</li> <li>Explains relationship between commissioning tests and ongoing QA.</li> <li>Verifies that QA documents are current, including source of all factors.</li> </ul>
	3.1.2.2 Commission and perform QA for a dosimeter other than an ion chamber for MV and kV dosimetry	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform commissioning and QA tests for at least one of the dosimeters listed in Level 1</li> <li>Audit QA worksheets to confirm factors current</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA records</li> <li>Commissioning reports</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. ACPSEM 1997 Table A1, AAPM TG40 Table IV, AAPM TG-106. If department uses alternative procedure, registrar should have an understanding of protocol recommendations, and explain any deviations.</li> <li>Draws conclusions from results</li> <li>Identifies limitations and tolerances</li> <li>Explains relationship between acceptance and commissioning tests and ongoing QA.</li> <li>Verifies that QA documents are current, including source of all factors.</li> </ul>
Level 3	3.1.3.1 Perform quality management for dosimetry systems	<ul style="list-style-type: none"> <li>Manage the commissioning of a new dosimeter</li> <li>Develop a new QA program for a dosimetry system</li> <li>Analyse an existing program and make recommendations</li> <li>Make recommendations for the purchase of a new detector</li> </ul>	<ul style="list-style-type: none"> <li>New program or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>References relevant published protocols</li> </ul>

## COMPETENCY 3.2 PERFORM QUALITY MANAGEMENT FOR ANCILLARY COMPONENTS OF DOSIMETRY SYSTEMS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	3.2.1.1 Understand the physical principles, operation and use of phantoms	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references.</li> <li>• Participate in dose measurements using phantoms.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary notes. Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Understands the concept of tissue equivalence and its relationship to physical density, electron density, atomic number, attenuation coefficients, scattering power and stopping power for kV photons, MV photons and electrons.</li> <li>• Explains the advantages, disadvantages and utility of common phantom materials (refer to ICRU Report 44, Tissue Substitutes in Radiation Dosimetry and Measurement), including: <ul style="list-style-type: none"> <li>○ Water</li> <li>○ Perspex</li> <li>○ Polystyrene</li> <li>○ Water equivalent plastics</li> <li>○ Tissue substitutes, e.g. bone, lung</li> </ul> </li> <li>• Explains correction factors required for non-water-equivalent phantom materials (difference for photons and electrons).</li> <li>• Understands the relationship between phantom design and purpose, for example <ul style="list-style-type: none"> <li>○ Scanning detector water tank phantoms</li> <li>○ Shape and size, considering issues such as electronic equilibrium, scatter, backscatter</li> <li>○ Construction, e.g. slab phantoms for electron dosimetry</li> <li>○ Composition</li> <li>○ Detector compatibility</li> <li>○ Anthropomorphic phantoms</li> <li>○ Intercomparison jigs or blocks</li> <li>○ Calibration blocks</li> <li>○ CT/MR/PET compatibility</li> </ul> </li> </ul>



	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	3.2.2.1 Accept, commission and perform QA for water tank dosimetry systems	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform acceptance, commissioning and QA tests on water tank phantoms</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA records, acceptance and commissioning reports</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, including software tests, e.g. AAPM TG-106. If department uses alternative method, registrar should have an understanding of protocol recommendations, and explain any deviations.</li> <li>Draws conclusions from results</li> <li>Identifies limitations and tolerances, including mechanical tolerances, hysteresis, orthogonality of scan axes, position to signal correlation</li> <li>Explains relationship between acceptance and commissioning tests and ongoing QA.</li> <li>Verifies that QA documents are current</li> <li>Justifies choice of data acquisition modes and scan parameters such as scan speed, scan mode (point to point, continuous),</li> <li>Explains function and operation of analysis tools, such as renormalisation, centring, symmetrising, smoothing, conversion of ionization to dose, central axis correction, comparison to reference data, calculation of flatness, symmetry and beam quality parameters</li> <li>Knowledge of data management capabilities such as scan labelling, storage</li> </ul>
	3.2.2.2 Accept, commission, and perform QA for other phantoms and ancillary components	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform acceptance, commissioning and QA tests (including tests on associated software and worksheets) for: <ul style="list-style-type: none"> <li>A common dosimetric accessory such as an intercomparison jig or calibration block</li> <li>A specialised phantom such as an anthropomorphic or respiratory gating phantom</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA records</li> <li>Acceptance and commissioning reports</li> <li>Oral presentation to department</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol or reference, where applicable</li> <li>Draws conclusions from results</li> <li>Identifies limitations and tolerances</li> <li>Explains relationship between acceptance and commissioning tests and ongoing QA.</li> <li>Knowledge of software tools where applicable.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	3.2.3.1 Perform quality management for ancillary components of dosimetry systems	<ul style="list-style-type: none"> <li>• Manage commissioning of an ancillary component of dosimetry system</li> <li>• Develop new QA program for ancillary components of a dosimetry system</li> <li>• Analyse an existing program and make recommendations</li> <li>• Design a new jig or phantom</li> <li>• Make recommendations for the purchase of a new jig or phantom</li> </ul>	<ul style="list-style-type: none"> <li>• New program or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• Review of program or report by assessor.</li> <li>• Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> </ul>

## COMPETENCY 3.3 PERFORM ABSORBED DOSE DETERMINATION IN EXTERNAL BEAM RADIOTHERAPY ACCORDING TO ESTABLISHED PROTOCOLS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	3.3.1.1 Describe how calibration factors are transferred from the PSDL to the department	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read textbooks</li> <li>Tutorials</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Logbook notes, short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL.</li> <li>Assessor review of evidence / discussion</li> </ul>	<ul style="list-style-type: none"> <li>Identifies primary standard, e.g., calorimeter, free air chamber</li> <li>Explains need for traceability to primary standard</li> <li>Explains process of transfer of calibration factors, including: <ul style="list-style-type: none"> <li>calibration of secondary standard at PSDL</li> <li>cross calibration of field chambers with secondary standard at hospital</li> </ul> </li> <li>Understands the conditions of measurement under which calibration issued by PSDL (energy, temp, press, humidity, bias voltage, polarity)</li> </ul>
	3.3.1.2 Describe the purpose of absorbed dose determination in the department	<ul style="list-style-type: none"> <li>Tutorials</li> <li>Discussions with colleagues</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes.</li> <li>Summary of key points</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the need for accuracy in the determination of absorbed dose and relates to patient outcomes</li> <li>Explains how absorbed dose is specified in terms of cGy/MU or cGy/min under reference conditions for <ul style="list-style-type: none"> <li>MV photons</li> <li>MV electrons</li> <li>kV photons</li> </ul> </li> <li>Explains how absorbed dose under reference conditions is related to patient dose via relative dose factors for MU or treatment time.</li> </ul>
	3.3.1.3 Understand the key principles of the protocol used for absorbed dose determination in the department	<ul style="list-style-type: none"> <li>Observe/assist with absorbed dose determinations</li> <li>Read and summarise key points of international dosimetry protocols for <ul style="list-style-type: none"> <li>MV photons (TRS398)</li> <li>MeV electrons (TRS398)</li> <li>kV photons (AAPM TG61)</li> </ul> </li> <li>Read departmental protocols</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes.</li> <li>Summary of key points.</li> <li>MSc assessment.</li> </ul>	<ul style="list-style-type: none"> <li>RPL.</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Identifies correct protocol for: <ul style="list-style-type: none"> <li>MV photons</li> <li>MV electrons</li> <li>kV photons</li> </ul> </li> </ul> <p>Recommended protocols for TEAP are listed in the RIOTs. If department uses alternative protocol, registrar should have an understanding of recommended protocol and explain any differences.</p> <ul style="list-style-type: none"> <li>Explains how protocol is implemented in department in terms of <ul style="list-style-type: none"> <li>frequency of calibration of secondary standard</li> <li>QA of secondary standard and field chambers</li> <li>frequency of intercomparison between field chambers and secondary standard</li> <li>frequency of absorbed dose calibration (annually, on commissioning a new linac, after repair, after variation in machine dose output as appropriate)</li> <li>relation between routine output checks and absorbed dose determination under reference conditions</li> </ul> </li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	3.3.2.1 Understand theory of key dosimetry protocols	<ul style="list-style-type: none"> <li>Read and summarise essential features of the protocol used in department for               <ul style="list-style-type: none"> <li>MV photons (TRS398)</li> <li>MeV electrons (TRS398)</li> <li>kV photons (AAPM TG61)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Summary report</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Defines beam quality</li> <li>Identifies reference conditions for beam quality determination, cross calibration and absorbed dose determination</li> <li>Explains chamber choice for beam quality determination and absorbed dose determination in accordance with protocol</li> <li>States equations used to calculate absorbed dose from measurements and defines all terms</li> <li>Relates Bragg-Gray cavity theory to TRS398 formalism, explaining how deviations from Bragg-Gray conditions are accounted for by correction factors (<math>p_{cav}</math>, <math>p_{cel}</math>, <math>p_{dis}</math>, <math>p_{wall}</math>) (refer Mayles <i>Handbook of Radiotherapy Physics: Theory and Practice</i>, Appendix D).</li> <li>Relates air kerma based theory to kilovoltage protocol formalism, including accounting for correction factors</li> </ul>
	3.3.2.2 Determine the radiation quality for common radiotherapy beams	<ul style="list-style-type: none"> <li>Determine               <ul style="list-style-type: none"> <li>TPR<sub>20,10</sub> for MV photons directly or from a PDD measurement</li> <li>R<sub>50</sub> for MeV electrons</li> <li>HVL for kV photons</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Records of beam quality measurement</li> </ul>	<ul style="list-style-type: none"> <li>Observation and Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work.</li> <li>Experimental setup conforms with recommendations in relevant code of practice</li> <li>Correct manual calculation of beam quality</li> <li>Compares with departmental baseline</li> </ul>
	3.3.2.3 Perform cross calibrations of ion chambers	<ul style="list-style-type: none"> <li>Perform cross calibration of reference chamber with               <ul style="list-style-type: none"> <li>field chamber for MV photons</li> <li>parallel plate chamber for MeV electrons</li> <li>field chamber for kV photons</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Records of cross calibration</li> </ul>	<ul style="list-style-type: none"> <li>Observation and Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work.</li> <li>Experimental setup conforms with recommendations in relevant code of practice</li> <li>Derives necessary information from PSDL calibration certificate</li> <li>Correct manual calculation of cross calibration factor (<math>N_{DwQcross}</math> or <math>N_k</math>)</li> <li>For cross calibration of parallel plate chamber for MeV electrons, explains choice of energy</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	3.3.2.4 Determine absorbed dose under reference conditions	<ul style="list-style-type: none"> <li>Measure absorbed dose under reference conditions for: <ul style="list-style-type: none"> <li>MV photons</li> <li>MV electrons</li> <li>kV photons</li> </ul> </li> <li>Review uncertainty discussions in TRS 398 and standards lab documentation.</li> </ul>	<ul style="list-style-type: none"> <li>Records of absorbed dose determination</li> </ul>	<ul style="list-style-type: none"> <li>Observation and Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work.</li> <li>Experimental setup conforms with recommendations in relevant code of practice</li> <li>Corrects for influence quantities and identifies the conditions on which they depend (e.g., temperature, pressure, dose rate and dose per pulse).</li> <li>Correct calculation of absorbed dose at measurement point</li> <li>Corrects to dose at departmental reference conditions (via PDD, TMR as appropriate)</li> <li>Compares measured absorbed dose with expected value, knows applicable tolerance &amp; identifies action to be taken if values outside tolerance</li> <li>Derives benchmark values for routine QA checks of absorbed dose (e.g. for daily QA by RTs or monthly QA by physicists)</li> <li>Identifies sources of uncertainty throughout the dosimetry chain and is aware of their magnitude</li> </ul>
Level 3	3.3.3.1 Perform absorbed dose determination in external beam radiotherapy according to established protocols	<ul style="list-style-type: none"> <li>Develop new absorbed dose protocol for department</li> <li>Review existing protocols and make recommendations</li> <li>Manage review of dosimetry after recalibration of reference chamber</li> <li>Respond to faults and perform tests to perform a treatment unit to service after repairs in real or mock exam scenario</li> <li>Audit dose for a treatment unit at another department</li> <li>Lead department's participation in multi-centre dosimetry intercomparisons</li> <li>Work with external regulators during dosimetry audits</li> <li>Correlate regular and annual dosimetry measurements and analyse Type A and Type B errors.</li> <li>Compare and contrast different dosimetry protocols – select one or more from the list below: <ul style="list-style-type: none"> <li>398 vs. AAPM TG 51</li> <li>TRS 398 vs. IPEMB vs. AAPM TG61 for kilovoltage</li> <li>TRS398 vs. older protocols TRS 277 &amp; 381</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>New protocol</li> <li>Protocol review</li> <li>Written or oral report.</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Meets general criteria for practical work</li> <li>For participation in audits: <ul style="list-style-type: none"> <li>Discusses audit outcomes with auditors/regulators</li> <li>Ability to write QA audit report</li> </ul> </li> </ul>

## COMPETENCY 3.4 MANAGE RELATIVE DOSE MEASUREMENTS IN EXTERNAL BEAM RADIOTHERAPY AND RELATE TO ABSORBED DOSE

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	3.4.1.1 Describe the purpose of relative dose measurements	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise textbooks</li> <li>• Tutorials</li> <li>• Assist with / observe relative dose measurements</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Logbook notes</li> <li>• Short report</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Assessor review of evidence / discussion</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies key occasions when relative dose measurements are performed in the department including               <ul style="list-style-type: none"> <li>○ acceptance testing of linac and kV unit</li> <li>○ commissioning of linac and kV unit</li> <li>○ commissioning of TPS, independent MU checker and manual calculation for MU or treatment time calculation</li> <li>○ annual QA</li> <li>○ measurement of patient specific factors (such as cutouts and treatment accessories)</li> </ul> </li> <li>• Explains relationship between absorbed dose determination under reference conditions and relative dose measurements.</li> </ul>
	3.4.1.2 Define key relative dosimetry terms	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Tutorials</li> <li>• Read and summarise               <ul style="list-style-type: none"> <li>○ Textbooks</li> <li>○ Departmental dose calculation manuals</li> <li>○ TPS reference manual</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Logbook notes</li> <li>• Short report,</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Assessor review of evidence / discussion</li> </ul>	<ul style="list-style-type: none"> <li>• Defines key relative dose factors, including:               <ul style="list-style-type: none"> <li>○ PDD</li> <li>○ TAR/TMR/TPR</li> <li>○ Off-axis ratios</li> <li>○ wedge factors</li> <li>○ scatter factors                   <ul style="list-style-type: none"> <li>▪ total scatter</li> <li>▪ head (collimator) scatter</li> <li>▪ phantom scatter</li> <li>▪ peak scatter</li> <li>▪ backscatter</li> </ul> </li> <li>○ electron and kV cutout and applicator factors</li> <li>○ accessory transmission factors (blocks, MLC, tray, couch, patient support devices)</li> </ul> </li> <li>• Definitions should include (where relevant):               <ul style="list-style-type: none"> <li>○ normalization depth</li> <li>○ reference field size</li> <li>○ SSD/SAD geometry</li> </ul> </li> <li>• Explains clinical relevance of above factors</li> <li>• Aware of differences in use of factors and definitions in different departments</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	3.4.2.1 Determine relative dose factors	<ul style="list-style-type: none"> <li>Determine the following:               <ul style="list-style-type: none"> <li>For MV photons:                   <ul style="list-style-type: none"> <li>PDD</li> <li>TAR/TMR/TPR</li> <li>Scatter factors (total, head, phantom, peak)</li> <li>Off axis ratios</li> <li>Wedge factors</li> <li>Accessory transmission factors</li> </ul> </li> <li>For MeV electrons:                   <ul style="list-style-type: none"> <li>PDD</li> <li>Applicator &amp; cutout factors</li> <li>Shielding transmission factors</li> <li>Dose / distance relationships</li> </ul> </li> <li>For kV photons:                   <ul style="list-style-type: none"> <li>PDD</li> <li>Applicator / cone / cutout factors</li> <li>Backscatter factors</li> <li>Shielding transmission factors</li> <li>Dose/distance relationship</li> </ul> </li> </ul> </li> <li>Review requirements for relative dosimetry in small fields where CPE does not exist (e.g. for IMRT or stereotactic applications)</li> </ul>	<ul style="list-style-type: none"> <li>Logbook notes</li> <li>Experimental records</li> </ul>	<ul style="list-style-type: none"> <li>Practical demonstration to assessor.</li> <li>Q&amp;A session to cover measurements not routinely performed in department.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Appropriate choice of detector and phantom</li> <li>Appropriate measurement geometry</li> <li>Justifies choice of local measurement or use of published data.</li> <li>Demonstrates an understanding of the consequences of CPE breakdown for dosimetry.</li> </ul>
	3.4.2.2 Analyze the uncertainty of relative dose measurements	<ul style="list-style-type: none"> <li>Literature review</li> <li>Assess departmental results for reproducibility, estimate Type A and Type B errors</li> <li>Compare measurements made via different techniques</li> <li>Compare departmental measurements with external benchmarks (e.g. BJR data)</li> </ul>	<ul style="list-style-type: none"> <li>Written report</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of report</li> <li>Q &amp; A with assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies key sources of uncertainty</li> <li>Calculates realistic estimate of uncertainty</li> <li>Suggests methods to reduce uncertainty</li> <li>Identifies how errors in factors affect overall patient dose delivery (all patients, group of patients or one patient)</li> </ul>
Level 3	3.4.3.1 Manage relative dose measurements in external beam radiotherapy and relate to absorbed dose	<ul style="list-style-type: none"> <li>Manage relative dose measurements that require selection of appropriate detector and measurement technique such as:               <ul style="list-style-type: none"> <li>commissioning new treatment unit, TPS or independent MU check software</li> <li>establishing or revising annual QA program for treatment unit</li> <li>commissioning new treatment technique</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Internal report and/or presentation.</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of report and Q&amp;A.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Sets appropriate tolerances relative to accuracy of measurement.</li> </ul>

## COMPETENCY 3.5 PERFORM IN-VIVO DOSIMETRY QUALITY MANAGEMENT FOR INDIVIDUAL PATIENTS AND PATIENT GROUPS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	3.5.1.1 Describe the purpose of an in-vivo dosimetry program	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise literature</li> <li>• Participate in a departmental tutorial or training day</li> <li>• Observe / assist with in-vivo dose measurements</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Logbook notes</li> <li>• Short report</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Assessor review of evidence / discussion and Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>• Understands how in-vivo dosimetry fits in to the bigger picture of accurate dose delivery to an RT patient.               <ul style="list-style-type: none"> <li>○ Ideally verifies the complete treatment delivery chain.</li> <li>○ May help identify / prevent radiation accidents</li> <li>○ Monitoring dose for organs at risk, pacemakers, junction doses, special techniques</li> <li>○ Legally required for all patients in some countries, recommended in ARPANSA RPS14.3 for new techniques</li> </ul> </li> <li>• Identifies limitations of in-vivo dosimetry such as               <ul style="list-style-type: none"> <li>○ Difficulty relating dose measured to dose at point of interest</li> <li>○ Effect of positional uncertainties</li> <li>○ Logistical issues (e.g. workload, resources required to resolve discrepancies, need for rapid turn-around)</li> </ul> </li> </ul>
	3.5.1.2 Understand the advantages and disadvantages of a range of detectors for an in-vivo dosimetry program	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read literature and tabulate advantages and disadvantages of a range of in-vivo dosimetry detectors</li> <li>• Participate in a departmental tutorial or training day</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary table</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Assessor review of evidence / discussion and Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>• Lists properties that impact on the accuracy and precision of in-vivo dosimetry measurements such as:               <ul style="list-style-type: none"> <li>○ Spatial resolution, energy dependency, directionality, temperature dependence, reproducibility, inherent buildup,</li> </ul> </li> <li>• Aware of the range of detectors used such as:               <ul style="list-style-type: none"> <li>○ Diodes, TLDs, MOSFETs, film, EPIDs</li> </ul> </li> <li>• Identifies suitable detector for measurement, considering the above properties and practical issues such as ease of positioning, patient comfort and time required for readout.</li> </ul>
Level 2	3.5.2.1 Perform in-vivo dosimetry measurements.	<ul style="list-style-type: none"> <li>• Perform in-vivo dosimetry measurements as required for a range of simple and more complex measurement scenarios, such as eye dose, gonad dose, TBI, junctions, skin, delivered dose in field.</li> <li>• Perform measurements with different detectors if feasible.</li> </ul>	<ul style="list-style-type: none"> <li>• In vivo dosimetry reports</li> <li>• Case study reports</li> </ul>	<ul style="list-style-type: none"> <li>• Observation</li> <li>• Assessor review of report / discussion and Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for practical work</li> <li>• Identifies roles of professional groups in the in-vivo dosimetry program.</li> <li>• Meets general criteria for communication and professionalism with patient and members of multidisciplinary team</li> <li>• Communicates outcome clearly</li> </ul>



	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	3.5.2.2 Analyze the uncertainty of in-vivo dose measurements	<ul style="list-style-type: none"> <li>Literature review</li> <li>Assessment of departmental results for reproducibility, sources of Type A and Type B errors.</li> <li>Compare measurements made via different techniques</li> </ul>	<ul style="list-style-type: none"> <li>Written report, logbook notes on patient results</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of report. Q &amp; A with assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies key sources of uncertainty such as: <ul style="list-style-type: none"> <li>Selecting valid reference point on treatment plan (avoiding high dose gradient, at appropriate depth to match detector buildup)</li> <li>Positioning dosimeter at point on skin that can be related to the reference point</li> <li>Dosimeter related: spatial resolution, energy dependency, directionality, temperature dependence, reproducibility, radiation damage, calibration</li> <li>Patient related: movement, oblique incidence, tissue inhomogeneities, immobilization</li> </ul> </li> <li>Estimates uncertainty for individual patients and patient groups.</li> <li>Suggests methods to reduce uncertainty</li> <li>Understands how uncertainty in measurement impacts on clinical decision making</li> </ul>
Level 3	3.5.3.1 Perform in-vivo dosimetry quality management for individual patients and patient groups	<ul style="list-style-type: none"> <li>Critique the use of in-vivo dosimetry for one or more of the following: <ul style="list-style-type: none"> <li>Lens of the eye</li> <li>In field measurements such as TBI, small field electrons, TSET, electron arcs</li> <li>Pacemaker</li> <li>Junction dose</li> <li>New treatment techniques</li> </ul> </li> <li>Propose an improvement (expansion or reduction) to an existing in-vivo dosimetry service.</li> <li>Develop and document a procedure for in-vivo dosimetry</li> <li>Commission an in-vivo dosimetry system.</li> <li>Manage an in-vivo dosimetry system.</li> <li>Provide advice to other professional groups on the suitability of in-vivo dosimetry requests</li> <li>Review existing in-vivo dosimetry practice with aim of determining its accuracy, precision and clinical utility</li> </ul>	<ul style="list-style-type: none"> <li>Internal report</li> <li>Oral presentation</li> <li>Departmental procedure</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of report.</li> <li>Q&amp;A with assessor or physics group.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> </ul>

