SPECIFICATION FOR MEDICAL PHYSICS TRAINING AND EDUCATION

1.0 PREAMBLE

This specification describes the requirements for registrar training and education in medical physics. It is based on the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) documents:

- Proposed Training, Education and Accreditation Programme for Radiation Oncology Medical in Australia.
- Radiation Oncology Physics Training and Education Programme Leading to Accreditation – Information Booklet.
- Radiation Oncology Physics Training and Education Programme Leading to Accreditation – Trainee's Handbook.
- ACPSEM Australasian Accreditation in Radiological Physics and Quality Assurance – Trainee's Kit.

The training and education leads to accreditation by the ACPSEM and recognition as a fully qualified medical physicist in the specialty of radiation oncology medical physics or radiology medical physics. In the programme a trainee will also qualify for the degree of MSc in Medical Physics.

For the purposes of this document the trainees for the programme will be known as 'medical physics registrars' (abbreviated to "registrar" in the rest of this document, although this may change when the programme is finally established and the correct terminology is defined by the ACPSEM.

Terms are defined in the CTA Head Agreement and/or Service Agreement.

2.0 DESCRIPTION OF SERVICES

The postgraduate education and training of a medical physicist will involve:

- Basic education and training in all relevant areas of medical physics, including the attainment of a MSc in Medical Physics.
- Advanced education and training in medical physics before applying for ACPSEM accreditation.

Specifically, the education and training will consist of:

- A five-year programme of postgraduate education and clinical training.
- The postgraduate education will consist of the completion of a full- or part-time MSc programme in medical physics accredited by the ACPSEM at a recognised university.

- A structured clinical training programme at an accredited hospital or training institution.
- Ongoing assessment as part of the accreditation examination process in medical physics.

2.1 LEARNING ENVIRONMENT

The five-year programme requirements will be vocational with a focus on both academic and clinical components:

- A formal education component, the equivalent of one year of full-time academic study at a university as part of an ACPSEM-accredited MSc in Medical Physics.
- A postgraduate research thesis in a relevant area of medical physics, the equivalent of one year of full-time academic study as part of the MSc.
- A period equivalent to three years of full-time clinical training and clinical responsibility at a hospital accredited by the ACPSEM for these purposes.
- ACPSEM accreditation examinations.

The programme will normally be structured as:

- One year of full-time academic study on an ACPSEM-accredited MSc in Medical Physics.
- Two years at an ACPSEM-acccredited hospital which will be conducted half-time as a medical physicist receiving clinical training and gaining experience, and half-time conducting research toward the registrar's MSc thesis.
- Two years further structured experience and responsibility at an ACPSEM-accredited hospital.
- It is considered desirable that a registrar obtains a minimum of four weeks work experience in medical physics in a hospital prior to commencing studies for the MSc degree.

Some variation in the structure will be permitted to meet the requirements of the hospitals when appropriate provided the total equivalent time spent in each of the above aspects is maintained.

2.1.1 Clinical Placements

General requirements

The purpose of the placement is to prepare the registrar to be able to independently carry out the tasks required of a qualified medical physicist in a professional manner in a clinical setting.

The registrar will be exposed to and trained in, all aspects of medical physics relevant to their intended accreditation such as treatment planning or quality assurance through to planning for and commissioning of major equipment such as a linear accelerator or a MRI scanner.

The placement will be in an ACPSEM-accredited hospital that provides a comprehensive radiation oncology or radiology imaging service and should employ, in addition to the registrar, a minimum of two physicists, each with at least five years relevant experience. At least one will have five years relevant experience in the registrar's specialty, and will be currently practicing in that area.

It is expected that the registrar will be rotated around other accredited hospitals for short periods to gain experience in techniques and equipment that are not available in the registrar's base hospital.

Specific Requirements

For the first two years of the clinical placement (years 2 and 3 of the 5-year programme), it is expected that 50% of the registrar's time will be spent carrying out research for the thesis component of the MSc degree, and 50% of their time spent in training including carrying out clinical tasks.

It is a specific requirement of the programme that radiation oncology medical physics registrars shall spend a total of three months in a radiology department and a nuclear medicine department gaining experience in image techniques and the related quality control procedures.

It is a specific requirement of the programme that radiology medical physics registrars shall spend a total of three months in a nuclear medicine department and a radiation oncology department gaining experience in imaging and radiotherapy techniques and the related quality control procedures.