## MODULE 4: EXTERNAL BEAM RADIATION THERAPY EQUIPMENT

### COMPETENCY 4.1 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON LINEAR ACCELERATORS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.1.1.1 Understand the physical principles of MV electron and x-ray beam production	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains acceleration of electrons in a wave guide</li> <li>Explains interactions of electrons in a target (excitation/ionization/characteristic x-rays/bremsstrahlung) including dependence on electron energy and target composition and thickness, and resulting energy spectrum &amp; angular distribution of x-rays</li> </ul>
	4.1.1.2 Understand the key design principles and operation of linear accelerators	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Observe installation, repair, maintenance and QA of linacs.</li> <li>Participate in regular QA of linacs.</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> <li>Practical demonstration – ask registrar to draw a block diagram and name key parts and explain their function, or to identify parts pointed out on a real linac</li> </ul>	<ul style="list-style-type: none"> <li>Describes linear accelerator safety systems               <ul style="list-style-type: none"> <li>Electrical, mechanical and radiation (IEC 60601-2-1)</li> <li>Record and verify system</li> </ul> </li> <li>Describes beam forming components of a linac               <ul style="list-style-type: none"> <li>Injection system</li> <li>RF power generation system</li> <li>Accelerating waveguide</li> <li>Microwave power transmission</li> <li>Auxiliary system</li> <li>Beam transport system</li> <li>Beam collimation and monitoring system for photons and electrons</li> <li>Differences between photon and electron beam configuration</li> </ul> </li> <li>Describes the effects on the beam characteristics of changes in systems and parameters of the linac</li> <li>Defines mechanical, optical and radiation isocentre (e.g., using a figure)</li> <li>Describes typical low and high energy linac configurations (e.g., using a block diagram)</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	4.1.2.1 Perform acceptance tests for a linear accelerator	<ul style="list-style-type: none"> <li>• Read and summarise references.</li> <li>• Read previous departmental acceptance reports.</li> <li>• Perform acceptance tests on a new or upgraded linac or repeat acceptance procedure for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Acceptance report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Explains goals of acceptance testing and general order of the tests.</li> <li>• Identifies relevant legislative requirements</li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g. manufacturer's protocol, AAPM TG-142, Van Dyk §11.7.</li> <li>• Identifies limitations and tolerances</li> <li>• Draws appropriate conclusions from results</li> <li>• Explains relationship between acceptance tests and ongoing QA.</li> </ul>
	4.1.2.2 Perform commissioning tests for a linear accelerator	<ul style="list-style-type: none"> <li>• Read and summarise references.</li> <li>• Review department's clinical requirements, commissioning procedures and reports.</li> <li>• Perform commissioning tests on a new or upgraded linac or repeat commissioning tests for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Commissioning report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the relevance of each major step in the commissioning procedure including: <ul style="list-style-type: none"> <li>○ Selection of equipment</li> <li>○ Radiation safety and surveys</li> <li>○ Data for treatment planning</li> <li>○ Reference calibrations</li> <li>○ Plan delivery tests</li> <li>○ Independent checks</li> <li>○ Setup of QA baselines</li> <li>○ Staff training</li> <li>○ Documentation</li> </ul> </li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g., AAPM TG-106, Van Dyk §11.8, departmental protocol</li> <li>• Identifies limitations and tolerances</li> <li>• Draws appropriate conclusions from results</li> <li>• Describe differences between full commissioning and commissioning a beam-matched linac</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	4.1.2.3 Perform QA for a linear accelerator	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental QA reports and protocols.</li> <li>Perform regular (e.g., daily, weekly, fortnightly, monthly, quarterly, annual) QA on a linac according to established protocols under general supervision</li> <li>Review common faults and interlocks encountered on the linac and corrective action taken</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA records and reports</li> <li>Written exam answers</li> <li>Clinical skills assessment</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describes the role of a QA program and its relevance to patient outcomes</li> <li>Identifies roles of multidisciplinary team in QA, e.g. AAPM TG40.</li> <li>Explains purpose of QA tests and their tolerances</li> <li>Explains test frequency and relationship between daily, medium and longer term QA.</li> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. AAPM TG-142, Van Dyk §11.9, departmental protocol.</li> <li>Draws appropriate conclusions from results</li> </ul>
Level 3	4.1.3.1 Perform quality management and provide scientific advice on linear accelerators	<ul style="list-style-type: none"> <li>Participate in managing acceptance of a new, upgraded or relocated linac</li> <li>Participate in managing commissioning of a new, upgraded or relocated linac</li> <li>Compare and contrast the departmental QM programs with national/international guidelines and best practice and make recommendations</li> <li>Develop new commissioning project plan for a linac</li> <li>Develop new ongoing QA program for a linac</li> <li>Participate in managing an ongoing QA program for a linac</li> <li>Respond to faults and perform tests to return a linac to service after repairs in real or mock exam scenarios</li> <li>Analyze the consequences of faults in major components of a linac and the tests required to return the linac to service</li> <li>Prepare specifications and advice for new equipment</li> <li>Commission a new QC tool, considering advantages, disadvantages and uncertainties.</li> </ul>	<ul style="list-style-type: none"> <li>New program or report summarizing recommendations</li> <li>Completed acceptance and/or commissioning records</li> <li>Mock exam results</li> <li>Documentation of fault repair and return of linac to clinical service</li> </ul>	<ul style="list-style-type: none"> <li>Review of program or report by assessor</li> <li>Mock exam</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Identifies potential consequences (e.g. change in energy, output, mechanical position etc.) as appropriate for the scenario</li> <li>Identifies appropriate tests and measurements and a logical order in which to perform them</li> <li>Describes different methods of performing tests, such as: determining collimator angle zero, measuring flatness and symmetry, checking radiation source position</li> <li>Understands how the test conditions and measurements relate back to clinical use of the equipment (e.g. number of MU delivered for an EPID image quality test)</li> <li>Understands importance of time constraints and meeting milestones and deadlines</li> <li>Explains how the linac is integrated with other linacs and radiotherapy systems, such as imaging, treatment planning and R&amp;V systems.</li> <li>Analyses differences between departmental procedures and tolerances and published recommendations.</li> <li>Describes new approaches to QM (e.g. AAPM TG-100)</li> <li>Describes impact of known incidents and accidents on the local QM system and makes recommendations</li> </ul>

## COMPETENCY 4.2 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON AN MLC USED FOR IMRT

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.2.1.1 Understand the principles of IMRT	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Observe IMRT treatment planning, verification and delivery</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Defines IMRT and describes methods to modulate beams and their pros and cons, including                             <ul style="list-style-type: none"> <li>Compensators, field in field, step and shoot and sliding window MLC, VMAT</li> </ul> </li> <li>Explains how IMRT differs from 3D conformal therapy, identifies pros and cons. Discusses impact of IMRT on planning volumes and dose constraints.</li> <li>Explains the connection between IMRT and inverse planning</li> </ul>
	4.2.1.2 Understand the key design principles and operation of MLC based IMRT	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Observe maintenance, repair and QA of MLCs.</li> <li>Participate in IMRT commissioning and QA</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes different MLC designs and their impact on IMRT delivery, e.g.:                             <ul style="list-style-type: none"> <li>Leaf end type (round, straight) and movement mechanism</li> <li>Leaf design to minimize inter-leaf leakage</li> <li>Leaf width</li> <li>Leaf positional and speed accuracy</li> <li>Field size restrictions</li> <li>MLC used as secondary or tertiary collimator</li> </ul> </li> <li>Identifies parameters required to commission IMRT and explains their significance, e.g.:                             <ul style="list-style-type: none"> <li>MLC transmission</li> <li>Dynamic leaf gap</li> <li>Inter-leaf leakage</li> <li>Output factors, profiles and depth doses for small MLC defined fields</li> <li>MLC alignment with respect to collimator rotation axis</li> </ul> </li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	4.2.2.1 Perform IMRT commissioning tests and measurements	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform IMRT commissioning tests and measurements or repeat for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Commissioning report</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g., AAPM TG-119, Van Esch, Lo Sasso</li> <li>Performs end-to-end tests <ul style="list-style-type: none"> <li>Selection of equipment</li> <li>Measurement methods</li> <li>Comparison of distribution maps</li> <li>Data transfer</li> <li>Log files</li> </ul> </li> <li>Identifies limitations and tolerances <ul style="list-style-type: none"> <li>Links IMRT limitations to linac performance limitations, e.g. consider small sub-fields, small MU, etc.</li> </ul> </li> <li>Draws appropriate conclusions from results</li> <li>Explains relationship between commissioning tests and ongoing QA.</li> </ul>
	4.2.2.2 Perform QA of an MLC used for IMRT	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental QA reports.</li> <li>Perform regular (e.g., daily, weekly, fortnightly, monthly, quarterly, annual) QA on an MLC used for IMRT (in addition to those tests performed for regular linac QA).</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA report</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. AAPM TG-119, including end-to-end tests as above.</li> <li>Identifies limitations and tolerances</li> <li>Draws appropriate conclusions from results</li> <li>Identifies roles of multidisciplinary team in QA.</li> <li>Explains relationship between daily, medium and longer term QA.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	4.2.3.1 Perform quality management and provide scientific advice on an MLC used for IMRT	<ul style="list-style-type: none"> <li>• Participate in managing commissioning of an MLC used for IMRT</li> <li>• Develop new commissioning program for an MLC used for IMRT or analyse an existing program and make recommendations</li> <li>• Develop new ongoing QA program for an MLC used for IMRT or analyse an existing program and make recommendations</li> <li>• Participate in managing an ongoing QA program for an MLC used for IMRT</li> <li>• Respond to faults and perform tests to return an MLC used for IMRT to service after repairs</li> <li>• Compare and contrast the departmental QM programs with national/international guidelines and best practice and make recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• New program or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> <li>• Identifies potential impact of changes in of MLC position and speed, linac dose rate and gantry speed on IMRT treatment delivery, as appropriate for the scenario</li> <li>• Identifies appropriate tests and measurements and a logical order in which to perform them</li> <li>• Describes different methods of performing tests</li> <li>• Understands how the test conditions and measurements relate back to clinical use of the equipment</li> <li>• Understands importance of time constraints and meeting milestones and deadlines</li> <li>• Explains how the linac IMRT components are integrated with planning, data transfer and verification.</li> <li>• Analyses differences between departmental procedures and tolerances and published recommendations.</li> <li>• Describes new developments to IMRT QM</li> <li>• Describes impact of known incidents and accidents on the local QM system and makes recommendations</li> </ul>

## COMPETENCY 4.3 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON BEAM MODIFIERS, PATIENT SETUP AND IMMOBILISATION

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.3.1.1 Understand principles of patient setup and immobilisation and use of beam modifiers	<ul style="list-style-type: none"> <li>Observe simulation, planning and treatment</li> <li>Read departmental protocols</li> <li>Complete level 1 of competency 5.3.</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes.</li> <li>Short summary of setup techniques used.</li> </ul>	<ul style="list-style-type: none"> <li>Discussion with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains patient setup using lasers on CT/simulator and linac</li> <li>Describes purpose and function of immobilisation devices such as breast boards, head and neck masks, indexing, vacuum bags, knee supports</li> <li>Describes purpose and function of localisation aids, such as tattoos, wires, fiducial markers</li> <li>Discusses uncertainties, margins and verification of setup</li> <li>Discusses differences in localisation and setup for photon, electron and kV treatments</li> <li>Discusses the above points for at least four common treatment techniques, such as breast, prostate, head and neck, lung, palliative, skin</li> <li>Completes level 1 of competency 5.3 to demonstrate understanding of principles and use of beam modifiers.</li> </ul>
Level 2	4.3.2.1 Commission and perform QA on beam modifiers, patient positioning and immobilization devices	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform commissioning and QA tests on beam modifiers, patient positioning and immobilization devices, e.g.:               <ul style="list-style-type: none"> <li>Bolus</li> <li>Patient support devices</li> <li>Head and neck masks</li> <li>Vacuum bags</li> <li>Compensators</li> <li>Fiducial marker systems</li> <li>Beam spoilers</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Commissioning report</li> <li>Test and QA records</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs appropriate tests and measurements, for example,               <ul style="list-style-type: none"> <li>Transmission factor, skin dose, uniformity, dimensional accuracy and consistency, CT number, positional reproducibility, suitability for use with imaging systems</li> </ul> </li> <li>Identifies limitations and tolerances</li> <li>Draws appropriate conclusions from results</li> </ul>



	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	4.3.3.1 Perform quality management and provide scientific advice on beam modifiers, patient setup and immobilisation	<ul style="list-style-type: none"> <li>Review existing protocols and make recommendations</li> <li>Provide scientific advice to ROs and RTs on patient immobilisation</li> <li>Participate in research projects related to patient setup and immobilisation</li> <li>Commission a new patient accessory or beam modifier or repeat the process.</li> <li>In depth review of immobilization for a body site of interest</li> <li>In house study of setup accuracy for a body site of interest</li> </ul>	<ul style="list-style-type: none"> <li>New protocol, protocol review and written or oral report.</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Understands potential limitations of beam modifiers, patient setup and immobilisation and advises on clinical impact</li> <li>Identifies risks and sources of uncertainty, and formulates strategies to mitigate them</li> <li>Makes recommendations for the safe and optimal clinical use of beam modifiers and immobilisation</li> <li>Provides scientific justification for recommendations</li> <li>Refers to literature to support conclusions</li> </ul>

## COMPETENCY 4.4 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON IGRT

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.4.1.1 Understand the principles of IGRT	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references.</li> <li>• Read departmental protocols</li> <li>• Observe IGRT imaging, planning and treatment, including MV portal imaging, and kV linac based imaging.</li> <li>• Site visits to other centres to observe other treatment localization imaging if not done in department, e.g., ultrasound, cone beam CT, Floor mounted kV imaging, CT on rails</li> <li>• Attend workshops</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes importance of geographic accuracy of treatment for patient outcomes</li> <li>• Describes requirements of Radiation Oncology imaging systems</li> <li>• Describes imaging systems and image acquisition; image handling, storage, registration, fusion and planning applications, 3D and 4D</li> <li>• Defines IGRT and explains how IGRT differs from patient setup using external landmarks</li> <li>• Explains sources of systematic and random positional uncertainty and error including, for example:               <ul style="list-style-type: none"> <li>○ CT, MRI and PET imaging, such as, orthogonality of images to couch, couch sag, distortion, resolution</li> <li>○ linac related, such as, mechanical and radiation accuracy</li> <li>○ setup related, such as laser positional accuracy</li> <li>○ patient related, such as, interfraction and intrafraction movement, fiducial marker relative to internal position</li> </ul> </li> <li>• Discusses impact of IGRT on planning margins.</li> <li>• Identifies groups of patients where IGRT is desirable and explains why IGRT is desirable for those groups</li> <li>• Describes methods to perform IGRT and their pros and cons (e.g. on patient dose, image quality, accuracy), for example               <ul style="list-style-type: none"> <li>○ Port films, MV EPID planar and cone-beam CT imaging, kV planar and cone-beam CT imaging, ultrasound, infrared reflective markers, optical surface systems, electromagnetic transponders, CT on rails</li> </ul> </li> <li>• Describes IGRT strategies, such as:               <ul style="list-style-type: none"> <li>○ no-action-level</li> <li>○ threshold level</li> <li>○ verification after move</li> <li>○ frequency of imaging, e.g. per fraction or per 5 fractions</li> </ul> </li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	4.4.1.2 Understand the key design principles and operation of MV EPID IGRT systems	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Observe maintenance, repair and QA of MV EPID IGRT systems.</li> <li>Participate in MV EPID IGRT commissioning and QA</li> <li>Observe and assist with review of clinical images (use mock scenario with humanoid phantom if necessary)</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes physics of how an EPID system forms an image, including panel construction and composition, conversion of photon beam into an electronic signal, image resolution</li> <li>Mechanics of how the EPID is mounted to the linac and its relationship to the mechanical and radiation isocentre</li> <li>Describes the EPID system imaging methods, such as, before, during or after treatment, treatment field or reference field, number of frames, number of monitor units . Discusses trade-off between dose and image quality.</li> <li>Describes how the images are used in IGRT, including matching and alignment functions with DRRs</li> <li>Describes how the IGRT system interfaces with the linac and information systems</li> <li>Identifies tests required to commission EPID IGRT and explains their significance, e.g.: <ul style="list-style-type: none"> <li>Safety systems – radiation, electrical, mechanical</li> <li>Patient dose reference levels</li> <li>Mechanical alignment</li> <li>Image quality</li> <li>Software</li> </ul> </li> </ul>
	4.4.1.3 Understand the key design principles and operation of linac kV IGRT systems	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references.</li> <li>Observe maintenance, repair and QA of kV EPID IGRT systems.</li> <li>Participate in kV EPID IGRT commissioning and QA</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes physics of how a kV IGRT system forms an image, including panel construction and composition, conversion of photon beam into an electronic signal, image resolution</li> <li>Mechanics of how the kV imager is mounted to the linac and its relationship to the mechanical and radiation isocentre</li> <li>Describes the kV system imaging methods, such as, before or during treatment, number of frames, choice of kV and mAs. . Discusses trade-off between image quality and patient dose.</li> <li>Describes how the images are used in IGRT, including matching and alignment functions with DRRs and 3D volumes</li> <li>Describes how the IGRT system interfaces with the linac and information systems</li> <li>Identifies tests required to commission a kV IGRT system and explains their significance, e.g.: <ul style="list-style-type: none"> <li>Safety systems – radiation, electrical, mechanical</li> <li>Patient dose reference levels</li> <li>Mechanical alignment</li> <li>Image quality</li> <li>Software</li> </ul> </li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	4.4.2.1 Perform IGRT acceptance and commissioning tests and measurements	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental acceptance and commissioning reports.</li> <li>Perform IGRT acceptance and commissioning tests and measurements or repeat for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Commissioning report</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g., AAPM TG-142, TG-179</li> <li>Identifies limitations and tolerances</li> <li>Draws appropriate conclusions from results</li> <li>Explains relationship between commissioning tests and ongoing QA.</li> </ul>
	4.4.2.2 Perform QA of an IGRT system	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental QA reports.</li> <li>Perform regular (e.g., daily, weekly, fortnightly, monthly, quarterly, annual) QA on an IGRT system (in addition to those tests performed for regular linac QA).</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA report</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. AAPM TG-142, TG-179</li> <li>Identifies limitations and tolerances</li> <li>Draws appropriate conclusions from results</li> <li>Identifies roles of multidisciplinary team in QA</li> <li>Explains relationship between daily, medium and longer term QA.</li> </ul>
Level 3	4.4.3.1 Perform quality management and provide scientific advice on IGRT	<ul style="list-style-type: none"> <li>Participate in managing acceptance and commissioning of an IGRT system</li> <li>Develop new commissioning program for an IGRT system or analyse an existing program and make recommendations</li> <li>Develop new ongoing QA program for an IGRT system or analyse an existing program and make recommendations</li> <li>Participate in managing an ongoing QA program for an IGRT system</li> <li>Respond to faults and perform tests to return an IGRT system to service after repairs</li> <li>Research and commission a new type of IGRT system, such as an augmented reality system</li> <li>Literature review of imaging modalities for a body site of interest</li> <li>Critically assess departmental imaging procedures and dose consequences and make recommendations</li> <li>Provide scientific advice and specifications for new equipment purchase</li> </ul>	<ul style="list-style-type: none"> <li>New program or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Understands potential limitations of IGRT and advises on clinical impact</li> <li>Identifies risks and sources of uncertainty, and formulates strategies to mitigate them</li> <li>Makes recommendations for the safe and optimal clinical use of IGRT</li> <li>Provides scientific justification for recommendations</li> <li>Refers to literature to support conclusions</li> </ul>

## COMPETENCY 4.5 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON RADIOTHERAPY CT SCANNERS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.5.1.1 Understand the physical principles and operation of CT scanners used for radiotherapy imaging	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references.</li> <li>• Observe installation, repair, maintenance and QA of CT.</li> <li>• Observe CT patient imaging for treatment planning</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the physics of CT x-ray production and typical beam energies used for radiotherapy imaging</li> <li>• Explains how CT images are formed</li> <li>• Explains image acquisition and handling, storage, fusion and planning applications; 3D and 4D</li> <li>• Describes typical CT configuration (block diagram)</li> <li>• Explains factors impacting on image formation, such as, helical or axial scanning, slice width, pitch, beam kV &amp; mA, spot size,</li> <li>• Describes CT safety systems <ul style="list-style-type: none"> <li>◦ Electrical, mechanical and radiation</li> </ul> </li> <li>• Describes relationship between CT imaging plane, couch movement axes and treatment isocentre</li> <li>• Identifies requirements of CT scanners used for radiotherapy imaging, such as, bore size, flat couch top, lasers</li> <li>• Defines Hounsfield Units and explains their relationship to electron density, atomic number and beam energy</li> <li>• Sketches typical HU vs. electron density curve and explains its shape</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	4.5.2.1 Perform acceptance and commissioning tests for a CT	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental acceptance and commissioning reports.</li> <li>Perform acceptance and commissioning tests on a new or upgraded CT or repeat procedure for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Acceptance and Commissioning report</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Explains goals of acceptance and commissioning, general order of the tests and the relevance of each major step in the procedure including: <ul style="list-style-type: none"> <li>Radiation safety and surveys</li> <li>HU to ED curves</li> <li>Imaging dose</li> <li>Image quality checks</li> <li>Mechanical and laser alignment tests</li> <li>Data transfer tests</li> <li>End to end testing</li> <li>Setup of QA baselines</li> <li>Staff training</li> <li>Documentation</li> </ul> </li> <li>Identifies appropriate legislative requirements</li> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. AAPM Report 39, AAPM TG-66, TG-53, CAPCA 2007, IAEA TECDOC 1583</li> <li>Identifies limitations and tolerances</li> <li>Draws appropriate conclusions from results</li> <li>Explains relationship between acceptance and commissioning tests and ongoing QA.</li> <li>Identifies roles of multidisciplinary team in acceptance and commissioning, e.g. manufacturer, engineer, diagnostic imaging physicist, license compliance tester, RTs.</li> </ul>
	4.5.2.2 Perform QA for a CT	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental QA reports and protocols.</li> <li>Perform regular (e.g., daily, monthly, annual) QA on a CT</li> <li>Review common faults and interlocks encountered on the CT and corrective action taken</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA report</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describes the role of a QA program and its relevance to patient outcomes</li> <li>Identifies roles of multidisciplinary team in QA.</li> <li>Explains purpose of QA tests and their tolerances</li> <li>Explains test frequency and relationship between daily, medium and longer term QA.</li> <li>Meets general criteria for practical work</li> <li>Performs tests and measurements listed in a suitable protocol, e.g. AAPM TG-66, CAPCA 2007</li> <li>Draws appropriate conclusions from results</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	4.5.3.1 Perform quality management and provide scientific advice on radiotherapy CT scanners	<ul style="list-style-type: none"> <li>• Participate in managing acceptance of a CT</li> <li>• Participate in managing commissioning of a CT</li> <li>• Compare and contrast the departmental QM programs with national/international guidelines and best practice and make recommendations</li> <li>• Develop new commissioning project plan for a CT</li> <li>• Develop new ongoing QA program for a CT</li> <li>• Participate in managing an ongoing QA program for a CT</li> <li>• Respond to faults and perform tests to return a CT to service after repairs</li> <li>• Analyze the consequences of faults in major components of a CT and the tests required to return the unit to service</li> <li>• Prepare specifications and advice for new equipment</li> <li>• Commission a new QC tool, considering advantages, disadvantages and uncertainties.</li> <li>• Participate in development of a new protocol and QM program for advancing techniques, e.g. 4DCT</li> </ul>	<ul style="list-style-type: none"> <li>• New program or report summarizing recommendations</li> <li>• Completed acceptance and/or commissioning records</li> <li>• Mock exam results</li> <li>• Documentation of fault repair and return of CT to clinical service</li> </ul>	<ul style="list-style-type: none"> <li>• Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> <li>• Identifies potential consequences (e.g. change in energy, image quality, patient dose etc.) as appropriate for the scenario</li> <li>• Identifies appropriate tests and measurements and a logical order in which to perform them</li> <li>• Understands the implications of differences between test conditions and clinical use of the equipment (e.g. kV, mAs, axial, helical etc.)</li> <li>• Understands importance of time constraints and meeting milestones and deadlines</li> <li>• Analyses differences between departmental procedures and tolerances and published recommendations.</li> </ul>

## COMPETENCY 4.6 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON KILOVOLTAGE THERAPY UNITS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.6.1.1 Understand the physical principles of kV x-ray beam production	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the physics of kV x-ray production, i.e.               <ul style="list-style-type: none"> <li>○ electron beam acceleration in x-ray tubes</li> <li>○ Characteristic x-rays</li> <li>○ Bremsstrahlung</li> </ul> </li> <li>• Describes the typical angular and energy distribution of emitted x-ray beam, including an explanation of the heel effect</li> <li>• Describes how the following factors influence the characteristics of the emitted x-ray beam:               <ul style="list-style-type: none"> <li>○ Target composition (atomic number)</li> <li>○ Spot size and target angle</li> <li>○ Tube kV</li> <li>○ Tube mA</li> <li>○ Filament current</li> <li>○ Additional filtration</li> </ul> </li> </ul>
	4.6.1.2 Understand the key design principles and operation of kilovoltage therapy units	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references.</li> <li>• Observe installation, repair, maintenance and QA of kilovoltage therapy units</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes safety systems and interlocks</li> <li>• Describes key components of kilovoltage therapy unit including:               <ul style="list-style-type: none"> <li>○ HV generating system</li> <li>○ X-ray tube (typical composition and arrangement of cathode, anode, exit window)</li> <li>○ Control unit</li> <li>○ Beam termination system: timer or dose</li> <li>○ Filters (purpose and typical composition)</li> <li>○ Cone / applicators (typical dimensions, composition and SSD)</li> <li>○ Stand</li> </ul> </li> <li>• Explains what is meant by superficial and deep therapy and describes typical configurations of units designed for these types of therapy (block diagram)</li> </ul>
Level 2	4.6.2.1 Perform acceptance tests for a kilovoltage therapy unit	<ul style="list-style-type: none"> <li>• Read and summarise references.</li> <li>• Read previous departmental acceptance reports.</li> <li>• Perform acceptance tests on a new or upgraded unit or repeat acceptance procedure for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Acceptance report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Explains goals of acceptance testing and general order of the tests.</li> <li>• Identifies appropriate legislative requirements</li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g. manufacturer's protocol, CAPCA 2005, Van Dyk §9.4.1 &amp; §9.5.1.</li> <li>• Identifies limitations and tolerances</li> <li>• Draws appropriate conclusions from results</li> <li>• Explains relationship between acceptance tests and ongoing QA.</li> </ul>



	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	4.6.2.2 Perform commissioning tests for a kilovoltage therapy unit	<ul style="list-style-type: none"> <li>• Read and summarise references.</li> <li>• Read previous departmental commissioning reports.</li> <li>• Perform commissioning tests on a new or upgraded kV unit or repeat commissioning procedure for an existing system</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Commissioning report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the relevance of each major step in the commissioning procedure including: <ul style="list-style-type: none"> <li>○ Selection of equipment</li> <li>○ Radiation safety and surveys</li> <li>○ Mechanical tests of system and applicators</li> <li>○ Data for treatment planning</li> <li>○ Reference calibrations</li> <li>○ End to end testing</li> <li>○ Independent checks</li> <li>○ Setup of QA baselines</li> <li>○ Staff training</li> <li>○ Documentation</li> </ul> </li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g., CAPCA 2005, Van Dyk §9.4.2 and §9.5.2 or departmental protocol</li> <li>• Justifies choice of use of measured or published data, e.g., PDD, BSF</li> <li>• Draws appropriate conclusions from results</li> <li>• Identifies limitations and tolerances</li> <li>• Explains relationship between commissioning tests and ongoing QA.</li> </ul>
	4.6.2.3 Perform QA for a kilovoltage therapy unit	<ul style="list-style-type: none"> <li>• Read and summarise references.</li> <li>• Read previous departmental QA reports and protocols.</li> <li>• Perform regular (e.g., daily, weekly, monthly, annual) QA on a kV unit</li> <li>• Review common faults and interlocks encountered on the unit and corrective action taken</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• QA report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the role of a QA program and its relevance to patient outcomes</li> <li>• Identifies roles of multidisciplinary team in QA, e.g. AAPM TG40.</li> <li>• Explains purpose of QA tests and their tolerances</li> <li>• Explains test frequency and relationship between daily, medium and longer term QA.</li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g. CAPCA 2005, Van Dyk §9.4.3 and §9.5.3, ACPSEM 1997 Table A3</li> <li>• Draws appropriate conclusions from results</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	4.6.3.1 Perform quality management and provide scientific advice on kilovoltage therapy units	<ul style="list-style-type: none"> <li>• Participate in managing acceptance of a kV unit</li> <li>• Participate in managing commissioning of a kV unit</li> <li>• Compare and contrast the departmental QM programs with national/international guidelines and best practice and make recommendations</li> <li>• Develop new commissioning project plan for a kV unit</li> <li>• Develop new ongoing QA program for a kV unit</li> <li>• Participate in managing an ongoing QA program for a kV unit</li> <li>• Respond to faults and perform tests to return a kV unit to service after repairs</li> <li>• Analyze the consequences of faults in major components of a kV unit and the tests required to return the unit to service</li> <li>• Prepare specifications and advice for new equipment</li> <li>• Commission a new QC tool, considering advantages, disadvantages and uncertainties.</li> </ul>	<ul style="list-style-type: none"> <li>• New program or report summarizing recommendations</li> <li>• Completed acceptance and/or commissioning records</li> <li>• Mock exam results</li> <li>• Documentation of fault repair and return of kV unit to clinical service</li> </ul>	<ul style="list-style-type: none"> <li>• Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> <li>• Identifies potential consequences (e.g. change in energy, output, mechanical position etc.) as appropriate for the scenario</li> <li>• Identifies appropriate tests and measurements and a logical order in which to perform them</li> <li>• Understands the implications of differences between test conditions and clinical use of the equipment (e.g. number of MU delivered, SSD etc.)</li> <li>• Understands importance of time constraints and meeting milestones and deadlines</li> <li>• Analyses differences between departmental procedures and tolerances and published recommendations.</li> </ul>

## COMPETENCY 4.7 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON ONCOLOGY INFORMATION SYSTEMS

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	4.7.1.1 Understand the key design principles and operation of Oncology Information Systems	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise references on OISs such as IPEM93</li> <li>• Observe the use of OIS in a clinical department for, for example: <ul style="list-style-type: none"> <li>○ Patient booking and scheduling</li> <li>○ Medical records</li> <li>○ Record and verify system</li> <li>○ Image storage</li> <li>○ Dosimetry information</li> </ul> </li> <li>• Read and summarize references on electronic communication standards used in radiation oncology such as DICOM, DICOM RT, HL7</li> <li>• Read and summarise reports and literature on radiation accidents and incidents attributed to human error.</li> <li>• Discuss with RT, IT and other relevant staff how they use the OIS. Write summary notes on this.</li> <li>• Observe use of an R&amp;V system for patient treatment, assist if possible.</li> <li>• Participate in physics QA tasks using R&amp;V system (e.g. IMRT QA)</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> <li>• Map of dataflow to and from OIS</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning</li> <li>• Review and Q&amp;A with Assessor</li> <li>• Demonstration to assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the key purpose, design principles and operation of an Oncology Information System, for example, using a map dataflow diagram which identifies where data is sourced (such as patient demographics) and where data is distributed (such as billing or treatment delivery system).</li> <li>• Describes the implementation planning phase for an Oncology Information System, including, for example: <ul style="list-style-type: none"> <li>○ Engagement of stakeholders and establishment of multi-disciplinary team</li> <li>○ System map and interdependencies</li> <li>○ Relational database design and operation</li> <li>○ Time and resource allocation</li> <li>○ Network security</li> <li>○ Data security requirements</li> <li>○ Data integrity requirements</li> <li>○ Training plan</li> </ul> </li> <li>• Describes electronic communication standards (e.g. Ethernet, FTP, DICOM, DICOM-RT, HL7)</li> <li>• Discusses impact and importance of OIS in minimising risk for radiotherapy practice and the need to quality assure these systems</li> <li>• Describes purpose and administration of a R&amp;V system and its place in the wider oncology information system</li> <li>• Explains how data is entered into a R&amp;V system and how it is checked</li> <li>• Explains key features of a R&amp;V system (e.g. tolerance tables, interlocks, user rights and warnings)</li> </ul>
Level 2	4.7.2.1 Perform acceptance tests for an Oncology Information System	<ul style="list-style-type: none"> <li>• Read and summarise references, such as IPEM93</li> <li>• Read previous departmental acceptance reports.</li> <li>• Perform acceptance tests on a new or upgraded system or repeat acceptance procedure for an existing system</li> <li>• Consult and coordinate with RT, IT and other relevant staff in their roles in acceptance of the OIS.</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Acceptance report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Explains goals of acceptance testing and general order of the tests.</li> <li>• Identifies appropriate legislative requirements</li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g., IPEM Report 93 or vendor protocol</li> <li>• Identifies differences between vendor protocol and a published protocol, such as IPEM 93</li> <li>• Identifies limitations and tolerances</li> <li>• Draws appropriate conclusions from results</li> <li>• Explains relationship between acceptance tests and ongoing QA.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	4.7.2.2 Perform commissioning tests for an Oncology Information System	<ul style="list-style-type: none"> <li>• Read and summarise references, such as IPEM93</li> <li>• Read previous departmental commissioning reports.</li> <li>• Perform commissioning tests on a new or upgraded system or repeat commissioning procedure for an existing system</li> <li>• Consult and coordinate with RT, IT and other relevant staff in their roles in commissioning of the OIS.</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Commissioning report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the relevance of each major step in the commissioning procedure</li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g., IPEM Report 93</li> <li>• Draws appropriate conclusions from results</li> <li>• Identifies limitations and tolerances</li> <li>• Explains relationship between commissioning tests and ongoing QA.</li> </ul>
	4.7.2.3 Perform QA for an Oncology Information System	<ul style="list-style-type: none"> <li>• Read and summarise references, such as IPEM93</li> <li>• Read previous departmental QA reports and protocols.</li> <li>• Perform regular QA on an Oncology Information System</li> <li>• Consult and coordinate with RT, IT and other relevant staff in their roles in QA of the OIS.</li> <li>• Transfer data to the R&amp;V system from the TPS</li> <li>• Use the R&amp;V system to deliver physics QA fields</li> <li>• Perform an audit of the R&amp;V system</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• QA report</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the role of a QA program and its relevance to patient outcomes</li> <li>• Identifies roles of multidisciplinary team in QA, e.g. IPEM Report 93.</li> <li>• Explains purpose of QA tests and their tolerances</li> <li>• Explains test frequency and relationship between short, medium and longer term QA.</li> <li>• Meets general criteria for practical work</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g., IPEM Report 93</li> <li>• Draws appropriate conclusions from results</li> <li>• Uses OIS efficiently to deliver treatments, such as physics QA or phantom treatments</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	4.7.3.1 Perform quality management and provide scientific advice on Oncology Information Systems	<ul style="list-style-type: none"> <li>• Participate in managing commissioning of a new or upgraded Oncology Information System</li> <li>• Compare and contrast the departmental QM programs with national/international guidelines and best practice and make recommendations</li> <li>• Develop commissioning project plan for a new Oncology Information System</li> <li>• Develop new ongoing QA program for an Oncology Information System</li> <li>• Participate in managing an ongoing QA program for an Oncology Information System</li> <li>• Analyse the consequences of faults in major components of an Oncology Information System and the tests required to return the system to service</li> <li>• Participate in the development of a disaster recovery plan for the Radiotherapy Oncology Information System</li> <li>• Review historical cases of the consequences of faults in Oncology Information Systems</li> <li>• Prepare specifications and advice for a new Oncology Information System</li> </ul>	<ul style="list-style-type: none"> <li>• New program or report summarizing recommendations</li> <li>• Completed acceptance and/or commissioning records</li> </ul>	<ul style="list-style-type: none"> <li>• Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Understands links between an OIS and other systems in radiation oncology department</li> <li>• Understands potential risks and limitations of an OIS, formulates strategies to mitigate them and advises on clinical impact</li> <li>• Makes recommendations for the safe and optimal clinical use of an OIS</li> <li>• Provides scientific justification for recommendations</li> <li>• Refers to literature to support conclusions</li> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> </ul>

## MODULE 5: EXTERNAL BEAM TREATMENT PLANNING

### COMPETENCY 5.1 PERFORM QUALITY MANAGEMENT AND PROVIDE SCIENTIFIC ADVICE ON AN EXTERNAL BEAM RADIOTHERAPY TREATMENT PLANNING SYSTEM

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	5.1.1.1 Understand the requirements for planning data in the department and the management thereof	<ul style="list-style-type: none"> <li>Review planning data books including MV photon, MV electron and kV photon</li> <li>Observe patient planning and independent MU check calculations</li> </ul>	<ul style="list-style-type: none"> <li>Short report</li> <li>Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes all planning data documentation in the department and its role in treatment planning</li> <li>Identifies key components of planning data</li> <li>Describes procedures for quality control of planning data</li> <li>Identifies links between planning data used by different systems (e.g. TPS, independent MU checker and data book), and their relation to treatment unit calibration</li> </ul>
	5.1.1.2 Describe the key features of a computerized external beam radiotherapy treatment planning system	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarize references such as TRS430 Chapters 6, 9 and 10, AAPM TG201 and 106, Pawlicki Quality and Safety in Radiotherapy Chapters 21 and 43 and AS ISO IEC 27002-2006 Information technology - Security techniques</li> <li>Tutorials</li> <li>Observe treatment planning procedures</li> <li>Research and report on features of different TPS</li> <li>Research and report on requirements for security of TPS data</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report</li> <li>Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes the departmental workflow for patients and how the TPS fits into it</li> <li>Identifies key components of a TPS and relates these to the department's operational needs (e.g. functionality, performance specifications, number of workstations, data storage requirements, data security, data input and output, networking, remote access)</li> <li>Describes differences between different vendors' treatment planning systems (pros and cons, different capabilities)</li> <li>Describes how the TPS interfaces with other computer systems in the department such as PACS, imaging equipment, oncology information system, R&amp;V and dosimetry equipment</li> </ul>
	5.1.1.3 Describe the acceptance, commissioning and QA requirements for an external beam radiotherapy treatment planning system.	<ul style="list-style-type: none"> <li>Read and summarise textbooks and published protocols such as IAEA TRS 430</li> <li>Review vendor and departmental guidelines, policies and worksheets for TPS administration and QA</li> <li>Review requirements for retention of patient records e.g. Radiation Oncology Practice Standard 3 and jurisdictional requirements</li> <li>Observe/assist with commissioning, periodic QA tests and tests following TPS software upgrades</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review notes / logbook</li> <li>Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describes key acceptance and commissioning requirements for a TPS and ancillary devices (e.g. as listed in IAEA TRS430 Chapter 8 &amp; 9)</li> <li>Describes key QA requirements for a TPS (e.g. as listed in IAEA TRS430 Chapter 10)</li> <li>Describes purpose of each commissioning and QA test, in terms of their importance for accurate patient dosimetry and the department's clinical operations.</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.1.1.4 Understand the basic principles of external beam photon treatment planning and MU calculation algorithms.	<ul style="list-style-type: none"> <li>• MSc Coursework</li> <li>• Attend tutorials</li> <li>• Read and summarise textbooks, literature and TPS user manuals (such as AARM Reports TG65 and TG114, ICRU Report No 24, ESTRO Booklet 10) covering the following algorithm classes:               <ul style="list-style-type: none"> <li>○ Manual dose calculation</li> <li>○ Measurement-based algorithms such as Milan-Bentley</li> <li>○ Pencil beam</li> <li>○ Convolution/superposition</li> <li>○ Monte Carlo</li> <li>○ Inverse planning</li> <li>○ MU calculation</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Review notes and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Defines key terms used in photon dose calculation such as fluence, point spread kernel, TERMA, KERMA and absorbed dose. (ICRU85)</li> <li>• Describes key principles of each class of algorithm – how is dose/MU calculated?</li> <li>• Describes differences between measurement-based and model-based algorithms and describes typical applications of each.</li> <li>• Identifies input data typically required by algorithms (such as depth doses, profiles, spectra, scatter factors, source size parameters)</li> <li>• Describes methods by which algorithms take into account tissue inhomogeneity, patient contour, field shape, treatment accessories and dynamic treatments</li> <li>• Describes typical limitations of each class of algorithm</li> <li>• Discusses the basics of inverse planning algorithms (both optimisation and leaf sequencing processes, differences between beamlet and direct aperture approaches)</li> </ul>
	5.1.1.5 Understand the basic principles of external beam electron treatment planning and monitor unit calculation algorithms	<ul style="list-style-type: none"> <li>• MSc Coursework</li> <li>• Read and summarise textbooks, literature and TPS user manuals (such as AARM Reports TG65 and TG114, ICRU Report No 24, ESTRO Booklet 10) covering the following algorithm classes:               <ul style="list-style-type: none"> <li>○ Manual dose calculation</li> <li>○ Pencil beam</li> <li>○ Monte Carlo</li> <li>○ MU calculation</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary notes</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes key principles of each class of algorithm – how is dose calculated?</li> <li>• Describes differences between measurement-based and model-based algorithms and describes typical applications of each.</li> <li>• Identifies input data typically required by algorithms (such as depth doses, profiles, output factors, virtual source distance etc.)</li> <li>• Describes methods by which algorithms take into account tissue inhomogeneity, patient contour, field shape, treatment accessories</li> <li>• Describes typical limitations of each class of algorithm</li> </ul>
Level 2	5.1.2.1 Perform commissioning measurements for the planning data book	<ul style="list-style-type: none"> <li>• Collate data for a section of the planning data book in a mock scenario if necessary</li> <li>• Validate existing data in planning book via measurement</li> <li>• Perform uncertainty analysis on planning data</li> </ul>	<ul style="list-style-type: none"> <li>• Report on commissioning tests</li> <li>• Page(s) of data for the data book</li> </ul>	<ul style="list-style-type: none"> <li>• Q&amp;A with assessor</li> <li>• Observation by assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes and performs appropriate data manipulations (such as smoothing, averaging, rounding, normalising)</li> <li>• Presents data in a suitable format for treatment planning</li> <li>• Demonstrates appropriate document control and quality management procedures for the planning data</li> <li>• Explains the relationship between planning data format and departmental MU formalism</li> <li>• Explains links with other departmental reference data</li> <li>• Quantifies uncertainty in data and explains clinical consequences</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.1.2.2 Perform acceptance tests on an external beam radiotherapy treatment planning system.	<ul style="list-style-type: none"> <li>Identify acceptance tests that are required based on clinical need</li> <li>Compare departmental acceptance test protocol with recommendations of TRS430 and TecDoc 1540</li> <li>Perform acceptance tests on a new or upgraded external beam radiotherapy TPS or simulate for existing system</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Report on acceptance tests</li> </ul>	<ul style="list-style-type: none"> <li>Review records</li> <li>Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs tests in accordance with a suitable protocol</li> <li>Explains similarities and differences between departmental protocol/practice and international protocols (e.g. TRS430 / TECDOC 1540)</li> <li>Identifies whether TPS meets local department's clinical needs</li> <li>Competent use of TPS software and operating system as required for tests, including tools for clinical planning, data analysis and system management.</li> <li>Identifies limitations and tolerances</li> <li>Draws conclusions from results</li> <li>Describes significance of tests.</li> <li>Explains relationship between acceptance tests and ongoing QA.</li> </ul>



	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.1.2.3 Perform commissioning tests on an external beam radiotherapy treatment planning system. <sup>3</sup>	<ul style="list-style-type: none"> <li>Identify commissioning tests that are required based on clinical need</li> <li>Compare departmental commissioning protocol with recommendations of TRS430 and TecDoc 1583</li> <li>Review departmental test procedures and worksheets for TPS commissioning.</li> <li>Perform commissioning tests on a new or upgraded external beam radiotherapy TPS or simulate for existing system</li> <li>Participate in multi-disciplinary meetings during TPS commissioning</li> <li>Starting from scratch, commission a photon beam and an electron beam in a real or mock scenario</li> <li>Participate in establishing a program for ongoing QA of TPS</li> <li>Assist with the writing of clinical release notes for a new TPS or algorithm upgrade advising department on changes and/or limitations.</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Report on commissioning tests</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> <li>Imaging aspects from 5.2 may be assessed in conjunction</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs and explains significance of tests listed in a suitable protocol and relates to clinical need</li> <li>Competent use of TPS software and operating system as required for tests, including tools for clinical planning, beam modelling, data analysis and system management.</li> <li>For both a photon beam and an electron beam model: <ul style="list-style-type: none"> <li>Identifies input data required by TPS</li> <li>Describes system's methods of using data entered e.g. PDD data entered but TPR data converted internally or output factors entered by user and collimator scatter factors produced by software.</li> <li>Verifies suitability of input data for modelling, including measurement technique and data manipulations such as smoothing/symmetrizing/normalizing and consistency checks.</li> <li>Describes all parameters used in beam model.</li> <li>Demonstrates logical process for optimizing beam model.</li> <li>Tests accuracy of optimized beam model against measurement, quantifies results and demonstrates awareness of clinical implications.</li> </ul> </li> <li>Understands all the steps required to commission the TPS including development of planning protocols, training staff, documentation</li> <li>Describes relationship between commissioning tests and ongoing QA.</li> <li>Identifies the baseline data required to build an ongoing QA program</li> </ul>
	5.1.2.4 Perform QA tests on an external beam radiotherapy treatment planning system.	<ul style="list-style-type: none"> <li>Review departmental test procedures and worksheets for QA.</li> <li>Perform routine QA checks on a TPS according to departmental protocols</li> <li>Monitor TPS fault logs and system maintenance records</li> <li>Monitor vendor communications about the TPS</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>QA records</li> </ul>	<ul style="list-style-type: none"> <li>Review records</li> <li>Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs and explains significance of tests listed in a suitable protocol and relates to clinical need</li> <li>Competent use of TPS software and operating system as required for tests, including tools for clinical planning, data analysis and system management.</li> <li>Identifies appropriate tolerances for QA tests.</li> <li>Takes appropriate action to ensure patient safety in fault situations and in response to vendor notifications</li> </ul>

<sup>3</sup> Refer to competency 5.2 for commissioning of the imaging aspects of a TPS

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.1.2.5 Assess limitations and risks associated with use of TPS	<ul style="list-style-type: none"> <li>Perform literature review on accuracy of TPS dose calculation.</li> <li>Research incidents/accidents linked to TPS</li> <li>Identify potential sources of error and uncertainty and their magnitude, associated with <ul style="list-style-type: none"> <li>Patient data</li> <li>Beam data</li> <li>Dose calculation algorithms</li> <li>Data transfer</li> </ul> </li> <li>Assist with the writing of clinical release notes for a new TPS or algorithm upgrade advising department on changes and/or limitations.</li> </ul>	<ul style="list-style-type: none"> <li>Literature review</li> <li>Report on errors and incidents</li> <li>Clinical release notes</li> </ul>	<ul style="list-style-type: none"> <li>Review reports</li> <li>Q&amp;A with assessor.</li> <li>May be assessed in conjunction with 5.1.2.2, 5.1.2.3 and 5.1.2.4.</li> </ul>	<ul style="list-style-type: none"> <li>Performs research to identify potential limitations of the TPS</li> <li>Identifies and describes key sources of uncertainty and provides realistic estimate of magnitude.</li> <li>Relates errors and uncertainties in TPS to patient outcome</li> <li>Suggests strategies to reduce uncertainty and the possibility of error.</li> </ul>
Level 3	5.1.3.1 Perform quality management and provide scientific advice on an external beam radiotherapy treatment planning system	<ul style="list-style-type: none"> <li>Participate in managing the acceptance and commissioning of a new or upgraded TPS</li> <li>Participate in managing the commissioning of a new technique on an existing TPS (see also competency 5.4).</li> <li>Provide advice for the purchase of a new or upgraded TPS taking future requirements into consideration.</li> <li>Develop a new QA program for a TPS or analyse an existing QA program and make recommendations</li> <li>Investigate the accuracy of a dose calculation algorithm on a TPS and make recommendations.</li> <li>Participate in audits of TPS accuracy as part of clinical trial QA</li> <li>Respond to TPS faults</li> <li>Perform TPS quality management tasks such as: <ul style="list-style-type: none"> <li>processing manufacturer technical bulletins, advisory notes and product corrections</li> <li>developing procedures for system administration tasks such as data transfer, archival and storage</li> <li>keeping records of quality management activities such as release of new versions, guidelines on use of equipment or limitations, system changes and upgrades, vendor communications, QA audits, monitoring of fault logs etc.</li> </ul> </li> <li>Train others in TPS quality management</li> </ul>	<ul style="list-style-type: none"> <li>New program or protocol, or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Understands potential limitations of TPS and advises on clinical impact</li> <li>Makes recommendations for the safe and optimal clinical use of TPS</li> <li>Demonstrates appropriate quality management processes for the TPS</li> <li>Refers to literature to support conclusions</li> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> </ul>

## COMPETENCY 5.2 PROVIDE SCIENTIFIC ADVICE ON THE SAFE AND OPTIMAL USE OF IMAGING FOR EXTERNAL BEAM RADIOTHERAPY TREATMENT PLANNING