2.1.2 Formal Teaching Programme

General Requirements

The formal teaching programme will consist of:

- A one academic-year course of lectures, tutorials, laboratories and site visits based at a university will form part of an MSc in Medical Physics accredited by the ACPSEM. The course must substantially meet the syllabi of the ACPSEM for accreditations in radiation oncology medical physics and radiology physics. Teaching will be provided by university staff and staff of hospitals, research organisations and other institutions as approved by the university. The format of the syllabus may be modified to suit the university's structure, subject to approval by the ACPSEM.
- A research thesis on a relevant medical physics-based topic equivalent to one year of full-time study.

- Ongoing training in a radiation oncology department, medical physics department or radiology department over the equivalent of three years full-time shall consist of work experience, teaching, tutoring and mentoring.

Training will be provided at a hospital accredited by the ACPSEM, by suitably qualified and experienced staff. A physicist at the hospital will be assigned the role of clinical supervisor for the registrar. Registrars will follow a specified programme and will keep a logbook to record their training. The logbook will be signed by the clinical supervisor as individual aspects of the training are completed.

Teaching, tutoring and mentoring will occupy a minimum of 240 hours in the first year of the programme, 96 hours per year for the second and third years of the programme, and 192 hours per year for the fourth and fifth years of the programme.

- The combination of the university and clinical training will cover the entire syllabus of the ACPSEM for accreditation in radiation oncology medical physics or in radiology medical physics.
- Registrars will sit the ACPSEM examinations in radiation oncology medical physics or in radiology medical physics.

Specific Requirements

- The syllabi of the six papers that make up the formal university-taught MSc programme are given in Appendix A of this document, and form part of this specification.
- The syllabus and requirements of ACPSEM for accreditation as a radiation oncology or radiology medical physicist must be completed.
- A pass in the examinations of the ACPSEM must be obtained.

2.1.3 Access to Resources

Resources to which the trainee requires access are as follows:

- The university will provide student access to libraries, lectures, laboratories, and academic staff. In addition, the university will be responsible for co-ordinating access to non-university facilities required for the provision of the MSc.
- ACPSEM will provide a list of tasks, assignments, etc. that registrars must complete during clinical training.

- The registrar's base hospital will provide all the facilities normally provided to a hospital physicist. It will ensure that suitable access is provided to education facilities such as library, computer equipment, audio-visual equipment, etc. It will provide or arrange access to the facilities needed by the registrar to complete the tasks and exercises required by the ACPSEM. The hospital will provide a suitably qualified clinical supervisor and a thesis supervisor approved by the university.

2.2 SUPERVISION

Supervision is required to ensure that a registrar's training is of high quality and that the registrar will fulfil the requirements of the ACPSEM and the university.

- Overall supervision of the registrar for the education and training programme will be the responsibility of ACPSEM who will appoint a programme co-ordinator. The programme co-ordinator will monitor the progress of registrars and will ensure that the requirements of the ACPSEM are met.
- Clinical supervision of a registrar during clinical training will be conducted by a physicist who shall be approved by ACPSEM and employed by the hospital. The supervisor will be a qualified physicist of at least five years relevant experience. The supervisor will act as mentor for the registrar and ensure that clinical training is provided to a standard acceptable to ACPSEM, the registrar's training and progress are monitored, documented and reported to the programme co-ordinator.
- Supervision of a registrar's thesis will be carried out in accordance with the regulations of the university. Normally the university and the registrar's base hospital will each provide a thesis supervisor.

2.2.1 Clinical Supervision

The clinical supervisor will normally be the senior physicist of the registrar's hospital. It is expected that the clinical supervisor will have a degree in physics from a recognised university and a minimum of five years relevant clinical experience.

The clinical supervisor will:

- Document the registrar's progress and report the progress to the programme co-ordinator.
- Meet regularly with the registrar to discuss progress.
- Ensure the registrar is placed in other hospitals for short periods to gain experience in techniques and equipment not available in the registrar's own hospital.
- Ensure that the registrar is trained in all clinical and practical aspects of radiation oncology or radiology medical physics.

- Ensure that the registrar has sufficient opportunities to prepare for the ACPSEM examinations in radiation oncology or radiology medical physics which occurs at the completion of the 5-year programme.

2.2.2 Thesis Supervision

The thesis shall be supervised by a staff member of the university and a physicist at the registrar's own hospital. The hospital thesis supervisor need not necessarily be the same person as the clinical supervisor. The hospital supervisor must be acceptable to the university and will have extensive relevant clinical and academic experience.
The hospital supervisor must spend a minimum of 50 hours one-to-one thesis supervision time with the trainee.