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	5.2.1.1 Understand how images are acquired and used for external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Observe imaging procedures used for planning and treatment in a clinical department including the use of CT, PET, MRI, CBCT and 4D imaging.</li> <li>• Review the different coordinate systems such as those used in the imaging equipment, external lasers, TPS and treatment unit.</li> <li>• Attend planning sessions where different images are used</li> <li>• Follow patients from planning to treatment, focusing on how imaging is used at each stage</li> <li>• Write a summary of the clinical and physical advantages and limitations of different imaging modalities for treatment planning.</li> <li>• Review and report on techniques for image registration including multi-modality image registration and rigid vs. deformable registration</li> <li>• Read departmental protocols describing imaging procedures</li> <li>• Write summary notes on the DICOM standard for medical images</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework,</li> <li>• Short written report.</li> <li>• Logbook notes</li> <li>• Case studies</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A with assessor</li> <li>• May be assessed in conjunction with Module 8 Diagnostic Imaging Medical Physics</li> </ul>	<ul style="list-style-type: none"> <li>• Lists imaging modalities (standard and non-standard) used in radiotherapy, including CT, MRI, PET, CBCT and 4D imaging</li> <li>• Describes how and why different imaging modalities are used in radiotherapy treatment planning (e.g. for diagnosis, staging, identification of and organs at risk, localization)</li> <li>• Identifies key variables in imaging protocols for standard imaging modalities for CT, MRI, PET, CBCT and 4D imaging</li> <li>• Explains pros and cons of clinical imaging techniques (why is CT, MRI, PET, CBCT, 4D imaging a good choice in a given clinical scenario, considering issues such as ability to identify tissues of interest, image distortions, artifacts, spatial resolution) Describes the process of image registration in the context of treatment planning</li> <li>• Describes how patients are positioned for imaging for treatment planning.</li> <li>• Identifies and describes localization methods and aids used in treatment planning images (wires, rectal or bladder markers, fiducials etc.)</li> <li>• Describes the different coordinate systems used in imaging and treatment, such as the coordinate systems used by the imaging equipment, external lasers, TPS and treatment unit,</li> <li>• Relates setup for imaging in treatment planning to setup for treatment</li> <li>• Demonstrates awareness of the DICOM standard for images and its application in radiotherapy</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.2.1.2 Perform basic operations on images used in external beam treatment planning	<ul style="list-style-type: none"> <li>For multimodality images of patients and/or phantoms, follow departmental protocols to:               <ul style="list-style-type: none"> <li>Transfer images between computer systems such as CT, MRI, PET, PACS, TPS, R&amp;V,</li> <li>Use image manipulation tools such as window level, window width, zoom</li> <li>Register images</li> <li>Fuse images</li> <li>Contour target volumes and organs at risk</li> <li>Use tools to modify contoured volumes, such as margin expansion, addition, subtraction</li> <li>Create 2D/3D representations of contoured body and tissue structures</li> <li>Adjust contours to correct for differences between imaging and treatment couches</li> <li>Contour structures and manually assign density or electron density e.g. in MRI images or to correct for artifacts in CT</li> <li>Generate Digitally Reconstructed Radiographs (DRRs)</li> <li>Identify reference points and markers for treatment setup</li> <li>Identify major structures on images</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Registered dataset of multi-modality images including outlined organs at risk and target volumes</li> </ul>	<ul style="list-style-type: none"> <li>Assessment by observation (demonstration of image transfer and use of image manipulation tools to assessor)</li> <li>Q&amp;A session with assessor</li> <li>May be assessed in conjunction with 5.3 (treatment planning)</li> </ul>	<ul style="list-style-type: none"> <li>Describes methods and purpose of contouring in treatment planning</li> <li>Successfully transfers images according to departmental protocols</li> <li>Understands what information is transferred and identifies appropriate quality control checks, including patient ID, image orientation, scan parameters and scaling</li> <li>Identifies major structures on images</li> <li>Proficient use of software for displaying, manipulating, registering, fusing and contouring images</li> <li>Meets the above criteria for at least one patient group involving at least 2 different image modalities. For example: lung with CT and PET, brain or prostate with MRI and CT.</li> </ul>
Level 2	5.2.2.1 Perform commissioning tests and QA required for the use of images in external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarise references such as TRS430, T Pawlicki et al <i>Quality and Safety in Radiotherapy</i>, FM Khan <i>Treatment Planning in Radiation Oncology</i> Chapter 9.</li> <li>Read previous departmental commissioning reports.</li> <li>Perform tests and QA related to the use of imaging systems for external beam radiotherapy treatment planning, such as tests of image transfer, geometric accuracy and image quality. Do this for CT and at least one other imaging modality.</li> <li>Perform tests of imaging software tools such as registration, fusion, contouring, export and import</li> <li>Observe DIMP commissioning and QA tasks</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Summary notes.</li> <li>Test and QA records</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> <li>May be assessed in conjunction with competencies 4.5 and 5.1 and Module 8</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Performs an appropriate set of tests and measurements for a given scenario, to a level required for the images to be used in radiotherapy treatment planning, based on published or local protocols, such as tests of:               <ul style="list-style-type: none"> <li>Image quality</li> <li>Geometric accuracy</li> <li>Software functionality</li> <li>Data transfer accuracy</li> <li>Patient dose</li> </ul> </li> <li>Explains purpose of QA tests and relates them to patient outcomes</li> <li>Draws conclusions from results</li> <li>Identifies limitations and tolerances</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.2.2.2 Analyze the uncertainty associated with the use of imaging systems for external beam treatment planning	<ul style="list-style-type: none"> <li>Literature review or investigation of departmental practices to assess sources of uncertainty associated with: <ul style="list-style-type: none"> <li>Imaging systems</li> <li>Image fusion and registration</li> <li>Contouring (e.g., intra- and inter-observer)</li> <li>Applying margins</li> </ul> </li> <li>Review criteria for the use of imaging in a clinical trial</li> </ul>	<ul style="list-style-type: none"> <li>Written report</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of report.</li> <li>Q &amp; A with assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies key sources of uncertainty in treatment planning associated with different imaging modalities, such as spatial resolution, partial volume effect, image artifacts, geometric distortions, contrast, implants and temporal averaging for CT, MRI, PET, CBCT and 4D imaging.</li> <li>Identifies uncertainties in contouring based on different imaging modalities and combinations of imaging modalities, for example, CT alone or CT + MRI.</li> <li>Determines an evidence based estimate of uncertainty</li> <li>Identifies how uncertainty in part of the process affects overall patient dose delivery</li> <li>Suggests methods to reduce uncertainty</li> </ul>
Level 3	5.2.3.1 Provide scientific advice on the safe and optimal use of imaging for external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>Develop new departmental imaging protocol for external beam radiotherapy treatment planning</li> <li>Review existing protocols and make recommendations</li> <li>Participate in commissioning a new imaging system for external beam radiotherapy treatment planning</li> <li>Resolve imaging issues in external beam radiotherapy treatment planning</li> <li>Participate in research projects and/or clinical trials related to imaging for external beam radiotherapy planning</li> <li>Provide advice for the purchase of a new imaging system for treatment planning, taking current and future requirements into consideration.</li> </ul>	<ul style="list-style-type: none"> <li>New protocol, protocol review</li> <li>Written or oral report.</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Understands potential limitations of imaging modality and advises on clinical impact</li> <li>Makes recommendations for the safe and optimal clinical use of imaging</li> <li>Refers to literature to support conclusions</li> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> </ul>

## COMPETENCY 5.3 PROVIDE SCIENTIFIC ADVICE FOR THE SAFE AND OPTIMAL PRACTICE OF EXTERNAL BEAM RADIOTHERAPY TREATMENT PLANNING

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	5.3.1.1 Understand the principles of tumour staging, dose prescription and reporting	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarise references, including Hansen and Roach (eds) Handbook of Evidence Based Radiation Oncology (2010), UICC TNM Classification of Malignant Tumours, ICRU Reports 50, 62, 71 &amp; 83</li> <li>• Read planning protocols</li> <li>• Perform patient case studies and discuss with radiation oncologist</li> <li>• Attend multi-disciplinary planning audit meetings</li> <li>• Participate in small group discussions of Problem Based Learning scenarios</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Short report</li> <li>• Case study reports</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes ICRU volume definitions such as GTV, CTV, ITV, PTV, OAR, PRV</li> <li>• Describes ICRU recommendations for dose prescription and reporting</li> <li>• Discusses the following points for at least four common treatment sites, such as prostate, breast, head &amp; neck, lung, gynae, skin, rectum, brain               <ul style="list-style-type: none"> <li>○ Basics of tumour staging (TNM classification)</li> <li>○ Planning intent (e.g. radical, adjuvant, prophylactic or palliative)</li> <li>○ Rationale for treatment technique</li> <li>○ Organs at risk and typical tolerance doses</li> <li>○ ICRU volumes and typical margins</li> <li>○ Typical dose and fractionation schemes and rationale for these</li> <li>○ ICRU dose reporting</li> </ul> </li> </ul>
	5.3.1.2 Describe the process of developing a treatment plan for external beam radiotherapy	<ul style="list-style-type: none"> <li>• Read and summarise planning protocols</li> <li>• Patient case studies: Observe and report on the key processes in completing an external beam radiotherapy treatment plan including patient setup on the treatment unit.</li> <li>• Attend RT educator and vendor led training</li> <li>• Attend multi-disciplinary planning audit meetings</li> <li>• Participate in small group discussions of Problem Based Learning scenarios</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Logbook.</li> <li>• Case study reports</li> </ul>	<ul style="list-style-type: none"> <li>• Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Identify key features of the planning process for at least four common treatment sites such as prostate, breast, head &amp; neck, lung, gynae, skin including:               <ul style="list-style-type: none"> <li>○ Patient immobilization</li> <li>○ Simulation, image acquisition and transfer to the TPS</li> <li>○ Decision making process of the Radiation Oncologist including                   <ul style="list-style-type: none"> <li>▪ Defining target volumes and organs at risk</li> <li>▪ Dose prescription</li> <li>▪ Setting dose constraints</li> </ul> </li> <li>○ Decision making process of the planner including                   <ul style="list-style-type: none"> <li>▪ Forward or inverse planning</li> <li>▪ Entering beams and modifiers</li> <li>▪ Beam weighting and plan normalization</li> <li>▪ Dose calculation</li> <li>▪ Plan evaluation (BEV, 2D and 3D isodose displays, DRRs, DVH)</li> <li>▪ Plan optimization based on physical dose and/or biological indices</li> </ul> </li> <li>○ Plan approval including any patient related QA</li> <li>○ Data transfer to record and verify system and treatment unit</li> </ul> </li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.3.1.3 Understand the principles of MV photon external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Tutorials</li> <li>• Sketch isodose distributions for simple plans such as single photon fields, opposed pairs and wedged pairs</li> <li>• Observe treatment and planning procedures in a clinical department. Should cover: <ul style="list-style-type: none"> <li>○ SSD/SAD techniques</li> <li>○ 3D conformal radiotherapy</li> <li>○ field matching (photon/photon, photon/electron)</li> <li>○ non-coplanar beam treatment</li> <li>○ wedges (fixed, motorized, dynamic/virtual)</li> <li>○ shielding (blocks, MLC, jaws)</li> <li>○ IMRT/VMAT</li> </ul> </li> <li>• Read departmental protocols describing treatment planning procedures</li> <li>• Review procedures for correcting planned dose distributions for the effects of the linac couch and other accessories.</li> <li>• Review and report on the effects of patient related factors on MV photon dose distributions, including: <ul style="list-style-type: none"> <li>○ Tissue inhomogeneity</li> <li>○ Patient contour</li> <li>○ Patient internal and external motion</li> <li>○ Contrast media</li> <li>○ Non-tissue equivalent implanted materials such as prostheses, dental fillings, cochlear implants and high density ports on breast expanders.</li> </ul> </li> <li>• Attend RT educator led training and RO registrar training programs</li> <li>• Attend multi-disciplinary planning audit meetings</li> <li>• Perform simple training treatment plans</li> <li>• Patient case studies</li> <li>• Participate in small group discussions of Problem Based Learning scenarios</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework,</li> <li>• Short report.</li> <li>• Logbook notes</li> <li>• Case study reports</li> <li>• Completed treatment plans</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Uses basics physics to describe the effects of beam energy, flattening filter, field size, field shape, beam modifiers, SSD and normalization on photon dose distributions, including their impact on the beam profile, penumbra, depth dose, entry and exit skin dose, isodose distribution and monitor units. Modifiers include shielding, asymmetric jaws, MLC, wedges, compensators, packing, bolus and treatment couch.</li> <li>• Sketches typical depth dose curves and isodose distributions for photon fields, which illustrate surface dose, depth of dose maximum, dose fall off with depth and penumbra.</li> <li>• Discusses differences in beam profile, fluence, penumbra and monitor units for IMRT and VMAT compared with 3DCRT.</li> <li>• Identifies suitable material and thickness for shielding</li> <li>• Describes methods for accounting for treatment couch such as modelling it in the TPS or the use of transmission factors,</li> <li>• Describes the effects of patient related factors on MV photon dose distributions, including: <ul style="list-style-type: none"> <li>○ Tissue inhomogeneity</li> <li>○ Patient contour</li> <li>○ Patient internal and external motion</li> <li>○ Contrast media</li> <li>○ Non-tissue equivalent implanted materials.</li> </ul> </li> <li>• Describes the decision making process of the radiation oncologist and planner in selecting techniques for achieving desired dose distributions with MV photons, including choice of: <ul style="list-style-type: none"> <li>○ Beam energy</li> <li>○ Isocentre location</li> <li>○ Number of beams and their orientation, e.g., single beams, parallel opposed beams, multiple co-planar beams, non-coplanar beams, junctional beams,, IMRT and VMAT techniques</li> <li>○ Beam modifiers</li> <li>○ Beam weighting and normalization</li> <li>○ Combination of photon and electron beams</li> </ul> </li> <li>• Sketches typical dose distributions for junctional fields and explains techniques for improving dose uniformity in junctions.</li> <li>• Discusses how the above points are applied for at least three common treatment sites, such as: prostate, breast, head &amp; neck, lung, gynae, rectum, brain</li> </ul>



	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.3.1.4 Understand the principles of MeV electron external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Tutorials</li> <li>• Sketch isodose distributions for simple plans such as single electron fields</li> <li>• Observe electron planning procedures including the use of include low melting point alloy cutouts, surface and internal shielding, junctions, small fields and oblique incidence and SSD.</li> <li>• Read departmental planning protocols</li> <li>• Patient case studies</li> <li>• Attend RT educator led training and RO registrar training sessions</li> <li>• Attend multi-disciplinary planning audit meetings</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework,</li> <li>• Short report.</li> <li>• Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Uses basics physics concepts to describe the effects of beam energy, field size, field shape, beam modifiers, SSD and normalization on electron dose distributions, including their impact on the beam profile, penumbra, depth dose, entry skin dose, isodose distribution and monitor units. Modifiers include applicators, cutouts, surface and internal shielding, packing and bolus.</li> <li>• Sketches typical depth dose curves and isodose distributions for both standard and small electron fields, which illustrate surface dose, depth of dose maximum, therapeutic range, practical range, bremsstrahlung tail, dose gradient and penumbra.</li> <li>• Identifies suitable material and thickness for shielding MeV electron beams.</li> <li>• Sketches typical dose distributions for junctional fields and explains techniques for improving dose uniformity in junctions.</li> <li>• Describes the effects of patient related factors on electron dose distributions including: <ul style="list-style-type: none"> <li>○ Tissue inhomogeneity</li> <li>○ Patient contour</li> <li>○ Patient internal and external motion</li> <li>○ Contrast media</li> <li>○ Prostheses</li> </ul> </li> <li>• Describes the decision making process of the RO and planner in selecting MeV electron treatment techniques including choice of: <ul style="list-style-type: none"> <li>○ Beam energy</li> <li>○ SSD</li> <li>○ Number of beams and their orientation</li> <li>○ Beam modifiers</li> <li>○ Beam weighting and normalization</li> <li>○ Combination of photon and electron beams</li> </ul> </li> <li>• Discusses how the above points are applied for at least two common treatment sites, such as breast and skin</li> </ul>



	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.3.1.5 Understand the principles of kV external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Tutorials</li> <li>• Sketch isodose distributions for simple plans</li> <li>• Observe kV planning procedures</li> <li>• Read departmental planning protocols</li> <li>• Patient case studies</li> <li>• Above should include surface and internal shielding.</li> <li>• Participate in small group discussions of Problem Based Learning scenarios ‘</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework,</li> <li>• Short report.</li> <li>• Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Uses basic physics concepts to describe the effects of energy, field size, field shape, beam modifiers, SSD, penumbra and normalization on kV dose distributions, including their impact on beam profile, depth dose, skin dose, isodose distribution and monitor units/treatment time. Modifiers include applicators, cutouts, surface and internal shielding, packing and bolus.</li> <li>• Sketches typical PDD and isodose distributions for low and high kV beams</li> <li>• Identifies suitable material and thickness for shielding</li> <li>• Describes the effects of patient related factors on kV dose distributions including: <ul style="list-style-type: none"> <li>○ Tissue inhomogeneity</li> <li>○ Patient contour</li> <li>○ Patient internal and external motion</li> <li>○ Prostheses</li> </ul> </li> <li>• Describes RO and RT decision making including factors influencing choice of kV photon treatment techniques for achieving desired dose distributions, such as: <ul style="list-style-type: none"> <li>○ Beam energy</li> <li>○ SSD</li> <li>○ Beam orientation</li> <li>○ Beam modifiers</li> </ul> </li> <li>• Discusses how the above points are applied for at least two patient cases</li> </ul>
	5.3.1.6 Understand basic principles of external beam monitor unit and treatment time calculations	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Tutorials</li> <li>• Read and summarise the literature [e.g. Mayles Ch. 23.3 , Khan Ch. , ESTRO Booklets 3 and 10, AAPM TG 114]</li> <li>• Read departmental planning protocols</li> <li>• Review the planning data book</li> <li>• Perform MU calculations for simple cases.</li> <li>• Report on a different MU calculation method (e.g. from another department or the literature)</li> <li>• Participate in measurement of data for MU calculations</li> <li>• Patient case studies, focusing on MU calculations and checks</li> <li>• Problem Based Learning scenarios – small group discussion</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework,</li> <li>• Short report.</li> <li>• Logbook notes</li> <li>• MU calculation examples</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how patient dose is related to absorbed dose under reference conditions via monitor unit or treatment time calculations</li> <li>• For at least two different formalisms, one of which is the formalism used in the registrar’s department, describes equations used for monitor unit and treatment time calculations for kV photon, MV photon and MeV electron fields</li> <li>• Defines all factors in the equations, describes how they are determined and describes how they relate to reference conditions</li> <li>• Applies equations to simple SSD and isocentric MU and time calculation cases, including single fields and opposed pairs.</li> <li>• Aware of methods for MU and time calculation for different treatment techniques, including standard photon (SSD and isocentric) and electron techniques, and specialist techniques such as IMRT, VMAT, TBI and TSET</li> <li>• Aware of limitations in MU and treatment time calculations</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	5.3.2.1 Perform megavoltage external beam treatment planning according to established protocols	<ul style="list-style-type: none"> <li>Perform treatment planning for a variety of treatment sites according to established protocols, including at least:               <ul style="list-style-type: none"> <li>Four plans requiring use of the computerized TPS</li> <li>One IMRT or VMAT plan</li> <li>One manual MV photon plan</li> <li>One plan involving the use of electrons</li> </ul> </li> <li>For example:               <ul style="list-style-type: none"> <li>Prostate</li> <li>Breast</li> <li>Head &amp; neck</li> <li>Lung</li> <li>Gynae</li> <li>CNS</li> <li>Rectum</li> <li>Skin</li> <li>Palliative or emergency patients</li> </ul> </li> <li>Calculate MU using TPS and check system</li> </ul>	<ul style="list-style-type: none"> <li>Completed treatment plans and documentation</li> </ul>	<ul style="list-style-type: none"> <li>Review completed plans</li> <li>Q&amp;A with Assessor.</li> <li>Observation of planning by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Demonstrates ability to perform treatment planning according to established protocols including at least:               <ul style="list-style-type: none"> <li>Four plans requiring use of the computerized TPS</li> <li>One IMRT or VMAT plan</li> <li>One manual MV photon plan</li> <li>One electron plan</li> </ul> </li> <li>Explains rationale for protocol, including dose to PTV and sparing of OAR</li> <li>Produces plan that meets protocol requirements</li> <li>Describes strategy used to achieve acceptable plan, such as choice of beam modality and energy, beam angles, field sizes and modifiers</li> <li>Consults a colleague experienced in planning as to whether the plans would be acceptable</li> <li>Uses computerized treatment planning system competently and efficiently</li> <li>Correctly calculates MU using TPS and check system</li> <li>Identifies any aspects that would need to be raised with the ROs and RTs, e.g. internal or external shielding, bolus, small fields, stand-off etc.</li> </ul>
	5.3.2.2 Perform kV external beam treatment planning according to established protocols	<ul style="list-style-type: none"> <li>Perform treatment planning for at least two patient cases</li> <li>Calculate MU or treatment time manually and using check system if available</li> <li>Investigate rationale for choosing kV or electrons for specific cases</li> </ul>	<ul style="list-style-type: none"> <li>Completed treatment plans and documentation</li> </ul>	<ul style="list-style-type: none"> <li>Review completed plans and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>For at least two kV patient cases:               <ul style="list-style-type: none"> <li>Describes rationale for protocol including margins and sparing of OAR where relevant</li> <li>Produces plan that meets protocol requirements</li> <li>Describes strategy used to achieve acceptable plan, such as beam energy, beam orientation, field sizes, packing, bolus and shielding</li> <li>Consults a colleague experienced in kV planning as to whether the plans would be acceptable</li> <li>Correctly calculates MU or treatment time</li> <li>Identifies any aspects that would need to be raised with the ROs and RTs, e.g. internal or external shielding, stand-off etc.</li> </ul> </li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.3.2.3 Understand all procedures required before plan proceeds to clinical treatment.	<ul style="list-style-type: none"> <li>• Complete documentation required for treatment</li> <li>• Follow patients from planning to treatment, identifying: <ul style="list-style-type: none"> <li>○ how patient setup procedures impact on planning and treatment</li> <li>○ the importance of the R&amp;V system</li> <li>○ the roles of multi-disciplinary team members in each part of the process</li> </ul> </li> <li>• Review ARPANSA RPS14.3 Safety Guide and/or NRL Code of Practice C12 recommendations for external beam treatment planning<sup>4</sup>.</li> <li>• Audit departmental procedures against RPS 14.3 or NRL recommendations</li> </ul>	<ul style="list-style-type: none"> <li>• Completed documentation</li> <li>• Audit report</li> </ul>	<ul style="list-style-type: none"> <li>• Review documentation and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Completes treatment documentation</li> <li>• Understands appropriate authorization before treatment commences</li> <li>• Explains how patient setup information is transferred from imaging, through planning to treatment, including the record and verify system.</li> <li>• Understands the complete chain to ensure safe delivery of treatment</li> <li>• Understands the importance of each step in the chain</li> <li>• Understands the role of the multi-disciplinary team members in each step of the chain</li> </ul>

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<sup>4</sup> It is recommended that New Zealand registrars also read ARPANSA RPS 14.3, as it contains more detail than NRL Code of Practice C12.

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	5.3.3.1 Provide scientific advice for the safe and optimal practice of external beam radiotherapy treatment planning	<ul style="list-style-type: none"> <li>• Provide physics support in the development of a new departmental planning protocol (see also Competency 5.4)</li> <li>• Review existing protocols and make recommendations</li> <li>• Provide advice to clinicians and therapists on planning issues, such as               <ul style="list-style-type: none"> <li>○ contrast media</li> <li>○ normalization point positioning</li> <li>○ junctions</li> <li>○ non-tissue equivalent implanted materials such as prostheses, dental fillings, cochlear implants and high density ports on breast expanders</li> <li>○ small fields</li> <li>○ electron oblique fields</li> <li>○ IMRT / VMAT</li> <li>○ re-treatments</li> <li>○ imaging artifacts and density overrides</li> <li>○ technical and IT support</li> <li>○ use of bolus</li> <li>○ impact of treatment accessories on skin dose, dose to target and monitor units</li> </ul> </li> <li>• Assess accuracy of TPS in calculating doses outside the field edge, and discuss the implications for estimation of dose to critical structures such as the lens, pacemakers, defibrillators and foetus.</li> <li>• Compare/contrast brachy vs. kV vs. photons vs. electrons for “difficult” cases e.g. scalp, bridge of nose, penis</li> <li>• Participate in research projects related to treatment planning</li> <li>• Explain rationale for modifications to standard plans for specific cases</li> <li>• Perform evidence based evaluation of site specific treatment margins including setup accuracy study</li> <li>• Analyse the uncertainties involved in the planning process and suggest how planning practice could be improved to reduce uncertainty</li> <li>• Assess a local planning protocol’s compliance with clinical trial requirements</li> </ul>	<ul style="list-style-type: none"> <li>• New protocol, protocol review and written or oral report.</li> </ul>	<ul style="list-style-type: none"> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Understands sources of uncertainty in treatment planning and advises on clinical impact</li> <li>• Makes recommendations for the safe and optimal practice of external beam radiotherapy treatment planning</li> <li>• Refers to literature to support conclusions</li> <li>• Provides appropriate clinical advice</li> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> </ul>

## COMPETENCY 5.4 PROVIDE SCIENTIFIC ADVICE FOR NEW OR SPECIALIST TREATMENT TECHNIQUES

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	5.4.1.1 Understand the process of implementing a new treatment technique	<ul style="list-style-type: none"> <li>Read internal reports relating to introduction of new techniques</li> <li>Review of literature relating to a new technique.</li> <li>Attend multi-disciplinary meetings about introducing new techniques</li> <li>Observe/assist with physics work to support new technique</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes</li> <li>Literature review</li> </ul>	<ul style="list-style-type: none"> <li>Discussion with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Lists key steps in introducing a new technique and explains their significance including: <ul style="list-style-type: none"> <li>Identifying clinical need</li> <li>Resource implications</li> <li>Equipment purchase</li> <li>Data acquisition</li> <li>Protocol development</li> <li>Verification of treatment accuracy</li> <li>Documentation</li> <li>Ongoing QA</li> <li>Training</li> </ul> </li> <li>Describes roles of ROMPs and other professional groups in introducing a new technique</li> </ul>
	5.4.1.2 Understand principles of specialist EBRT treatment techniques	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarise references for TSET, TBI, SRT, Stereotactic Ablative Body Radiotherapy (SABR) and at least three of radiosurgery, electron arc therapy, intraoperative radiotherapy, cyberknife, tomotherapy, protons or other specialist techniques</li> <li>Read and summarize references for motion management techniques such as gating, tracking, adaptive radiotherapy</li> <li>Observe treatment and planning procedures for specialist techniques in a clinical department if possible</li> <li>Read departmental protocols describing specialist treatment techniques</li> <li>Attend training days, workshops and seminars about specialist treatment techniques</li> </ul>	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Short written report.</li> <li>Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Discusses for TSET, TBI, SRT, SABR and at least three of radiosurgery, electron arc therapy, intraoperative radiotherapy, cyberknife, tomotherapy, protons or other specialist techniques: <ul style="list-style-type: none"> <li>conditions for which the technique is used (e.g. bone marrow ablation for TBI) and the associated target volume (e.g., entire skin, bone marrow, small lesions in brain)</li> <li>Typical dose and fractionation schemes</li> <li>Typical dose distributions</li> <li>Broad description of equipment required</li> <li>Overview of imaging, planning and treatment procedures</li> <li>Overview of physics considerations, such as small fields, extended/reduced SSDs, different scatter conditions</li> <li>Techniques for managing patient movement</li> <li>Resource implications</li> <li>Role of ROMPs and other professional groups</li> </ul> </li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	5.4.2.1 Support the development of new treatment techniques	<ul style="list-style-type: none"> <li>Participate in the introduction of a new treatment technique in a real or simulated scenario, such as:               <ul style="list-style-type: none"> <li>IMRT or VMAT, including extending an existing program to a new treatment site</li> <li>Adaptive radiotherapy</li> <li>Gated radiotherapy</li> <li>A new or modified 3DCRT technique (e.g. change to patient immobilization, SSD to SAD technique etc.)</li> <li>One of the specialist techniques listed in 5.4.1.2</li> <li>A new technique required for a clinical trial</li> </ul> </li> <li>Participate in multidisciplinary team meetings introducing new techniques</li> <li>Acquire dosimetry data for new techniques</li> <li>Participate in commissioning equipment required for specialist techniques</li> <li>Participate in commissioning the TPS for the new technique</li> <li>Perform measurements to verify accuracy of treatment plans (in phantom and, if applicable, in vivo)</li> <li>Participate in setting up an ongoing QA protocol for the new technique</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes</li> <li>Departmental experimental books</li> <li>Internal reports</li> <li>Working group minutes</li> </ul>	<ul style="list-style-type: none"> <li>Practical demonstration to assessor, or submission of short report outlining work undertaken.</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes clinical rationale for introducing the new technique</li> <li>Describes workflow for patient planning and treatment for the new technique</li> <li>Performs research to identify issues that need to be investigated and formulates strategies for dealing with them</li> <li>Performs dosimetric measurements required to commission the new technique</li> <li>Uses TPS competently both for commissioning and patient planning for the new technique</li> <li>Performs suitable measurements to verify the accuracy of the new technique (in phantom and, if applicable, in-vivo)</li> <li>Meets general criteria for practical work</li> </ul>
Level 3	5.4.3.1 Provide scientific advice for the development of new or specialist treatment techniques	<ul style="list-style-type: none"> <li>Participate in representing physics on multidisciplinary team introducing a new technique.</li> <li>Participate in managing the implementation of new technology or a new technique</li> <li>Train staff in new techniques</li> <li>Develop treatment delivery and QA procedures for a new technique</li> <li>Prepare a detailed commissioning plan for introduction of a new technique, using a mock scenario if necessary.</li> <li>Develop an ongoing QA program for the new technique.</li> <li>Perform a planning study to investigate the pros and cons of a new technique for specific patient groups</li> <li>Provide physics support for a new technique used in a clinical trial.</li> </ul>	<ul style="list-style-type: none"> <li>Internal report</li> <li>Commissioning plan</li> <li>Oral presentation.</li> </ul>	<ul style="list-style-type: none"> <li>Written report or oral presentation to department</li> </ul>	<ul style="list-style-type: none"> <li>Describes new technique and the implications for clinical practice, workflow and resources, and makes recommendations</li> <li>Identifies risks and sources of uncertainty, and formulates strategies to mitigate them</li> <li>Relates current or proposed departmental practices to best practice described in literature</li> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> </ul>

## COMPETENCY 5.5 PERFORM AND PROVIDE SCIENTIFIC ADVICE ON QUALITY MANAGEMENT OF TREATMENT PLANS

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	5.5.1.1 Understand the principles and key elements of patient plan checking	<ul style="list-style-type: none"> <li>For a variety of body sites and plan types, observe and assist an experienced plan checker with plan checking</li> <li>Review departmental plan checklist</li> <li>Review ARPANSA RPS14.3 and RANZCR-ACPSEM-AIR Tripartite Committee Radiation Oncology Practice Standards (2011) and Supplementary Guide recommendations for planning</li> <li>Summarise the patient plan check process from a global perspective including: what is being checked, where the checks occur in the process and who does them, and the extent to which the defence-in-depth approach may have been applied</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes</li> <li>Brief summary</li> </ul>	<ul style="list-style-type: none"> <li>Review evidence</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Identifies and describes the purpose of the key elements of the plan check in the RANZCR-ACPSEM-AIR Tripartite Committee Radiation Oncology Practice Standards (2011) and Supplementary Guide including: <ul style="list-style-type: none"> <li>patient identification and consent</li> <li>prescription</li> <li>setup and immobilization</li> <li>imaging</li> <li>contouring</li> <li>beam arrangements</li> <li>dose constraints to PTV and OAR</li> <li>independent MU, time or dose check</li> <li>plan verification via measurement</li> <li>transfer to R&amp;V and/or treatment unit</li> </ul> </li> <li>Identifies who is responsible for performing each check and when it occurs in the planning process.</li> <li>Describes how the plan check process meets the defence in depth principles</li> </ul>
	5.5.1.2 Describe the effects of treatment planning errors on dose received by patients	<ul style="list-style-type: none"> <li>Carry out research on radiotherapy errors related to treatment planning &amp; prepare summary. Consider the following information sources: departmental QC records, internet searches, textbooks, ROSIS, IIMS reports/RSC, IAEA, reports from regulators.</li> </ul>	<ul style="list-style-type: none"> <li>Oral presentation to physics – RT team meeting</li> </ul>	<ul style="list-style-type: none"> <li>Review presentation</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes for at least four different examples of treatment planning errors: <ul style="list-style-type: none"> <li>the error</li> <li>factors contributing to the error</li> <li>the clinical impact of the error</li> <li>whether the error could have been picked up through plan QC and if so how</li> </ul> </li> </ul>
	5.5.1.3 Understand methods, measurement equipment and analysis tools to verify the accuracy of treatment plans for individual patients	<ul style="list-style-type: none"> <li>Review the local department protocols and best practice recommendations on performing verification measurements of treatment plans. Examples could include patient specific QA for IMRT, VMAT, gated therapies, junctional fields.</li> <li>Observe/assist with dosimetric verification measurements for individual patients.</li> </ul>	<ul style="list-style-type: none"> <li>Brief summary</li> </ul>	<ul style="list-style-type: none"> <li>Review evidence</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes verification process, i.e. what is required before a plan is approved for treatment</li> <li>Describes rationale behind choice of appropriate dosimeter and phantom for specific patient verification measurements.</li> <li>Describes basic analysis tools for the verification process, such as 2D profiles, 3D isodoses, DVH, dose conformity indices,</li> <li>Describes applicability of distance metrics and dose difference metrics, and methods of combining these (e.g., gamma index), to quantify agreement between plan and measurement.</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	5.5.2.1 Compare treatment plans against quality control benchmarks	<ul style="list-style-type: none"> <li>Perform research to identify suitable benchmarks, for example, Handbook of Evidence based Radiation Oncology (2010), QANTEC guidelines, clinical trial requirements</li> <li>Attend multi-disciplinary planning audit meetings</li> <li>Attend conference presentations on evidence based radiation oncology.</li> <li>For a variety of body sites and plan types, compare plans against benchmarks for dose to target and organs at risk.</li> </ul>	<ul style="list-style-type: none"> <li>Set of plans with accompanying notes on whether plan meets benchmarks</li> </ul>	<ul style="list-style-type: none"> <li>Describe process of plan comparison to assessor</li> </ul>	<ul style="list-style-type: none"> <li>For at least two different treatment types, including 3D conformal and IMRT/VMAT: <ul style="list-style-type: none"> <li>selects suitable quality control benchmark and justifies choice</li> <li>selects appropriate tools for the task such as 2D or 3D isodoses, DVH, dose conformity indices, biological indices</li> <li>interprets information from tools correctly</li> <li>correctly identifies whether plans meet benchmarks</li> </ul> </li> </ul>
	5.5.2.2 Perform QC of individual treatment plans	<ul style="list-style-type: none"> <li>Review the local department plan checking protocol.</li> <li>For a variety of body sites and plan types, complete QC check of patient plans using the local departmental checklist(s).</li> </ul>	<ul style="list-style-type: none"> <li>Range of completed checklists</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of checklists, plus Q&amp;A session</li> <li>Passing internal credentialing exam</li> </ul>	<ul style="list-style-type: none"> <li>For at least four different treatment types: <ul style="list-style-type: none"> <li>Correctly checks that plan meets local protocol requirements</li> <li>Analyses the plan as a whole and not just each check item</li> <li>Describes the purpose of each check</li> <li>Performs checks in an appropriate order</li> <li>Identifies and follows up on any plan errors</li> <li>Discusses implications of plan errors</li> </ul> </li> <li>Meets minimum reporting requirements from ICRU and Tripartite Committee Radiation Oncology Practice Standards (2011)</li> <li>Understands the different checks required for different types of treatment (kV vs. MV etc.)</li> </ul>
	5.5.2.3 Check dose/MU/time accuracy with an independent dosimetry calculation system	<ul style="list-style-type: none"> <li>For a variety of body sites and plan types, perform independent MU/time/dose calculations using the standard departmental system (could be an independent MU check program or manual calculations). Should include MV photon, MV electron and kV photon calculations in the set, plus special techniques where used.</li> </ul>	<ul style="list-style-type: none"> <li>Independent MU calculation worksheets</li> </ul>	<ul style="list-style-type: none"> <li>Supervisor review of worksheets, plus Q&amp;A session</li> <li>Passing internal credentialing exam</li> </ul>	<ul style="list-style-type: none"> <li>Produces correct independent MU checks for a range of patients including MV photons, MeV electrons and kV photons, until the following criteria are met: <ul style="list-style-type: none"> <li>Can explain algorithms used by the independent check systems</li> <li>Understands common sources of discrepancy between independent check systems and TPS, such as corrections for tissue inhomogeneity or lack of scatter</li> <li>Interprets results, identifying when the difference between independent calculation and TPS is outside tolerance limits</li> <li>Follows up out of tolerance results in accordance with departmental protocol</li> </ul> </li> </ul>



	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	5.5.2.4 Perform dosimetric measurements to verify the accuracy of treatment plans for individual patients	<ul style="list-style-type: none"> <li>Transfer patient plans to a phantom geometry, and calculate dose for comparison with measurement</li> <li>Perform dose measurements (point dose and dose plane) and carry out the required analysis according to departmental protocols.</li> <li>Examples could include patient specific QA for IMRT, VMAT, gated therapies, junctional fields.</li> </ul>	<ul style="list-style-type: none"> <li>Completed departmental worksheets showing measurement and analysis</li> </ul>	<ul style="list-style-type: none"> <li>Demonstration to supervisor</li> </ul>	<ul style="list-style-type: none"> <li>Follows departmental protocol or suitable published protocol, e.g. AAPM TG 119</li> <li>Uses TPS tools to transfer plans to the appropriate phantom</li> <li>Exports dose information in form suitable for comparison with measurement (e.g. point doses, fluence maps, planar dose distributions)</li> <li>Selects suitable phantom and measurement equipment and justifies choice</li> <li>Meets general criteria for practical work</li> <li>Interprets results, identifying when results are outside tolerance limits</li> <li>Follows up out of tolerance results in accordance with departmental protocol</li> </ul>
Level 3	5.5.3.1 Perform and provide scientific advice on quality management of treatment plans	<ul style="list-style-type: none"> <li>Perform plan checking for clinical patients</li> <li>Resolve discrepancies between TPS and independent MU check system</li> <li>Routinely perform dosimetric verification of treatment plans for clinical patients</li> <li>Develop protocols for quality management of individual treatment plans</li> <li>Analyze existing treatment planning quality management protocols against international standards and make recommendations.</li> <li>Represent physics on multi-disciplinary teams working on changes to treatment planning QC (e.g. the elimination of paper records)</li> <li>Provide advice to RTs and ROs on use and limitations of plan checking systems, in mock scenario if necessary</li> <li>Audit departmental planning practice for a patient group against published benchmarks and make recommendations</li> <li>Participate in an independent audit of local treatment planning protocols/plans</li> </ul>	<ul style="list-style-type: none"> <li>QC protocol designed by registrar or critical review of existing protocols</li> <li>Meeting minutes or MDT report</li> <li>Departmental memos or protocols.</li> <li>Presentations to department on TPS limitations</li> </ul>	<ul style="list-style-type: none"> <li>Supervisor review of evidence plus Q &amp; A session</li> <li>Mock exam scenario</li> </ul>	<ul style="list-style-type: none"> <li>Critically analyses the plan as a whole and not just each check item</li> <li>Understands purpose of planning QC protocols</li> <li>Understands the importance of different checks and the impact of treatment planning errors on dose delivered to the patient</li> <li>Understands the origin and process of establishment of action levels.</li> <li>Provides quantitative estimates of the impact of TPS limitations for a given treatment plan.</li> <li>Explains sources of discrepancy between TPS and independent checks, and provides appropriate advice for treatment (supported by measurement, if required)</li> <li>Explains the uncertainties that contribute to difference between planned and delivered dose to the patient (e.g. weight change, etc.).</li> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> </ul>

## MODULE 6: BRACHYTHERAPY

Competencies 6.1 – 6.6 contain the Level 1 and Level 2 learning outcomes that are compulsory for all TEAP registrars. Competency 6.7 contains the optional Level 3 learning outcomes for registrars who intend to seek Certification with Level 3 Proficiency in Brachytherapy.

### COMPETENCY 6.1 PARTICIPATE IN ACCEPTANCE, COMMISSIONING AND QA TESTS ON AN HDR SYSTEM

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	6.1.1.1 Understand the basic physics principles of HDR and PDR sources.	<ul style="list-style-type: none"> <li>MSc Coursework</li> <li>Read and summarise textbooks or literature</li> </ul>	<ul style="list-style-type: none"> <li>University assessment</li> <li>Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review notes and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the basic physics of HDR and PDR radioactive sources including               <ul style="list-style-type: none"> <li>source production</li> <li>decay modes</li> <li>exponential decay and half-life</li> <li>physical dimensions and encapsulation</li> <li>energy spectrum</li> <li>activity, specific activity and source strength</li> </ul> </li> <li>Explains what characteristics of an isotope make it suitable for HDR and PDR (not just what is available)</li> </ul>
	6.1.1.2 Describe the design principles and operation of HDR and PDR systems.	<ul style="list-style-type: none"> <li>Read and summarise textbooks and manuals</li> <li>Observe a preventative maintenance service and source change for an HDR or PDR unit</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describe the components of HDR/PDR brachytherapy systems including:               <ul style="list-style-type: none"> <li>radiation safety systems and shielding</li> <li>methods of source movement and positioning</li> <li>applicators/transfer tubes</li> <li>timer systems, dwell times/positions</li> <li>treatment control system, data transfer methods</li> </ul> </li> <li>Explain the differences between afterloaders incorporating HDR and PDR</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	6.1.2.1 Review acceptance and perform commissioning and QA tests on an HDR system	<ul style="list-style-type: none"> <li>• Read and summarise references on acceptance, commissioning, QA and past incidents.</li> <li>• Read previous departmental acceptance and commissioning reports.</li> <li>• Review methods, test procedures and worksheets.</li> <li>• Review acceptance and perform commissioning and QA tests (including tests after faults or repair) on HDR or PDR units, including the: <ul style="list-style-type: none"> <li>○ afterloader</li> <li>○ source</li> <li>○ applicators</li> <li>○ transfer tubes</li> <li>○ ancillary equipment such as templates or jigs</li> <li>○ treatment control computer</li> </ul> </li> <li>• If experience is gained on a PDR unit, visit a department with an HDR unit to gain familiarity with HDR acceptance and commissioning tests.</li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes.</li> <li>• Acceptance and commissioning records and reports</li> <li>• QA records and reports</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> <li>• Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for practical work</li> <li>• Explains significance of acceptance and commissioning tests.</li> <li>• Explains significance of QA tests and frequency.</li> <li>• Explains relationship between acceptance and commissioning tests and ongoing QA.</li> <li>• Identifies tests that are unique to acceptance testing that are not performed in regular QA</li> <li>• Performs tests and measurements listed in a suitable protocol, e.g. ACPSEM 1997 Table A7, AAPM TG-56, ESTRO Guidelines, AAPM TG 59 for: <ul style="list-style-type: none"> <li>○ afterloader</li> <li>○ source</li> <li>○ applicators</li> <li>○ transfer tubes</li> <li>○ ancillary equipment such as templates or jigs</li> <li>○ treatment control computer</li> </ul> </li> <li>• Draws conclusions from results</li> <li>• Identifies limitations and tolerances</li> <li>• Analyses uncertainties and sources of error and their implications</li> <li>• Discusses QA tests required after faults and repairs</li> <li>• Discusses past incidents e.g. ICRP 103</li> </ul>
	6.1.2.2 Participate in emergency drills for an HDR system	<ul style="list-style-type: none"> <li>• Read and summarise references on past emergencies</li> <li>• Participate in emergency drills</li> <li>• Review emergency procedures</li> </ul>	<ul style="list-style-type: none"> <li>• Training drill certificate</li> <li>• Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>• Review records and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>• Explains roles and responsibilities in an emergency</li> <li>• Discusses past emergencies e.g. ICRP 103, IAEA website</li> <li>• Participates in emergency drills for an HDR system</li> <li>• Identifies equipment required for emergencies</li> </ul>

## COMPETENCY 6.2 PARTICIPATE IN CALIBRATION OF HDR BRACHYTHERAPY SOURCES ACCORDING TO ESTABLISHED PROTOCOLS

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	6.2.1.1 Describe how calibration factors are transferred from the PSDL to departmental chambers used in brachytherapy	<ul style="list-style-type: none"> <li>University coursework</li> <li>Read textbooks</li> <li>Tutorials, publications</li> </ul>	<ul style="list-style-type: none"> <li>University assessment</li> <li>Logbook notes</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Assessor review of evidence / discussion</li> </ul>	<ul style="list-style-type: none"> <li>Identifies primary standard for both well and cylindrical chambers</li> <li>Identifies correct calibration certificate for ionisation chamber. Explains process of transfer of calibration factors from PSDL to department for both well and cylindrical chambers</li> <li>Identifies relevant references</li> </ul>
	6.2.1.2 Describe the purpose of source strength calibration in a department	<ul style="list-style-type: none"> <li>Tutorials</li> <li>Discussions with colleagues</li> </ul>	<ul style="list-style-type: none"> <li>Log book notes.</li> <li>Summary of key points</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the need for accuracy in the determination of absorbed dose.</li> <li>Explains how source strength is specified for brachytherapy sources.</li> <li>Explains the relationship between source strength and reference air kerma rate.</li> </ul>
	6.2.1.3 Understand the key principles of the protocol used for source strength determination in a department	<ul style="list-style-type: none"> <li>MSc Coursework</li> <li>Read and summarise textbooks or literature</li> <li>Observe source calibration with well chamber and cylindrical chamber</li> <li>Read departmental protocols</li> </ul>	<ul style="list-style-type: none"> <li>University assessment.</li> <li>Log book notes.</li> <li>Summary of key points.</li> </ul>	<ul style="list-style-type: none"> <li>RPL.</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Identifies correct protocol e.g. TecDoc 1274.</li> <li>Explains how protocol is implemented in department in terms of                             <ul style="list-style-type: none"> <li>Chamber calibration frequency</li> <li>QA of chambers</li> <li>frequency of source strength calibration (e.g., annually, at source change, after repair)</li> </ul> </li> <li>Describes set up for source calibration including, for example, equipment position to avoid wall scatter, experimental geometry, optimum source and detector position, jigs and holders.</li> <li>Lists steps in calibration procedure for an HDR source</li> <li>Defines and explains all factors in IAEA TecDoc1274 for both well chamber and cylindrical chamber calibration</li> </ul>
Level 2	6.2.1.1 Determine and use reference air kerma rate for HDR brachytherapy sources	<ul style="list-style-type: none"> <li>Measure reference air kerma rate for HDR sources with well and cylindrical chambers.</li> <li>Derive an <math>N_k</math> calibration factor for a cylindrical ionisation chamber.</li> </ul>	<ul style="list-style-type: none"> <li>Records of source strength measurement</li> </ul>	<ul style="list-style-type: none"> <li>Observation and Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work.</li> <li>Correctly calculates reference air kerma rate</li> <li>Compares measured reference air kerma rate with expected value including:                             <ul style="list-style-type: none"> <li>knowledge of applicable tolerance</li> <li>identification of action to be taken if values outside typical variation and tolerance</li> </ul> </li> <li>Derives benchmark values for routine QA checks of reference air kerma rate</li> <li>Identifies source strength to be used for planning (measured or manufacturer's)</li> <li>Prepares source data for treatment planning</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
					<ul style="list-style-type: none"> <li>• Checks treatment planning source decay tables versus control station</li> <li>• Aware of where and how source data is used – including checking and notification mechanisms</li> <li>• Explains differences in calibration procedures for LDR and HDR</li> </ul>
	6.2.2.2 Analyze the uncertainty of reference air kerma rate determination	<ul style="list-style-type: none"> <li>• Review uncertainty discussions in IAEA TecDoc1274</li> <li>• Review uncertainty estimates in calibration certificates for chambers and sources</li> <li>• Review experimental results from department (reproducibility of results)</li> <li>• Literature review</li> <li>• Compare reference air kerma rate determination via well and cylindrical chambers</li> </ul>	<ul style="list-style-type: none"> <li>• Written report</li> </ul>	<ul style="list-style-type: none"> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Realistic assessment of overall uncertainty in reference air kerma rate determination</li> <li>• Identifies methods to minimize uncertainties</li> <li>• Explains advantages, disadvantages and uncertainties associated with source calibration using a well chamber and a cylindrical chamber</li> <li>• Explains impact of calibration errors on overall patient dose delivery, and links with probability of tumour control and normal tissue complication and any relevant incidents that have occurred</li> </ul>

## COMPETENCY 6.3 PARTICIPATE IN ACCEPTANCE, COMMISSIONING AND QA TESTS OF AN HDR BRACHYTHERAPY TREATMENT PLANNING SYSTEM

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	6.3.1.1 Understand the basic principles of brachytherapy treatment planning algorithms.	<ul style="list-style-type: none"> <li>MSc Coursework</li> <li>Read and summarise textbooks or literature</li> <li>Compare source data in TPS with published data</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review notes and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Defines source strength and its relation to source activity and air kerma rates</li> <li>Understands treatment planning system requirements for source specification including: <ul style="list-style-type: none"> <li>Selection of correct source type/model</li> <li>Input of correct source strength</li> </ul> </li> <li>Understands uncertainties associated with source data</li> <li>Explains key principles of algorithms including, source strength, inverse square law, line and point source, anisotropy, source energy and its relation to scatter and attenuation, source decay, treatment time.</li> <li>Defines and explains all factors in TG43 and updates</li> <li>Identifies the origin of the source related planning data used in brachytherapy planning systems</li> <li>Awareness of model based treatment planning algorithms</li> </ul>
	6.3.1.2 Describe the QA requirements for an HDR brachytherapy treatment planning system.	<ul style="list-style-type: none"> <li>Read and summarise textbooks and manuals</li> <li>Observe routine QA tests and tests following software upgrades</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Lists QA tests (including frequencies and tolerances) for a brachytherapy TPS (e.g. TRS 430) with respect to the following: <ul style="list-style-type: none"> <li>Image input</li> <li>Catheter/source reconstruction/position</li> <li>Defining target volumes and organs at risk</li> <li>Dosimetry</li> <li>Optimisation</li> <li>Plan evaluation (DVH etc.)</li> <li>Data transfer to treatment unit</li> </ul> </li> </ul>
Level 2	6.3.2.1 Participate in commissioning and QA of an HDR brachytherapy treatment planning system	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Read previous departmental commissioning reports and review methods, test procedures and worksheets.</li> <li>Perform commissioning tests on a new or upgraded brachytherapy TPS or repeat commissioning for existing system, for example after entry of new source data</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Commissioning reports</li> </ul>	<ul style="list-style-type: none"> <li>Review records and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Participates in tests and measurements listed in a suitable protocol, e.g. TRS 430</li> <li>Draws conclusions from results</li> <li>Identifies limitations and tolerances</li> <li>Explains significance of commissioning and QA tests.</li> <li>Explains relationship between acceptance and commissioning tests and ongoing QA.</li> </ul>

## COMPETENCY 6.4 PARTICIPATE IN APPLICATION OF IMAGING MODALITIES FOR HDR BRACHYTHERAPY

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	6.4.1.1 Understand principles of imaging modalities used for HDR brachytherapy	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Observe brachytherapy imaging procedures in a clinical department</li> <li>• Attend planning sessions where different images are used</li> <li>• Read departmental protocols describing imaging procedures</li> <li>• E-learning</li> <li>• Observe QA aspects of brachytherapy imaging</li> <li>• Investigate safety aspects associated with brachytherapy equipment in imaging e.g. metal applicators</li> </ul>	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Written report</li> <li>• Logbook notes</li> <li>• Presentation on topic</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Q&amp;A session with supervisor</li> </ul>	<ul style="list-style-type: none"> <li>• Lists imaging modalities used clinically, including CT, ultrasound, MRI and planar x-rays.</li> <li>• Describes how images are used (e.g. for applicator reconstruction, identification of PTV, identification of organs at risk etc.)</li> <li>• Describes optimal parameters for imaging protocols, including for: <ul style="list-style-type: none"> <li>○ planar x-rays: kV, mAs, FFD,</li> <li>○ CT: kV, mAs, FOV, slice width, slice spacing</li> <li>○ MRI: slice width, slice spacing, imaging sequence</li> <li>○ US: slice separation</li> </ul> </li> <li>• Lists QA aspects of brachytherapy imaging, e.g. artifact reduction, deformation and accuracy of geometry in the TPS with specific reference to: <ul style="list-style-type: none"> <li>○ Catheter/applicator reconstruction</li> <li>○ accurate determination of dwell positions relative to the catheter/applicator</li> </ul> </li> </ul>
Level 2	6.4.2.1 Explain selection of imaging modalities for HDR brachytherapy	<ul style="list-style-type: none"> <li>• Perform research to identify international guidelines for the use of imaging in HDR brachytherapy</li> <li>• In a clinical centre or at a workshop, use images taken for insertion, treatment planning and pre-treatment verification with the following imaging modalities: <ul style="list-style-type: none"> <li>○ Radiographs</li> <li>○ CT</li> <li>○ MRI</li> <li>○ Ultrasound</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Summary notes</li> </ul>	<ul style="list-style-type: none"> <li>• Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>• Explains pros and cons of imaging modalities for insertion, treatment planning and pre-treatment verification (why is ultrasound, CT, MRI a good choice? e.g., image distortions or artifacts).</li> <li>• Identifies appropriate consensus documents for imaging modalities, e.g. GEC-ESTRO recommendations for gynaecological HDR brachytherapy</li> <li>• Describes how patients are positioned and identifies immobilization devices used</li> <li>• Describes how imaging equipment is positioned with respect to patient (e.g. tube position for planar x-rays, stepper for US etc.)</li> <li>• Identifies any localization aids used (wires, rectal or bladder markers, fiducials etc.)</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	6.4.2.2 Analyze the uncertainty associated with the use of imaging systems for HDR brachytherapy	<ul style="list-style-type: none"> <li>Literature review</li> <li>Assessment of all imaging modalities for sources of random and systematic error for the following;               <ul style="list-style-type: none"> <li>Planar x-rays</li> <li>CT</li> <li>MRI</li> <li>US</li> </ul> </li> <li>Compare and contrast imaging for gynaecological and prostate cancer in terms of reproducibility and uncertainty</li> </ul>	<ul style="list-style-type: none"> <li>Written report</li> </ul>	<ul style="list-style-type: none"> <li>Assessor review of report. Q &amp; A with assessor.</li> <li>Assessment can be literature or practical based.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies key sources of uncertainty for each of the following imaging modalities               <ul style="list-style-type: none"> <li>Planar x-rays</li> <li>CT</li> <li>MRI</li> <li>US</li> </ul> </li> <li>Calculates realistic estimate of uncertainty</li> <li>Identifies how uncertainty in particular measurement affects overall patient dose delivery</li> <li>Suggests methods to reduce uncertainty</li> </ul>



## COMPETENCY 6.5 PARTICIPATE IN HDR BRACHYTHERAPY TREATMENT PLANNING AND DELIVERY

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	6.5.1.1 Understand HDR and PDR treatment regimes	<ul style="list-style-type: none"> <li>Read and summarise textbooks, literature or consensus documents for the following treatment types:                             <ul style="list-style-type: none"> <li>Intracavitary</li> <li>Interstitial</li> <li>Superficial</li> <li>Intraluminal</li> </ul> </li> <li>Attend patient pre-treatment consultation and/or a multidisciplinary meeting</li> <li>Follow patient pathways from applicator insertion to treatment delivery for a range of treatment types, including but not limited to:                             <ul style="list-style-type: none"> <li>Intracavitary</li> <li>Interstitial</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Summary notes</li> <li>Logbook</li> </ul>	<ul style="list-style-type: none"> <li>Presentation to group</li> <li>Review notes and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describes why a patient is selected for HDR and PDR treatments instead of or in combination with EBRT</li> <li>Describes HDR and PDR treatment regimes, including                             <ul style="list-style-type: none"> <li>Dose</li> <li>Dose rate</li> <li>Fractionation</li> <li>Treatment process</li> <li>Immobilisation</li> <li>Resource requirements</li> <li>Radiation safety and protection</li> </ul> </li> </ul>
	6.5.1.2 Understand principles of HDR brachytherapy treatment planning	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarise references</li> <li>Draw isodose distributions for point and line sources and describe key points</li> <li>Observe planning procedures in a clinical department or a workshop including the following treatment types:                             <ul style="list-style-type: none"> <li>Intracavitary</li> <li>Interstitial</li> <li>Superficial</li> <li>Intraluminal</li> </ul> </li> <li>Read departmental planning protocols</li> <li>E-learning</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report.</li> <li>Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with supervisor</li> </ul>	<ul style="list-style-type: none"> <li>Understands impact of basic physics on dose distributions, including:                             <ul style="list-style-type: none"> <li>Inverse square law</li> <li>Energy of isotope / attenuation</li> <li>Source construction, active length, encapsulation</li> <li>Source placement for clinical dose distributions</li> </ul> </li> <li>Describes technical methods for achieving desired dose distributions, such as applicators and templates</li> <li>Describes historical development of:                             <ul style="list-style-type: none"> <li>Interstitial implant systems including Paris, Manchester and Quimby systems</li> <li>Gynaecological systems (Manchester)</li> </ul> </li> <li>Describes limitations of historic planning methods and transition to modern image based planning</li> <li>Explains basic principles of optimisation including forward (manual, geometric) and inverse methods</li> <li>Discusses factors to be considered when planning brachytherapy as a monotherapy or in combination with external beam therapy for common treatment sites (e.g., prostate, gynaecological cancer, skin), including                             <ul style="list-style-type: none"> <li>Radiobiology</li> <li>Normal tissue sparing</li> <li>Target volume definition</li> </ul> </li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	6.5.1.3 Describe the operational process in developing a treatment plan for brachytherapy	<ul style="list-style-type: none"> <li>Read and summarise textbooks and manuals</li> <li>Observe the key processes in completing an HDR brachytherapy treatment plan</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Identifies key features of the brachytherapy planning process for example: <ul style="list-style-type: none"> <li>Image input</li> <li>Catheter reconstruction and source positions</li> <li>Defining target volumes and organs at risk</li> <li>Defining planning objectives</li> <li>Optimisation</li> <li>Plan evaluation (DVH, etc.)</li> <li>Data transfer to treatment unit</li> </ul> </li> </ul>
	6.5.1.4 Describe treatment preparation, delivery and QA processes	<ul style="list-style-type: none"> <li>Review and summarise references, e.g. AAPM TG-59</li> <li>Observe the plan checking process</li> <li>Observe treatment preparation processes including assembly and sterilisation of treatment applicators and ancillary equipment</li> <li>Observe pre-treatment QA processes</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Correctly assembles treatment applicators and ancillary equipment for a range of treatment sites</li> <li>Describes the cleaning and sterilisation requirements for brachytherapy treatment equipment</li> <li>Describes the pre-treatment QA processes according to published guidelines, such as AAPM TG-59 recommendations</li> </ul>
Level 2	6.5.2.1 Participate in HDR brachytherapy treatment planning according to established protocols	<ul style="list-style-type: none"> <li>Participate in treatment planning in a clinical department or at a workshop for <ul style="list-style-type: none"> <li>HDR prostate cancer</li> <li>HDR gynaecological cancer,</li> <li>At least one other site, e.g., skin, intraluminal, interstitial</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Completed treatment plans</li> </ul>	<ul style="list-style-type: none"> <li>Review completed plans and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Independently produces plans to meet protocol requirements for <ul style="list-style-type: none"> <li>HDR prostate cancer</li> <li>HDR gynaecological cancer</li> <li>At least one other site, e.g., skin, intraluminal, interstitial</li> </ul> </li> <li>Critically reviews these plans according to established protocol requirements</li> <li>Completes treatment documentation</li> </ul>
	6.5.2.2 Perform calculations of radiobiological equivalence of treatment schemes, including combined EBRT – HDR brachytherapy treatment.	<ul style="list-style-type: none"> <li>Perform radiobiological calculations for combining brachytherapy and external beam radiotherapy treatments</li> </ul>	<ul style="list-style-type: none"> <li>Completed calculations</li> </ul>	<ul style="list-style-type: none"> <li>Review completed calculations and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Correctly uses radiobiological calculation methods</li> <li>Understands the radiobiology behind the calculations</li> <li>Understands the limitations of the calculations</li> <li>Understands how results are used</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	6.5.2.3 Perform plan checks on HDR brachytherapy treatment plans	<ul style="list-style-type: none"> <li>Perform plan checks at a clinical centre or workshop for               <ul style="list-style-type: none"> <li>HDR prostate cancer</li> <li>HDR gynaecological cancer,</li> <li>At least one other site, e.g., skin, intraluminal, interstitial</li> </ul> </li> <li>Review cases where errors have been detected (including mock scenarios) and discuss implications</li> </ul>	<ul style="list-style-type: none"> <li>Completed plan checklists</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>Review checklists and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Explains purpose of plan checking</li> <li>Checks treatment plans for               <ul style="list-style-type: none"> <li>HDR prostate cancer</li> <li>HDR gynaecological cancer</li> <li>At least one other site, e.g., skin, intraluminal, interstitial</li> </ul> </li> <li>Identifies checks required for brachytherapy treatments</li> <li>Critically analyses the plans as a whole and not just each check box option</li> <li>Identifies and follows up on any plan errors</li> <li>Identifies common sources of error in treatment planning from the literature</li> <li>Discusses implications of plan errors</li> </ul>
	6.5.2.4 Identify uncertainties involved in the dose planning processes	<ul style="list-style-type: none"> <li>Critically review a treatment plan in the context of applicator displacement</li> <li>Review and summarise references related to the clinical application of model based dosimetry calculation algorithms (MBDCA), e.g. AAPM TG-186</li> </ul>	<ul style="list-style-type: none"> <li>Notes on plan review</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>Review notes and report and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Discusses consequences of applicator movement</li> <li>Discusses uncertainties in calculated dose due to heterogeneities including:               <ul style="list-style-type: none"> <li>Patient anatomy</li> <li>Non tissue-equivalent materials</li> <li>Air gaps</li> </ul> </li> <li>Discusses these uncertainties in the context of model based dosimetry calculation algorithms (MBDCA)</li> </ul>
	6.5.2.5 Understand all regulatory and safety requirements for clinical treatment	<ul style="list-style-type: none"> <li>Review national and local regulatory and safety requirements for brachytherapy treatment</li> <li>Review departmental emergency procedures</li> <li>Identify roles and responsibilities of brachytherapy team members</li> <li>Using a mock scenario of an HDR brachytherapy source becoming stuck in a patient during treatment, report on all steps required during and after the emergency and perform staff and patient dose calculations</li> </ul>	<ul style="list-style-type: none"> <li>Completed documentation</li> </ul>	<ul style="list-style-type: none"> <li>Review documentation and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describes appropriate authorization before treatment commences</li> <li>Defines the roles and responsibilities of the ROMP, RO and other brachytherapy team members in each step of the process</li> <li>Explains the reporting process in the event of an emergency or incident</li> <li>Performs staff and patient dose calculations following a radiation exposure incident</li> </ul>

## COMPETENCY 6.6 PARTICIPATE IN AN LDR BRACHYTHERAPY PROGRAM

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	6.6.1.1 Understand the basic physics principles of LDR brachytherapy sources	<ul style="list-style-type: none"> <li>MSc Coursework</li> <li>Read and summarise textbooks or literature, for                             <ul style="list-style-type: none"> <li>LDR prostate permanent seed implants</li> <li>eye plaques</li> <li>LDR manual or afterloader</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Summary notes</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review notes and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Explains the basic physics of LDR radioactive sources including                             <ul style="list-style-type: none"> <li>source production</li> <li>decay modes</li> <li>exponential decay and half-life</li> <li>physical dimensions and encapsulation</li> <li>energy spectrum</li> <li>activity, specific activity and source strength</li> </ul> </li> <li>Explains the characteristics of isotopes suitable for LDR brachytherapy (not just what is available)</li> </ul>
	6.6.1.2 Understand LDR treatment regimes	<ul style="list-style-type: none"> <li>Read and summarise textbooks, literature or consensus documents for                             <ul style="list-style-type: none"> <li>LDR prostate permanent seed implants</li> <li>Eye plaques</li> <li>LDR manual or afterloader</li> </ul> </li> <li>Attend patient pre-treatment consultation and/or a multidisciplinary meeting</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes</li> <li>Logbook</li> </ul>	<ul style="list-style-type: none"> <li>Presentation to group</li> <li>Review notes and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Describes LDR treatment regimes, including:                             <ul style="list-style-type: none"> <li>Dose</li> <li>Dose rate</li> <li>Temporary and</li> <li>Permanent (including but not limited to prostate brachytherapy)</li> </ul> </li> <li>Describes patient selection process</li> </ul>
	6.6.1.3 Understand principles of LDR brachytherapy treatment planning	<ul style="list-style-type: none"> <li>MSc coursework</li> <li>Read and summarise references</li> <li>Draw isodose distributions for point and line sources and describe key points</li> <li>Observe LDR Prostate brachytherapy planning procedures in a clinical department</li> <li>Observe LDR planning procedures for temporary implants e.g. eye plaques in a clinical department or at a workshop</li> <li>Read departmental planning protocols</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment</li> <li>Short report.</li> <li>Logbook notes</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Q&amp;A session with supervisor</li> </ul>	<ul style="list-style-type: none"> <li>Understands impact of basic physics on dose distributions, including:                             <ul style="list-style-type: none"> <li>Inverse square law</li> <li>Energy of isotope / attenuation</li> <li>Source construction, active length, encapsulation</li> <li>Source placement for clinical dose distributions</li> </ul> </li> <li>For prostate:                             <ul style="list-style-type: none"> <li>Describes treatment goals and constraints based on dose volume indices such as V100, V200, D90</li> <li>Describes technical methods for achieving desired dose distributions,</li> <li>Describes limitations of historic planning methods and transition to modern image based planning</li> <li>Explains basic principles of optimisation</li> <li>Understands principles of target and OAR definition</li> </ul> </li> <li>For at least one type of temporary implant, (e.g. eye plaques), describes methods for achieving desired dose distributions</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	6.6.1.4 Describe the principles and operation of LDR brachytherapy source delivery systems	<ul style="list-style-type: none"> <li>Read and summarise textbooks and manuals</li> <li>Observe an LDR brachytherapy prostate procedure in a clinical department</li> <li>Review LDR procedures for temporary implants e.g. eye plaques</li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>For LDR prostate permanent seed implants describes               <ul style="list-style-type: none"> <li>radiation safety systems, source handling, shielding,</li> <li>different source delivery systems, including:                   <ul style="list-style-type: none"> <li>manual loading</li> <li>robotic loading including position calibration</li> </ul> </li> <li>catheters and ancillary equipment such as jigs and templates</li> </ul> </li> <li>For temporary LDR (eg eye plaques), describes radiation safety systems, source handling, shielding and applicators</li> </ul>
Level 2	6.6.2.1 Participate in quality management of LDR prostate sources	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>Participate in and/or observe LDR prostate seed management including               <ul style="list-style-type: none"> <li>Seed ordering and receiving</li> <li>Storage</li> <li>Loading</li> <li>Calibration/verification</li> <li>Implantation</li> <li>Post implant follow up</li> <li>Seed inventory and disposal</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Observation</li> <li>Review notes/logbook and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Explains significance of LDR prostate seed management and radiation safety implications of:               <ul style="list-style-type: none"> <li>Seed ordering and receiving</li> <li>Storage</li> <li>Loading</li> <li>Calibration/verification</li> <li>Implantation</li> <li>Post implant follow up</li> <li>Seed inventory and disposal</li> </ul> </li> <li>Participates in source calibration/verification tests and measurements listed in a suitable protocol, e.g. ACPSEM 1997 Table A7 and A8, AAPM TG-56, CAPCA</li> <li>Identifies which source strength value is entered into the TPS e.g. Measured or calibration certificate</li> </ul>
	6.6.2.2 Participate in implementation of LDR prostate brachytherapy imaging equipment for implantation	<ul style="list-style-type: none"> <li>Read and summarise references.</li> <li>In a clinical centre or workshop, participate in:               <ul style="list-style-type: none"> <li>calibration of the template system</li> <li>stepper stabiliser setup</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Summary notes.</li> <li>Logbook.</li> <li>Completion of work as part of HDR prostate procedures</li> </ul>	<ul style="list-style-type: none"> <li>Review notes/logbook and Q&amp;A with Assessor.</li> <li>Recognition of prior learning</li> </ul>	<ul style="list-style-type: none"> <li>Discusses the application of imaging modalities in LDR prostate brachytherapy implant procedures including ultrasound and fluoroscopy</li> <li>Discusses considerations of staff and patient safety in the use of imaging</li> <li>Explains how the ultrasound system and stepper stabilisation device are used to acquire a 3D volume</li> <li>Explains the significance of template calibration including the effects of geometric distortion</li> <li>Identifies the impact on quality of ultrasound images due to loss of contact between probe and tissue surface, artefacts due to air &amp; seeds, image noise, probe frequency</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	6.6.2.3 Perform LDR brachytherapy treatment planning according to established protocols	<ul style="list-style-type: none"> <li>In a clinical centre or workshop, participate in treatment planning for:               <ul style="list-style-type: none"> <li>LDR prostate</li> <li>eye plaque</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Completed treatment plans</li> </ul>	<ul style="list-style-type: none"> <li>Review completed plans and Q&amp;A with Assessor.</li> <li>Observation by Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for practical work</li> <li>Describes steps in pre-treatment planning process including               <ul style="list-style-type: none"> <li>Selection of correct source type/model</li> <li>Selection of correct dosimetry parameters</li> <li>Input of correct source strength</li> <li>Understands uncertainties associated with source data</li> </ul> </li> <li>Discusses advantages and disadvantages of pre-planning and real-time planning approaches for LDR prostate brachytherapy</li> <li>Explains strategies for seed placement to produce plans that meet protocol dose constraints for target coverage and OAR in:               <ul style="list-style-type: none"> <li>LDR prostate,</li> <li>eye plaque</li> </ul> </li> <li>Identifies appropriate plan verification procedures</li> <li>Identifies limitations and tolerances</li> <li>Completes treatment documentation</li> </ul>
	6.6.2.4 Participate in post implant dosimetry for LDR prostate brachytherapy	<ul style="list-style-type: none"> <li>In a clinical centre or workshop, participate in post implant dosimetry for LDR prostate brachytherapy</li> </ul>	<ul style="list-style-type: none"> <li>Analysis of completed post implant studies</li> <li>Logbook.</li> </ul>	<ul style="list-style-type: none"> <li>Review completed work and Q&amp;A with Assessor.</li> </ul>	<ul style="list-style-type: none"> <li>Critically evaluates and assesses a post-implant dosimetry study</li> <li>Explains the steps involved in the process, including choice of imaging modality</li> <li>Discusses timing of the imaging with respect to time of implant</li> <li>Discusses the pros and cons of the post-implant reconstruction methods i.e. accuracy of source identification, accuracy of target delineation and advantages and disadvantages of combining modalities</li> </ul>

## COMPETENCY 6.7 MANAGE AND PROVIDE SCIENTIFIC ADVICE FOR A BRACHYTHERAPY PROGRAM

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	6.7.3.1 Develop or critically evaluate a quality management program for a brachytherapy system	<ul style="list-style-type: none"> <li>Analyse an existing commissioning and ongoing QA program and make recommendations or develop a new program for a LDR, HDR or PDR system.</li> <li>Respond to faults (consider past published incidents)</li> <li>Write an emergency procedure for an HDR service and conduct emergency drills</li> <li>Analyse an existing or develop a comprehensive safety program for an LDR prostate implant service</li> <li>Audit a QM program at another centre</li> <li>Train others in quality management for brachytherapy</li> </ul>	<ul style="list-style-type: none"> <li>New program or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Review of program or report by assessor</li> <li>Drill into knowledge in an unfamiliar situation in a mock oral exam</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Able to perform quality management for a clinical brachytherapy system under minimal supervision</li> <li>Applies prior knowledge to unfamiliar situations and recognises limitations; e.g. if training completed for HDR, should discuss what would need to be considered for LDR</li> <li>Exercises judgement regarding safe use of brachytherapy equipment in clinical situations</li> </ul>
	6.7.3.2 Perform calibration of brachytherapy sources according to established protocols	<ul style="list-style-type: none"> <li>Mock exam of calibration</li> <li>Respond to a mock fault condition</li> <li>Develop new departmental protocol for absolute dosimetry</li> <li>Review existing protocols and make recommendations</li> <li>Review of department's absolute dosimetry after recalibration of reference chamber</li> <li>Audit dose at another department</li> <li>Compare and contrast different dosimetry protocols</li> </ul>	<ul style="list-style-type: none"> <li>New protocol, protocol review and written or oral report.</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> <li>Drill into knowledge in an unfamiliar situation in a mock practical or oral exam</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Able to perform brachytherapy source calibration for clinical use under minimal supervision</li> <li>Recommends actions to be taken in the event of a discrepancy between measured and certified source strength</li> <li>Applies prior knowledge to unfamiliar situations and recognises limitations</li> <li>Recognises advantages and disadvantages of different source calibration techniques</li> </ul>

	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	6.7.3.3 Provide advice on imaging modalities for brachytherapy	<ul style="list-style-type: none"> <li>Provide advice in mock or real situations for incorporating a new imaging modality into an existing service, e.g., moving from 2D to 3D gynaecological cancer planning</li> <li>Review existing protocols and make recommendations</li> <li>Commission a new imaging system for brachytherapy or repeat commissioning for existing system</li> <li>Resolve imaging issues in brachytherapy</li> <li>Participate in research projects related to brachytherapy imaging</li> <li>Provide advice for the purchase of a new imaging system taking account of current and future requirements</li> </ul>	<ul style="list-style-type: none"> <li>New protocol, protocol review and written or oral report.</li> </ul>	<ul style="list-style-type: none"> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Make recommendations for the safe and optimal clinical use of images in brachytherapy</li> <li>Exercises judgement regarding safe application of brachytherapy imaging modalities in clinical situations</li> <li>Applies prior knowledge to unfamiliar situations and recognises limitations</li> </ul>
	6.7.3.4 Perform quality management for a brachytherapy treatment planning system	<ul style="list-style-type: none"> <li>Analyse an existing acceptance, commissioning and ongoing QA program and make recommendations or develop a new program for a brachytherapy TPS.</li> <li>Provide advice on TPS QM in mock or real situations, e.g. introduction of HDR into a department with only LDR brachytherapy</li> </ul>	<ul style="list-style-type: none"> <li>New program or report summarizing recommendations</li> </ul>	<ul style="list-style-type: none"> <li>Review of program or report by assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication</li> <li>Meets general criteria for professionalism</li> <li>Able to perform quality management for a clinical brachytherapy treatment planning system under minimal supervision</li> <li>Understands potential limitations of TPS and advises on clinical impact</li> <li>Makes recommendations for the safe and optimal clinical use of TPS</li> <li>Demonstrates appropriate quality management processes for the TPS</li> <li>Refers to literature to support conclusions</li> <li>Applies prior knowledge to unfamiliar situations and recognises limitations</li> </ul>



	Learning Outcome	Recommended Items of Training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 3	6.7.3.5 Provide advice on brachytherapy treatment planning and delivery	<ul style="list-style-type: none"> <li>• Develop new departmental treatment planning protocol for brachytherapy (actual or repeat)</li> <li>• Develop new departmental treatment delivery protocol for brachytherapy (actual or repeat)</li> <li>• Review existing protocols and make recommendations</li> <li>• Resolve treatment planning issues in brachytherapy</li> <li>• Participate in research projects related to brachytherapy treatment planning</li> <li>• Explain rationale for modifications to standard plans for specific cases</li> <li>• Analyse the uncertainties involved in the planning process and suggest how planning practice could be improved to reduce uncertainty</li> <li>• Perform treatment planning and delivery under clinical time constraints</li> </ul>	<ul style="list-style-type: none"> <li>• New protocol, protocol review and written or oral report</li> <li>• Case studies</li> </ul>	<ul style="list-style-type: none"> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> <li>• Able to perform treatment planning for a clinical patients under minimal supervision</li> <li>• Applies prior knowledge to treatment planning of unfamiliar sites</li> <li>• Applies prior knowledge to treatment delivery of unfamiliar sites</li> <li>• Exercises judgement regarding safe planning and delivery of brachytherapy treatments</li> <li>• Understands sources of uncertainty in treatment planning and delivery and advises on clinical impact</li> <li>• Makes recommendations for the safe and optimal practice of brachytherapy treatment planning</li> <li>• Refers to literature to support conclusions</li> <li>• Provides appropriate clinical advice</li> </ul>

## MODULE 7: PROFESSIONAL AWARENESS, MANAGEMENT AND TRAINING

### COMPETENCY 7.1 DEMONSTRATE PROFESSIONALISM

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	7.1.1.1 Describe the role of medical physicists and professional medical physics organizations	<ul style="list-style-type: none"> <li>Review and report on the scope of practice and career structure of ROMPs and how TEAP relates to this</li> <li>Draw an organizational chart summarising the radiation oncology department's staff structure, including registrars.</li> <li>Define own career plan and develop a CV.</li> <li>Review and report on the structure of the ACPSEM, including the roles and responsibilities of key committees, office bearers and staff</li> <li>Review the role arrangements of the Radiotherapy Tripartite (RANZCR, ACPSEM, AIR)</li> <li>Review and report on professional, regulatory and standards organizations relevant to ROMPs</li> <li>Keep a record of ongoing topical issues related to ROMPs</li> <li>Join a professional medical physics organization and actively participate</li> <li>Complete Assignment 7.1 from Moodle</li> <li>Review International Labour's definition of Medical Physicist</li> <li>Review IOMP, AFOMP, IAEA and AAPM Policy documents such as the <a href="#">IAEA Human Health Series #25, Roles and Responsibilities, and Education and Training Requirements for Clinically Qualified Medical Physicists</a></li> <li>Become familiar with the TEAP syllabus for Diagnostic Medical Imaging</li> </ul>	<ul style="list-style-type: none"> <li>Organizational chart of department</li> <li>Career plan and up to date CV</li> <li>Evidence of membership of professional organizations</li> <li>Evidence of participation in and contribution to professional activities</li> <li>Short report or oral presentation comparing role and structure of different professional organizations</li> <li>Reflective writing on ROMP topical issues</li> <li>Completed assignment 7.1 from Moodle</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains roles, responsibilities and reporting lines for self and other ROMPs within the department</li> <li>Explains roles and responsibilities for other physicists and engineers in clinical settings, such as DIMPs</li> <li>Describes how the components of TEAP contribute to the development of the skills, knowledge and attitudes required to practice as a professional ROMP (e.g. Brian Thomas talk)</li> <li>Describes broad structure and key activities of ACPSEM (e.g. with reference to the ACPSEM mission statement)</li> <li>Lists key professional organizations of relevance to ROMPs (other than the ACPSEM) and describes their main activities (including other professional groups)</li> <li>Describes links between national and international professional organizations such as ACPSEM, AAPM, AFOMP, IPEM, IOMP etc. and regulatory and standards organizations such as the IAEA, ICRU, ICRP, NRL and ARPANSA,.</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	7.1.1.2 Display respect for ethical and legal responsibilities	<ul style="list-style-type: none"> <li>Review the ACPSEM Code of Ethics and discuss how it should be applied in real or mock scenarios.</li> <li>Compare the ACPSEM Code of Ethics with other ethics policies such as hospital policies or the ethics codes of other professional organizations</li> <li>Investigate the requirements for ethics clearance for clinical research projects.</li> <li>Investigate the requirements for patient consent</li> <li>Attend hospital training sessions on ethical and legal responsibilities, such as occupational health and safety, incident reporting, equal opportunity, bullying, privacy and confidentiality</li> <li>Review the basics of intellectual property laws and report on their application in medical physics, for example in software licensing, warranties, responsibilities in distributing copyright material and ownership of intellectual property in research and development.</li> <li>Complete Assignment 7.1 from Moodle</li> </ul>	<ul style="list-style-type: none"> <li>Contribution to group discussion on ethics issues</li> <li>Attendance records for hospital training sessions</li> <li>Completed assignment 7.1 from Moodle</li> <li>Short report on one or more RIOTs (possibly bulleted list)</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains key provisions of ACPSEM Code of Ethics</li> <li>Demonstrates appropriate ethical behaviour</li> <li>Describes when ethics approval is required</li> <li>Describes key requirements for ethics review by an institutional ethics board for research projects</li> <li>Describes obligations with respect to OH&amp;S, incident reporting, equal opportunity, bullying and confidentiality</li> <li>Describes basics of intellectual property law and its application in medical physics, such as in software licensing, warranties, responsibilities in distributing copyright material and ownership of intellectual property in research and development</li> <li>Acknowledges own limitations (refers to ACPSEM Code of Ethics regarding this)</li> </ul>
	7.1.1.3 Participate in continuing professional development	<ul style="list-style-type: none"> <li>Join the ACPSEM CPD program or an alternative formal CPD program</li> <li>Review ACPSEM and legislative requirements for CPD</li> <li>Keep a diary or logbook of CPD activities</li> <li>Identify own professional development needs and formulate strategies to meet them</li> <li>Actively participate in CPD activities such as conferences, workshops, seminars, informal meetings</li> </ul>	<ul style="list-style-type: none"> <li>Evidence of participation in a CPD program</li> <li>Evidence of attendance at CPD activities</li> <li>Reflective writing on purpose of CPD and own needs</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A session with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Defines what is meant by CPD (e.g. by reference to ACPSEM CPD definition)</li> <li>Explains purpose and importance of CPD for a medical physics professional</li> <li>Explains ACPSEM CPD requirements for both registrars and qualified medical physicists</li> <li>Participates in CPD activities</li> <li>Demonstrates understanding of the value of life-long learning</li> </ul>

## COMPETENCY 7.2 DEMONSTRATE BASIC MANAGEMENT SKILLS AND UNDERSTANDING OF THE PRINCIPLES OF QUALITY MANAGEMENT

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria (needs review by expert group)
Level 1	7.2.1.1 Understand the fundamental principles of management	<ul style="list-style-type: none"> <li>Attend courses on management skills such as running effective meetings, conflict resolution, performance management, time management.</li> <li>Review relevant literature</li> <li>Tutorial</li> </ul>	<ul style="list-style-type: none"> <li>Evidence of attendance at courses on management skills</li> <li>Report</li> <li>Presentation</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Understands the fundamental principles and basic skills associated with management that can be applied to all TEAP modules.</li> </ul>
	7.2.1.2 Demonstrate basic management skills	<ul style="list-style-type: none"> <li>Take responsibility for organizing, scheduling, chairing and/or taking minutes for a departmental meeting such as a TEAP tutorial session, a journal club or a QA review meeting</li> <li>As above for teleconferences</li> <li>Take responsibility for pro-actively managing own TEAP progress, including mapping out training plan, organizing meetings with supervisors and trainers, monitoring and documenting progress.</li> <li>Assist with the supervision of a research student</li> <li>Join an organizing committee for a conference, workshop or seminar.</li> <li>Define or assist in managing the budget for a small research or technical project</li> <li>Observe and review the role of the Chief Physicist</li> </ul>	<ul style="list-style-type: none"> <li>Minutes and agendas for meetings organized by registrar</li> <li>Logbook notes, reports and/or reflective writing on management experience</li> <li>Evidence of active role by registrar in managing own training</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>Meets general criteria for communication (refer Clinical Training Guide)</li> <li>Meets general criteria for professionalism</li> <li>Monitors own progress against TEAP training plan</li> <li>Demonstrates basic skills associated with management such as               <ul style="list-style-type: none"> <li>Planning and setting timeframes</li> <li>Liaising with others</li> <li>Considering resource requirements where applicable</li> <li>Monitoring progress against the plan</li> <li>Working within the planned timeframe or taking appropriate action if this is not achievable</li> <li>Reporting outcomes in a suitable format</li> </ul> </li> <li>Acts safely and within limits of delegated authority, seeking advice and support from senior staff when required to act outside these limits.</li> </ul>

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria (needs review by expert group)
	7.2.1.3 Understand key quality management principles	<ul style="list-style-type: none"> <li>Read and summarize references on the principles of quality management such as Standards Australia / Standards New Zealand</li> <li>Read and summarize references on the role of quality management in radiotherapy such as Leer et al, ESTRO Physics Booklet 4, 2008</li> <li>Review the department's quality management system</li> <li>Attend and actively participate in physics quality assurance meetings</li> <li>Understand the development of procedures and policies for the department's quality management system</li> <li>Attend hospital training sessions on quality management and quality auditing</li> <li>Attend meetings or review meeting minutes of the hospital quality committee</li> <li>Observe or review departmental/hospital quality audits</li> </ul>	<ul style="list-style-type: none"> <li>Oral presentation on quality management principles and their application in radiotherapy</li> <li>Reflective writing on quality improvement activities in the department</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>Lists the key principles of quality management and explains their purpose, for example as defined by Standards Australia/Standards New Zealand (plan, do, check, act)</li> <li>Explains the meaning of key terms such as quality, quality process, quality assurance, quality control, quality management and quality audit</li> <li>Describes the importance of a quality management system for a radiation oncology department</li> <li>Describes the purpose of key elements of quality management systems including <ul style="list-style-type: none"> <li>organizational structure</li> <li>documentation of quality policy and procedures (quality manual)</li> <li>resource requirements including workforce</li> <li>responsibilities</li> <li>role of multi-disciplinary team</li> <li>quality review mechanisms</li> </ul> </li> <li>Demonstrates familiarity with the quality management system used in own department through actively complying with policies and procedures</li> </ul>
Level 2	7.2.2.1. Apply the principles of quality management	<ul style="list-style-type: none"> <li>Investigate how Tripartite Standards apply within department</li> <li>Contribute to the development of procedures and policies for the department's quality management system</li> <li>Participate in departmental/hospital quality audits (e.g. ISO9000, ISO9001)</li> <li>Perform a risk assessment</li> </ul>	<ul style="list-style-type: none"> <li>Quality management documents to which registrar has contributed</li> <li>Reports from quality audits</li> <li>Formal review of a reported incident</li> <li>Completed risk assessment</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>Describes how departmental quality management system aligns with Tripartite Standards</li> <li>Contributes to quality improvement activities such as <ul style="list-style-type: none"> <li>Documentation of quality policy</li> <li>Documentation of quality procedures (quality manual)</li> <li>Contributing to quality audit</li> <li>Contribute to training on quality</li> </ul> </li> </ul>

## COMPETENCY 7.3 UNDERSTAND THE PRINCIPLES OF PROCUREMENT OF RADIOTHERAPY EQUIPMENT

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	7.3.1.1 Understand the principles of procurement of radiotherapy equipment	<ul style="list-style-type: none"> <li>Read and summarize key references on equipment procurement such as <i>Setting up a Radiotherapy Programme: Clinical, Medical Physics, Radiation Protection and Safety Aspects, IAEA 2008</i></li> <li>Review RANZCR Faculty of Radiation Oncology Position Paper <i>Techniques And Technologies In Radiation Oncology 2012 Horizon Scan</i> <a href="http://www.ranzcr.edu.au/resources/professional-documents/position-statements">http://www.ranzcr.edu.au/resources/professional-documents/position-statements</a></li> <li>Review and report (in a mock scenario if necessary) on department needs for an item of new equipment such as a therapy unit, imaging system, brachytherapy system, treatment planning system or physics dosimetry equipment, considering               <ul style="list-style-type: none"> <li>Clinical need</li> <li>Equipment functionality and performance</li> <li>Compatibility with existing equipment</li> <li>Training requirements</li> <li>Maintenance and service requirements</li> </ul> </li> <li>Review new and emerging technology and how it may relate to department</li> <li>For one of the equipment types listed above, perform market research to identify available equipment, functionality for each and how it relates to your department<sup>5</sup>. Prepare a summary table comparing the different options.</li> <li>Review legislative requirements and international recommendations on safety of equipment.</li> <li>Review tender documentation previously used in the department or available on Moodle</li> <li>Complete Moodle assignment.</li> </ul>	<ul style="list-style-type: none"> <li>Oral presentation on departmental needs for new equipment</li> <li>Completed Moodle exercise</li> <li>Summary table of market research</li> </ul>	<ul style="list-style-type: none"> <li>Review of evidence</li> <li>Q&amp;A</li> </ul>	<ul style="list-style-type: none"> <li>Identifies key steps in the equipment procurement process and explains their importance, including               <ul style="list-style-type: none"> <li>Identification of clinical need</li> <li>Functionality requirements</li> <li>Training requirements</li> <li>Maintenance and service requirements</li> <li>Resource requirements</li> <li>Preparation of a business case</li> <li>Development of specifications and tender documents</li> <li>Evaluation of tender responses</li> </ul> </li> <li>Explains links between equipment procurement processes and acceptance testing of new equipment</li> <li>Demonstrates an understanding of recommendations for equipment safety</li> </ul>

<sup>5</sup>Sufficient information for this RIOT can be gained from suppliers' websites, brochures and presentations. If this RIOT is being performed as a training exercise rather than an actual purchase, registrars should not obtain formal quotes from suppliers.

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
		<ul style="list-style-type: none"> <li>• Attend multidisciplinary equipment procurement meetings.</li> <li>• Review and report on departmental procedures for equipment procurement including:               <ul style="list-style-type: none"> <li>○ Development of specifications and tender documents (if applicable)</li> <li>○ Evaluation of tender responses against specifications</li> <li>○ Cost evaluation (equipment plus operational)</li> <li>○ Negotiations with vendors</li> <li>○ Purchase recommendation</li> </ul> </li> </ul>			

## COMPETENCY 7.4 PROVIDE TEACHING AND TRAINING

Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	7.4.1.1 Understand basic principles of teaching and training	<ul style="list-style-type: none"> <li>Attend a course on how to provide effective training</li> <li>Review and report on a range of educational topics such as:               <ul style="list-style-type: none"> <li>Models of learning</li> <li>Differences in learning styles</li> <li>Competency based training</li> <li>Differences between group and individual learning</li> <li>How to give effective feedback</li> <li>How to motivate learners</li> <li>Principles of adult learning</li> <li>Assessment principles and methods</li> </ul> </li> <li>Review and report on the education, training and assessment requirements of TEAP</li> <li>Write an essay or keep a journal reflecting on your own experiences of training, both as a trainee and as a trainer</li> <li>Read some of the following talks  <a href="http://www.aapm.org/meetings/2010SS/ProgramInfo.asp">http://www.aapm.org/meetings/2010SS/ProgramInfo.asp</a> </li> </ul>	<ul style="list-style-type: none"> <li>Attendance records and/or certificate of completion in training course</li> <li>Reflective journal</li> <li>Short report</li> </ul>	<ul style="list-style-type: none"> <li>RPL</li> <li>Review of evidence and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes different learning and teaching styles and methods, including their own</li> <li>Describes different methods of feedback and assessment</li> <li>Describes the education, training and assessment requirements of TEAP</li> <li>Describes differences between competency based and didactic training</li> </ul>



Level	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 2	7.4.2.1 Provide teaching and training	<ul style="list-style-type: none"> <li>• Provide tutoring in medical physics for other radiation oncology professionals such as radiation oncology registrars or radiation therapy students</li> <li>• Assist with training less experienced ROMP registrars</li> <li>• Perform a mock practical and/or oral assessment of a learning outcome (lower than what they have achieved) and provide feedback for a less experienced registrar.</li> <li>• Write an assignment or mock exam question with a model answer to contribute to the assessment of a TEAP learning outcome (either as a written assessment or for assessment by RPL).</li> <li>• Give lectures on aspects of radiation oncology medical physics to different audiences such as secondary school students, tertiary students, and hospital staff groups.</li> <li>• Train other staff members in how to use a new item of equipment or a new procedure</li> <li>• Develop work instructions for others to use.</li> <li>• Gather feedback on your efforts at teaching/training and demonstrate how the feedback has been incorporated into your approach to teaching</li> <li>• Participate in a mentoring program</li> </ul>	<ul style="list-style-type: none"> <li>• Evidence of previous teaching experience (including adult and/or clinical education not necessarily ROMP)</li> <li>• Assignment or mock exam question and model answer</li> <li>• Logbook</li> <li>• Lesson plan for tutorial or training session</li> <li>• Lecture presentation</li> <li>• Feedback summary</li> <li>• Work instructions</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Review of evidence and Q&amp;A with Assessor</li> <li>• Observational – assessor sits in on feedback or teaching session</li> <li>• Review instructional material</li> </ul>	<ul style="list-style-type: none"> <li>• Meets general criteria for communication</li> <li>• Meets general criteria for professionalism</li> <li>• Explains the TEAP competency levels</li> <li>• Demonstrates an ability to develop high quality teaching and training resources and deliver them</li> <li>• Demonstrated ability to map content of teaching session against a learning outcome or prescribed syllabus</li> <li>• Chooses appropriate teaching materials / methods structured appropriately to reach audience</li> <li>• Is able to design assessment of teaching <ul style="list-style-type: none"> <li>○ Examinations/assessment</li> <li>○ Feedback</li> </ul> </li> <li>• Demonstrates engagement with feedback obtained through formal feedback / evaluation of own teaching</li> </ul>

## MODULE 8: DIAGNOSTIC IMAGING MEDICAL PHYSICS

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To complete Module 8, Registrars must complete **all** of:

- Competency 8.1 Understand the Principles of Medical Imaging and Image Quality Evaluation
- Competency 8.2 Understand CT Diagnostic Imaging in Relation to Radiation Oncology
- Competency 8.3 Understand MRI Diagnostic Imaging in Relation to Radiation Oncology
- Competency 8.4 Understand PET Diagnostic Imaging in Relation to Radiation Oncology

and **one** of:

- Competency 8.5 Understand Radiographic and Fluoroscopic Diagnostic Imaging in Relation to Radiation Oncology
- Competency 8.6 Understand Ultrasound Diagnostic Imaging in Relation to Radiation Oncology
- Competency 8.7 Understand Gamma Camera and SPECT Diagnostic Imaging in Relation to Radiation Oncology

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### COMPETENCY 8.1 UNDERSTAND THE PRINCIPLES OF MEDICAL IMAGING AND IMAGE QUALITY EVALUATION

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	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.1.1.1 Understand the principles of image acquisition, processing and display	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references on standard the processes of image acquisition, processing algorithms and display settings focussing on:               <ul style="list-style-type: none"> <li>○ Image acquisition                   <ul style="list-style-type: none"> <li>▪ Multi stage nature of detector elements</li> <li>▪ The sensitivity or DQE of image acquisition devices and their relationship to image quality (8.1.1.2)</li> </ul> </li> <li>○ Classes of image processing                   <ul style="list-style-type: none"> <li>▪ Reconstruction of 2D, 3D or 4D data sets from acquired data</li> <li>▪ Extraction of information from image data sets, e.g., point, line, image or volume data</li> <li>▪ Noise reduction techniques such as filtering and smoothing</li> <li>▪ Tools for edge and contrast enhancement</li> <li>▪ Segmentation algorithms</li> <li>▪ Compression of images (PACS)</li> </ul> </li> <li>○ Image display                   <ul style="list-style-type: none"> <li>▪ Optimising image display through windowing and levelling</li> <li>▪ Optimal monitor setup – SMPTE – AAPM TG18</li> <li>▪ Viewing conditions</li> </ul> </li> </ul> </li> <li>• Investigate the impact of different algorithms and display settings on the quantitative image quality parameters from 8.1.1.2, using images acquired on equipment in the RT department (for example as part of competencies 4.4, 4.5, 5.2, 6.4 and 6.6)</li> <li>• Observe the image processing algorithms and display settings selected during acquisition of diagnostic images for different body sites in a clinical diagnostic imaging department. Discuss with a radiologist, a DIMP and/or diagnostic radiographer. Observe a radiologist's reporting session if possible.</li> <li>• Attend a teaching session with a DIMP</li> <li>• Perform basic image processing operations in an image processing application, e.g., <a href="#">ImageJ</a>.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> <li>• Answers to online resources on e-learning website</li> <li>• Results from practical exercises using image processing application</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes basic principles of image acquisition, processing algorithms and display settings focussing on:               <ul style="list-style-type: none"> <li>○ Image acquisition                   <ul style="list-style-type: none"> <li>▪ Multi stage nature of detector elements</li> <li>▪ The sensitivity or Detective Quantum Efficiency (DQE) of image acquisition devices and their relationship to image quality (8.1.1.2)</li> </ul> </li> <li>○ Classes of image processing                   <ul style="list-style-type: none"> <li>▪ Reconstruction of 2D, 3D or 4D data sets from acquired data</li> <li>▪ Extraction of information from image data sets, e.g., point, line, image or volume data</li> <li>▪ Noise reduction techniques such as filtering and smoothing</li> <li>▪ Tools for edge and contrast enhancement</li> <li>▪ Segmentation algorithms (AAPM TG132)</li> <li>▪ Compression (lossy and lossless) of images (PACS)</li> </ul> </li> <li>○ Image display                   <ul style="list-style-type: none"> <li>▪ Optimising image display through windowing and levelling</li> <li>▪ Optimal monitor setup – SMPTE – AAPM TG18</li> <li>▪ Viewing conditions</li> </ul> </li> </ul> </li> <li>• Discusses differences between manipulations which alter the image data and those which merely alter the display.</li> <li>• Describes the impact of common smoothing and enhancement algorithms on the quantitative image quality parameters from 8.1.1.2</li> <li>• Describes the impact of display settings on qualitative image quality.</li> <li>• Explains the role of quality management procedures applied to image processing algorithms and display settings in ensuring optimal clinical image quality.</li> <li>• Describes the role of a DIMP in quality management of image processing and display</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	8.1.1.2 Understand concepts and some key measures of image quality	<ul style="list-style-type: none"> <li>• MSc coursework</li> <li>• Read and summarize references on the image quality concepts of contrast, resolution and noise and their inter-relationships and dependence on primary signal (often dose).</li> <li>• Read and summarize references on the measures of image quality through parametric analysis, quantitative phantom measurements and structured clinical image comparisons: <ul style="list-style-type: none"> <li>○ Parametric evaluation <ul style="list-style-type: none"> <li>▪ MTF, NPS, DQE, SNR, SDNR</li> </ul> </li> <li>○ Quantitative phantom measurement <ul style="list-style-type: none"> <li>▪ Noise</li> <li>▪ Uniformity</li> <li>▪ Low contrast resolution</li> <li>▪ High contrast resolution</li> <li>▪ Geometric integrity</li> <li>▪ Artifacts to be discussed along with each image modality</li> </ul> </li> <li>○ Structured clinical image comparisons <ul style="list-style-type: none"> <li>▪ Receiver Operator Characteristic (ROC)</li> <li>▪ Clinical quality indicators</li> <li>▪ Artifacts</li> <li>▪ Tumour response evaluation criteria, e.g. RECIST</li> </ul> </li> </ul> </li> <li>• Perform measurements of the above on the imaging equipment in the RT department (for example as part of competencies 4.4, 4.5, 5.2 and 6.4)</li> <li>• Observe/participate in diagnostic imaging quality assurance checks with a DIMP and/or diagnostic radiographer. Contrast these with the checks done on the imaging systems in the RT department</li> <li>• Attend a teaching session with a DIMP</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment</li> <li>• Summary notes.</li> <li>• Reflective writing discussing how quantitative measures of image quality relate to clinical diagnostic requirements</li> <li>• Answers to online resources on e-learning website</li> </ul>	<ul style="list-style-type: none"> <li>• RPL</li> <li>• Review of evidence</li> <li>• Q&amp;A with assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Defines the measures of image quality through parametric analysis, quantitative phantom measurements and structured clinical image comparisons : <ul style="list-style-type: none"> <li>○ Parametric evaluation <ul style="list-style-type: none"> <li>▪ MTF, NPS, DQE, SNR, SDNR</li> </ul> </li> <li>○ Quantitative phantom measurement <ul style="list-style-type: none"> <li>▪ Noise</li> <li>▪ Uniformity</li> <li>▪ Low contrast resolution</li> <li>▪ High contrast resolution</li> <li>▪ Geometric integrity</li> </ul> </li> <li>○ Structured clinical image comparisons <ul style="list-style-type: none"> <li>▪ Receiver Operator Characteristic (ROC)</li> <li>▪ Clinical quality indicators</li> <li>▪ Artifacts</li> <li>▪ Tumour response evaluation criteria, e.g. RECIST</li> </ul> </li> </ul> </li> <li>• Describes techniques for measuring each of the above parameters</li> <li>• Explains how the above parameters relate to each other</li> <li>• Discusses the relation between quantitative and qualitative measures of image quality, and how they relate to clinical imaging requirements.</li> </ul>

## CORE REFERENCES

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## COMPETENCY 8.2 UNDERSTAND CT DIAGNOSTIC IMAGING IN RELATION TO RADIATION ONCOLOGY

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.2.1.1 Understand the physical principles and operation of diagnostic CT scanners	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references on principles and operation of CT scanners, e.g. IAEA DR Handbook, Bushberg</li> <li>• Attend a teaching session with a DIMP</li> <li>• Observe maintenance and QA of diagnostic CT scanners</li> <li>• Observe clinical use of CT scanners in diagnostic departments and contrast with their use in radiation therapy departments (for example using knowledge gained from competencies 4.4, 4.5, 5.2, 6.4 and 6.6). Note how CT scan settings are optimized for the clinical application</li> <li>• Review specialist and emerging CT imaging techniques, for example, cardiac imaging, CT angiography, artifact reduction, dose reduction techniques, including iterative techniques and their interplay with HU to electron density conversion, dual energy imaging</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> <li>• Answers to online resources on e-learning website</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> <li>• May be assessed in conjunction with aspects of competencies 4.4, 4.5, 5.2 and 6.4</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the basic physics of x-ray production for CT imaging</li> <li>• Explains key parameters and terms used in CT imaging such as kV, mAs, pitch, filtration, slice width, slice spacing, scan length and gives typical values, extended field of view</li> <li>• Describes typical CT scanner configuration (block diagram) for 3<sup>rd</sup> generation scanners, including single slice and multi-slice machines</li> <li>• Explains how CT images are reconstructed and stored</li> <li>• Explain how CT settings affect the image quality parameters listed in 8.1.1.2</li> <li>• Discusses differences and similarities between CT imaging procedures in the diagnostic and therapy departments</li> <li>• Describes typical artifacts observed in CT images and their causes</li> <li>• Describes 4DCT acquisition, reconstruction and image display techniques</li> <li>• Describes CT imaging strengths and weaknesses</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	8.2.1.2 Understand the safety and quality management procedures for diagnostic CT imaging	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarize regulatory requirements for CT safety (such as ARPANSA CoP and jurisdictional regulatory requirements)</li> <li>• Apply the radiation safety principles of optimization and justification to the medical use of CT imaging for a small sample of clinical cases and discuss the optimisation processes used.</li> <li>• Read and summarise references on CT quality management such as <i>IAEA Human Health Series 19</i></li> <li>• Identify and explain common image artifacts on images acquired in an imaging department</li> <li>• Read departmental safety and quality assurance protocols</li> <li>• Observe QA of CT imaging systems in the diagnostic department and contrast with procedures in the therapy department (for example using knowledge gained from competencies 4.4, 4.5, 5.2, 6.4 and 6.6)</li> <li>• Attend a teaching session on CT safety and quality management with a DIMP</li> <li>• Review literature on patient dose from CT scanners such as <i>Nagel</i>, <i>IAEA Human Health Report 5</i>, <i>AAPM TG204</i>, <i>ICRP 87</i>.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> <li>• May be assessed in conjunction with competency 4.5</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the safety requirements for diagnostic CT imaging systems including regulatory requirements</li> <li>• Describes the quality management procedures for diagnostic CT scanners, as listed in a suitable published protocol, e.g. <i>IAEA Human Health Series 19</i></li> <li>• Discusses differences and similarities between safety and quality management procedures required for CT scanners in the diagnostic imaging and therapy departments</li> <li>• Discusses the impact of CT scan settings such as kVp, mAs pitch, reconstruction algorithm and scan length on patient dose</li> <li>• Explains how the radiation safety principles of optimization and justification apply to the medical use of CT imaging</li> <li>• Explains the concept of a diagnostic reference level. Describe the parameters used in CT imaging to measure them, e.g. Dose Length Product (DLP), Computed Tomography Dose Index (CTDI), etc. Gives typical values for, e.g., head, chest, body.</li> <li>• Identifies and explains common image artifacts, such as, beam hardening, volume averaging, high density objects</li> <li>• Describes the role of a DIMP in safety and quality management of diagnostic CT imaging systems</li> </ul>
	8.2.1.3 Understand how diagnostic CT images are used in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. studies of the impact of CT and other imaging modalities on cancer management, such as <i>RCR2004 Imaging for Oncology</i>.</li> <li>• Observe CT patient imaging for diagnosis, staging, treatment planning, image guided therapy and monitoring</li> <li>• Attend multi-disciplinary case review meetings</li> <li>• Patient case study</li> <li>• Observe diagnostic imaging procedures for different body sites and with different imaging modalities to gain an understanding of which aspects of image quality are clinically important. Discuss with a radiologist, a DIMP and/or diagnostic radiographer. Observe a radiologist's reporting session if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> <li>• May be assessed in conjunction with competencies 5.2 and 6.4</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how CT images are used in the management of cancer, for example, in diagnosis, staging, treatment planning, image guided therapy and monitoring.</li> <li>• Discusses the pros and cons of CT imaging in the management of cancer</li> <li>• Illustrates this by describing at least two clinical scenarios where CT imaging is used</li> <li>• Describes the use of contrast agents and its impacts on image quality</li> </ul>

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## COMPETENCY 8.3 UNDERSTAND MRI DIAGNOSTIC IMAGING IN RELATION TO RADIATION ONCOLOGY

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.3.1.1 Understand the physical principles and operation of MRI systems	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references on the physical principles and operation of MRI systems, e.g. <i>IAEA DR Handbook</i>, <i>Bushberg Essential physics for medical imaging</i>, <a href="http://www.cis.rit.edu/htbooks/mri/">http://www.cis.rit.edu/htbooks/mri/</a> and <a href="http://www.imaio.com/en/e-Courses/e-MRI">http://www.imaio.com/en/e-Courses/e-MRI</a>.</li> <li>Attend a teaching session with a DIMP</li> <li>Observe maintenance and QA of MRI systems.</li> <li>Observe clinical use of MRI in diagnostic departments and contrast with its use for radiation therapy planning (for example using knowledge gained from competencies 5.2 and 6.4). Note how imaging parameters are optimized for the clinical application</li> <li>Review specialist and emerging MRI techniques such as diffusion weighted imaging, spectroscopy, functional MRI, open magnet</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment.</li> <li>Summary notes.</li> <li>Logbook notes.</li> <li>Answers to online resources on eLearning website</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the basic physics of MRI including NMR, image formation, image reconstruction in k-space, field strength and its effects on image quality.</li> <li>Describes the key parameters such as T1 and T2</li> <li>Describes typical configuration of MRI scanners (block diagram), include surface coils</li> <li>Explains key parameters and terms used in MRI such as magnetic gradients, pulse-echo, free-induction decay, pulse sequences</li> <li>Explain the function of STIR and FLAIR pulse sequences</li> <li>Explains how MRI scan settings affect the image quality parameters listed in 8.1.1.2</li> <li>Describes typical system-related and patient-related artifacts observed in MR images and their causes</li> <li>Describes MRI imaging strengths and weaknesses</li> </ul>
	8.3.1.2 Understand the safety and quality management procedures for MRI imaging systems	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarize references on MRI safety such as the <i>RANZCR MRI Safety Guidelines (2007)</i>, <i>ACR Guideline Document for Safe MR Practices (2007)</i></li> <li>Read and summarise references on quality management of MRI such as <i>AAPM Report No. 100 Acceptance Testing and Quality Assurance Procedures for Magnetic Resonance Imaging Facilities (2010)</i></li> <li>Read departmental safety and QM protocols</li> <li>Observe QM of MRI in the diagnostic department</li> <li>Attend a teaching session on MRI safety and quality management with a DIMP</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment.</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes the safety requirements for MRI systems including regulatory requirements, as listed in a suitable published protocol, such as <i>ACR 2004 MRI Quality Control Manual</i></li> <li>Describes the quality management procedures for MRI systems<sup>6</sup> as listed in a suitable published protocol such as <i>AAPM Report No. 100, MHRA, ACR MRI Quality Manual 2004, ACR Guidance Document on MR Safe Practices 2013, IPEN Report 81 Physics aspects of quality control in radiotherapy (section 3.3 Magnetic resonance imaging)</i>.</li> <li>Describes the role of a DIMP in safety and quality management of MRI systems</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	8.3.1.3 Understand how MRI images are used in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. studies of the impact of MRI and other imaging modalities on cancer management, such as RCR2004 <i>Imaging for Oncology</i>.</li> <li>• Observe MRI imaging for diagnosis, staging, treatment planning, image guided therapy and monitoring</li> <li>• Attend multi-disciplinary case review meetings</li> <li>• Patient case study</li> <li>• Observe diagnostic imaging procedures for different body sites and with different imaging modalities to gain an understanding of which aspects of image quality are clinically important. Discuss with a radiologist, a DIMP and/or diagnostic radiographer. Observe a radiologist's reporting session if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how MRI is used in the management of cancer, for example, in diagnosis, staging, treatment planning, image-guided therapy and monitoring.</li> <li>• Discusses the pros and cons of MRI in the management of cancer</li> <li>• Illustrates this by describing at least two clinical scenarios where MRI is used</li> <li>• Gives a few examples of function/spectroscopic applications to oncology</li> <li>• Describes gated MRI techniques</li> </ul>

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## COMPETENCY 8.4 UNDERSTAND PET DIAGNOSTIC IMAGING IN RELATION TO RADIATION ONCOLOGY

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.4.1.1 Understand the physical principles and operation of PET systems	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references on the physical principles and operation of PET systems, e.g. IAEA DR Handbook, Bushberg <i>Essential physics for medical imaging. Ch. 19.</i> Cherry &amp; Sorenson <i>Physics in Nuclear Medicine 4<sup>th</sup> Ed.</i></li> <li>• Attend a teaching session with a DIMP</li> <li>• Observe maintenance and QA of PET systems.</li> <li>• Observe clinical use of PET in diagnostic departments and contrast with its use for radiation therapy planning (for example using knowledge gained from competencies 5.2 and 6.4). Note how imaging parameters are optimized for the clinical application</li> <li>• Review specialist and emerging PET techniques such as PET-MR, radiopharmaceuticals used in PET, proton therapy in PET</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> <li>• Answers to online resources on eLearning website</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the basic physics of PET including image formation, iterative techniques, maximum likelihood expectation, ordered subset expectation, typical system characteristics (sensitivity and resolution), CT based attenuation correction, randoms and scatters, straggling, time of flight</li> <li>• Describes typical configuration of PET scanners (block diagram)</li> <li>• Explains key parameters and terms used in PET</li> <li>• Explain the calculation and use of SUV and equipment and physiological factors associated with it.</li> <li>• Explains how PET scan settings affect the image quality parameters listed in 8.1.1.2</li> <li>• Describes typical artifacts observed in PET images and their causes</li> <li>• Describes PET imaging strengths and weaknesses</li> </ul>
	8.4.1.2 Understand the safety and quality management procedures for PET imaging systems	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarize references on PET safety, such as, Safety Reports Series No. 58, Radiation protection in newer medical imaging techniques: PET/CT, IAEA, Vienna, 2008</li> <li>• Read and summarise references on quality management of PET such as AAPM Task Group No. 126 "PET/CT Acceptance Testing and Quality Assurance", PET NEMA NU2, IAEA Human Health Series 1</li> <li>• Read departmental safety and QM protocols</li> <li>• Observe QM of PET in the diagnostic department</li> <li>• Attend a teaching session on PET safety and quality management with a DIMP</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the safety requirements for PET systems including regulatory requirements</li> <li>• Describes the quality management procedures for PET systems as listed in a suitable published protocol such as PET NEMA NU2, IAEA Human Health Series 1, AAPM TG 126</li> <li>• Discusses typical patient doses and techniques to reduce patient dose</li> <li>• Discusses how patient dose is affected by the choice of PET imaging protocol</li> <li>• Explains how the radiation safety principles of optimization and justification apply to the medical use of PET imaging systems</li> <li>• Describes the role of a DIMP in safety and quality management of PET systems</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	8.4.1.3 Understand how PET images are used in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. studies of the impact of PET and other imaging modalities on cancer management, such as AAPM Report 255 <i>An introduction to molecular imaging in radiation oncology</i>, RCR2004 <i>Imaging for Oncology</i>.</li> <li>• Observe PET imaging for diagnosis, staging, treatment planning, image guided therapy and monitoring</li> <li>• Attend multi-disciplinary case review meetings</li> <li>• Patient case study</li> <li>• Discuss with NM physician delineation of tumours based on imaging and contrast and compare with practice of RO on the same images.</li> <li>• Observe diagnostic imaging procedures for different body sites and with different imaging modalities to gain an understanding of which aspects of image quality are clinically important. Discuss with a radiologist, a DIMP and/or diagnostic radiographer. Observe a radiologist's reporting session if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how PET is used in the management of cancer, for example, in diagnosis, staging, treatment planning and monitoring.</li> <li>• Discusses the pros and cons of PET in the management of cancer</li> <li>• Illustrates this by describing at least two clinical scenarios where PET is used</li> </ul>

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## COMPETENCY 8.5 UNDERSTAND RADIOGRAPHIC AND FLUOROSCOPIC DIAGNOSTIC IMAGING IN RELATION TO RADIATION ONCOLOGY

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.5.1.1 Understand the physical principles and operation of radiographic and fluoroscopic diagnostic imaging	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references on the physical principles and operation of radiographic and fluoroscopic imaging systems, e.g. IAEA DR Handbook, Bushberg <i>Essential physics for medical imaging</i>. Should cover digital radiography, fluoroscopy, angiography</li> <li>• Attend a teaching session with a DIMP</li> <li>• Observe maintenance and QA of radiographic and fluoroscopic imaging systems.</li> <li>• Observe clinical use of radiographic and fluoroscopic imaging systems in diagnostic departments, for example, mammography and barium swallow, and contrast with their use in radiation therapy departments (for example using knowledge gained from competencies 4.4, 5.2 and 6.4. Note how imaging parameters are optimized for the clinical application</li> <li>• Review specialist and emerging radiographic and fluoroscopic imaging techniques such as breast tomosynthesis</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> <li>• Answers to online resources on eLearning website</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the basic physics of x-ray production and image formation for radiographic and fluoroscopic diagnostic imaging, including digital radiography, fluoroscopy.</li> <li>• Describes typical configuration of diagnostic x-ray units and image forming systems (block diagram)</li> <li>• Explains key parameters and terms used in radiographic and fluoroscopic imaging such as kV, mAs, filtration, grids, magnification and gives typical values where appropriate</li> <li>• Explain how x-ray settings affect the image quality parameters listed in 8.1.1.2</li> <li>• Describes typical artifacts observed in radiographic and fluoroscopic images and their causes</li> <li>• Describes the use of contrast agents.</li> <li>• Describes radiographic and fluoroscopic imaging strengths and weaknesses</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	8.5.1.2 Understand the safety and quality management procedures for radiographic and fluoroscopic diagnostic imaging systems	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarize regulatory requirements for safety of radiographic and fluoroscopic diagnostic imaging systems (such as ARPANSA CoP and safety guides, and jurisdictional regulatory requirements) ICRP85</li> <li>• Read and summarise references on quality management such as the <i>ACPSEM position paper Recommendations for a technical quality control program for diagnostic X-ray equipment (2005)</i>.</li> <li>• Read departmental safety and QM protocols</li> <li>• Observe QM of radiographic and fluoroscopic imaging systems in the diagnostic department and contrast with procedures in the therapy department (for example using knowledge gained from competencies 4.4, 5.2, 6.4 and 6.6)</li> <li>• Attend a teaching session on x-ray safety and quality management with a DIMP</li> <li>• Review literature on patient dose from radiographic and fluoroscopic imaging such as UK HPA-CRCE-034</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the safety requirements for diagnostic radiographic and fluoroscopic imaging systems including regulatory requirements</li> <li>• Describes the quality management procedures for diagnostic radiographic and fluoroscopic imaging systems, as listed in a suitable published protocol such as the ACPSEM 2005 position paper or IPEM Rpt. 107.</li> <li>• Discusses differences between quality management procedures required for diagnostic radiographic and fluoroscopic imaging systems in the diagnostic imaging and therapy departments</li> <li>• Discusses the impact of diagnostic radiographic and fluoroscopic imaging settings such as kV, mAs, filtration, field size, screens and grids on patient dose</li> <li>• Explains how the radiation safety principles of optimization and justification apply to the medical use of diagnostic radiographic and fluoroscopic imaging systems</li> <li>• Explains concept of a diagnostic reference level for radiographic and fluoroscopic imaging and lists typical values for common imaging procedures</li> <li>• Describes the role of a DIMP in safety and quality management of radiographic and fluoroscopic imaging systems</li> </ul>
	8.5.1.3 Understand how radiographic and fluoroscopic images are used in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. studies of the impact of radiographic and fluoroscopic and other imaging modalities on cancer management, such as RCR2004 <i>Imaging for Oncology</i>.</li> <li>• Observe radiographic and fluoroscopic imaging for diagnosis, staging, treatment planning, image guided therapy and monitoring</li> <li>• Attend multi-disciplinary case review meetings</li> <li>• Patient case study</li> <li>• Observe diagnostic imaging procedures for different body sites and with different imaging modalities to gain an understanding of which aspects of image quality are clinically important. Discuss with a radiologist, a DIMP and/or diagnostic radiographer. Observe a radiologist's reporting session if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how radiographic and fluoroscopic images are used in the management of cancer, for example, in diagnosis, staging, treatment planning, image-guided therapy and monitoring.</li> <li>• Discusses the pros and cons of radiographic and fluoroscopic imaging in the management of cancer</li> <li>• Illustrates this by describing at least two clinical scenarios where radiographic and/or fluoroscopic imaging is used</li> </ul>

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## COMPETENCY 8.6 UNDERSTAND ULTRASOUND DIAGNOSTIC IMAGING IN RELATION TO RADIATION ONCOLOGY

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.6.1.1 Understand the physical principles and operation of ultrasound imaging systems	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. IAEA DR Handbook, Bushberg (Essential physics for medical imaging)</li> <li>• Attend a teaching session with a DIMP</li> <li>• Observe maintenance and QA of ultrasound systems.</li> <li>• Observe clinical use of ultrasound in diagnostic departments and contrast with its use for radiation therapy planning (for example using knowledge gained from competencies 4.4 and 6.4). Note how imaging parameters are optimized for the clinical application</li> <li>• Review specialist and emerging ultrasound techniques such as elasticity measurements for breast cancer detection</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> <li>• Answers to online resources on eLearning website</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Explains the basic physics of ultrasound including image formation, B-mode and Doppler imaging</li> <li>• Describes typical configuration of ultrasound scanners (block diagram)</li> <li>• Explains how ultrasound scan settings affect the image quality parameters listed in 8.1.1.2</li> <li>• Describes typical artifacts observed in ultrasound images</li> <li>• Describes ultrasound imaging strengths and weaknesses</li> </ul>
	8.6.1.2 Understand the safety and quality management procedures for ultrasound imaging systems	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, such as <i>AAPM Report 65 Real time B-mode ultrasound quality control test procedures</i> and <i>AAPM Report 28 Quality assurance tests for prostate brachytherapy ultrasound systems</i></li> <li>• Read departmental safety and QM protocols</li> <li>• Observe QM of ultrasound imaging systems in diagnostic and therapy departments</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes the safety requirements for ultrasound imaging systems</li> <li>• Describes the quality management procedures for ultrasound imaging systems, as listed in a suitable published protocol, e.g. AAPM Reports 65 and 128</li> <li>• Discusses differences between ultrasound quality management procedures required in the diagnostic imaging and therapy departments</li> <li>• Describes the role of a DIMP in safety and quality management of ultrasound systems</li> </ul>
	8.6.1.3 Understand how ultrasound images are used in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. studies of the impact of ultrasound and other imaging modalities on cancer management, such as <i>RCR2004 Imaging for Oncology</i>.</li> <li>• Observe ultrasound patient imaging for diagnosis, staging, treatment planning, image guidance and monitoring</li> <li>• Patient case study</li> <li>• Observe diagnostic imaging procedures for different body sites and with different imaging modalities to gain an understanding of which aspects of image quality are clinically important. Discuss with a radiologist, a DIMP and/or diagnostic radiographer. Observe a radiologist's reporting session if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how ultrasound images are used in the management of cancer, for example, in diagnosis, staging, treatment planning, image guided therapy and monitoring.</li> <li>• Discusses the pros and cons of ultrasound imaging in the management of cancer</li> <li>• Illustrates this by describing at least two clinical scenarios where ultrasound imaging is used, e.g. to differentiate solid and cystic lesions</li> </ul>



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## COMPETENCY 8.7 UNDERSTAND GAMMA CAMERA AND SPECT DIAGNOSTIC IMAGING IN RELATION TO RADIATION ONCOLOGY

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
Level 1	8.7.1.1 Understand the physical principles and operation of Gamma Camera and SPECT systems	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarise references on the physical principles and operation of Gamma Camera and SPECT systems, e.g. IAEA DR Handbook, Bushberg <i>Essential physics for medical imaging</i>, Cherry &amp; Sorenson <i>Physics in Nuclear Medicine 4<sup>th</sup> Ed.</i></li> <li>Attend a teaching session with a DIMP</li> <li>Observe maintenance and QA of Gamma Camera and SPECT systems.</li> <li>Observe clinical use of Gamma Camera and SPECT in diagnostic departments. Note how imaging parameters are optimized for the clinical application</li> <li>Review specialist and emerging Gamma Camera and SPECT techniques such as lympho-scintigraphy</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment.</li> <li>Summary notes.</li> <li>Logbook notes.</li> <li>Answers to online resources on eLearning website</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Explains the basic physics of Gamma Cameras and SPECT including image formation, collimator options, iterative reconstruction, filtered back-projection</li> <li>Describes typical configuration of Gamma Cameras and SPECT scanners (block diagram)</li> <li>Discuss how various Gamma Camera and SPECT components affect image quality parameters listed in 8.1.1.2</li> <li>Discuss the image parameters affecting resolution in Gamma Camera and SPECT imaging.</li> <li>Describes typical artifacts observed in Gamma Camera and SPECT images and their causes</li> <li>Describes Gamma Camera and SPECT imaging strengths and weaknesses</li> <li>Discuss the characteristics and function of two of the most commonly used radiopharmaceuticals (e.g. Tc99-MDP, Tc99m, sulphur colloid, Ga67 citrate), including                         <ul style="list-style-type: none"> <li>Bio-distribution/kinetics</li> <li>Physical and effective half life</li> <li>Principal emissions</li> <li>Typical administered activities</li> </ul> </li> </ul>
	8.7.1.2 Understand the safety and quality management procedures for Gamma Camera and SPECT imaging systems	<ul style="list-style-type: none"> <li>MSc coursework.</li> <li>Read and summarize references on Gamma Camera and SPECT safety such as NEMA NU1</li> <li>Read and summarise references on quality management of Gamma Camera and SPECT such as IAEA Human Health Series 6, AAPM TG177 Gamma Camera, SPECT, and SPECT/CT Acceptance Testing and Annual Physics Surveys, ANZSMN <i>Minimum QC requirements for NM equipment</i></li> <li>Read departmental safety and QM protocols</li> <li>Observe QM of Gamma Camera and SPECT in the diagnostic department</li> <li>Attend a teaching session on Gamma Camera and SPECT safety and quality management with a DIMP</li> </ul>	<ul style="list-style-type: none"> <li>MSc assessment.</li> <li>Summary notes.</li> <li>Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of Prior Learning,</li> <li>Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>Describes the safety requirements for Gamma Camera and SPECT systems including regulatory requirements</li> <li>Discusses specific issues related to staff radiation safety</li> <li>Describes the quality management procedures for Gamma Camera and SPECT systems as listed in a suitable published protocol</li> <li>Discusses how patient dose is affected by the choice of Gamma Camera and SPECT imaging protocol. Gives examples of typical patient doses for common scans.</li> <li>Explains how the radiation safety principles of optimization and justification apply to the medical use of Gamma Camera and SPECT imaging systems</li> <li>Describes the role of a DIMP in safety and quality management of Gamma Camera and SPECT systems</li> </ul>

	Learning Outcome	Recommended items of training (RIOTs)	Suggested Evidence for RIOTs	Suggested Assessment Method	Assessment Criteria
	8.7.1.3 Understand how Gamma camera and SPECT images are used in the management of cancer	<ul style="list-style-type: none"> <li>• MSc coursework.</li> <li>• Read and summarise references, e.g. studies of the impact of Gamma camera and SPECT and other imaging modalities on cancer management, such as RCR2004 <i>Imaging for Oncology</i>.</li> <li>• Observe Gamma camera and SPECT imaging for diagnosis, staging, treatment planning and monitoring</li> <li>• Review NM imaging relevant to oncology, bone scan, gallium</li> <li>• Attend multi-disciplinary case review meetings</li> <li>• Patient case study, e.g., attend breast lymphoscintigraphy and observe sentinel lymph node biopsy in theatres</li> <li>• Observe diagnostic imaging procedures for different body sites and with different imaging modalities to gain an understanding of which aspects of image quality are clinically important. Discuss with a NM physician, a DIMP and/or NM technologist. Observe a physician's reporting session if possible.</li> </ul>	<ul style="list-style-type: none"> <li>• MSc assessment.</li> <li>• Summary notes.</li> <li>• Logbook notes.</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of Prior Learning,</li> <li>• Review and Q&amp;A with Assessor</li> </ul>	<ul style="list-style-type: none"> <li>• Describes how Gamma camera and SPECT is used in the management of cancer, for example, in diagnosis, staging, treatment planning and monitoring.</li> <li>• Discusses the pros and cons of Gamma camera and SPECT in the management of cancer</li> <li>• Illustrates this by describing at least two clinical scenarios where Gamma camera and/or SPECT are used</li> </ul>

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