The thesis supervisors' responsibilities include:

- Ensuring that the thesis topic is appropriate to radiation oncology or radiology physics.
- Ensuring that research is of an academic standard appropriate to an MSc.
- Ensuring that the resources to carry out the research are provided.
- Meeting regularly with the registrar to discuss progress and provide timely advice and direction.
- Providing advice in the preparation of the thesis.
- Ensuring that the thesis is submitted in accordance with the university's regulations.

2.3 PROGRAMME CO-ORDINATION

The programme shall be approved by ACPSEM.

The overall co-ordination will be carried out by a programme supervisor appointed by ACPSEM. The programme coordinator's responsibilities will be to:

- Liaise with ACPSEM on the provision of the programme.
- Liaise with the university on the content and provision of the MSc programme.
- Liaise with the hospitals whose registrars are involved in the programme.
- Liaise with the university on acceptability of registrars to enter the MSc programme.
- Monitor and document the progress of registrars.
- Co-ordinate the clinical training with the hospitals and ensure that training is of a high standard and that the education and training needs of the registrars are being met.

The university will appoint a university co-ordinator who shall be responsible for the MSc programme. The university co-ordinator's responsibilities will be to:

- Liaise with ACPSEM on the content and provision of the MSc programme.
- Co-ordinate the provision of the academic programme specified in Appendix A.
- Co-ordinate the supervision of theses.

2.4 EXPECTED OUTCOMES

2.4.1 Registrar Outcomes

To satisfactorily complete the programme, a registrar is required to have:

- Successfully completed the MSc in Medical Physics.
- Successfully completed the programme of clinical training.
- Passed the relevant accreditation examination of the ACPSEM.

Upon successfully gaining ACPSEM accreditation, the registrar will be recognised as a qualified medical physicist.

From the programme of postgraduate study and clinical training, the registrar should have:

- An adequate span of theoretical knowledge and practical experience to work on standard medical physics tasks appropriate to the registrar's accreditation.
- An ability to exercise individual judgement and initiative in the application of physics principles, techniques and methods.
- An ability to explain problems to other specialists and to respond with appropriate vocabulary.
- An ability to work without supervision in areas of medical physics as appropriate to the registrar's accreditation.
- An ability to supervise the practice of standard medical physics tasks as appropriate to the registrar's accreditation.
- An ability to establish new work programmes.
- A capacity for judgement, innovation and creativity.
- A capacity for interpreting the state of the art to non-specialist clients, professionals in related disciplines, students, enforcing authorities or administrators.

3.0 ELIGIBILITY

3.1 REGISTRAR ELIGIBILITY

Entry to the training, education and accreditation programme will require:

- Acceptance into a five-year registrar position at an accredited hospital training institution. This will be subject to that institution's normal employment practice usually requiring a competitive interview process.
- A BSc degree in physics (or equivalent) that satisfies the prerequisites for entry to the MSc programme. The registrar's hospital must ensure that the university will enrol the registrar in the MSc programme before appointing the registrar.
- Trainee must have New Zealand Residency.

Graduates who do not meet the academic qualification criterion may be considered on a case-by-case basis.

3.2 PROVIDER ELIGIBILITY

Universities providing the programme are to be approved by the ACPSEM, and the Clinical Training Agency. The academic programme must be accredited by the Committee for University Academic Programmes (CUAP).

Hospitals providing the clinical training are to be accredited by the ACPSEM. It is expected that the hospital will be a provider of a comprehensive radiation oncology service or radiology department or medical physics department and will employ at least two medical physicists with a minimum of five years experience.

4.0 LOCATION AND SETTING

Training should take place:

- In a university approved by the ACPSEM and the Clinical Training Agency and
- In public hospitals accredited by the ACPSEM.

Any secondment of a trainee to another location for further training experience must comply with Part 9 of the CTA Head Agreement.

5.0 ASSOCIATED LINKAGES

The university will have linkages with:

- All public hospitals accredited by the ACPSEM for training in this programme.
- Other institutions with expertise in the topics in the syllabus such as Crown Research Institutes and the National Radiation Laboratory.
- The ACPSEM.

The hospitals will have linkages with:

- The ACPSEM.
- Other institutions able to provide other suitable experience that they cannot provide for the trainee.
- The university providing the ACPSEM-accredited MSC in Medical Physics.

6.0 PURCHASE UNIT

A registrar in the ACPSEM's accreditation programme in radiation oncology medical physics or radiology medical physics.

7.0 QUALITY STANDARDS: PROGRAMME SPECIFIC

This section *should be read in conjunction with Schedule 1 Part 3 of the CTA Head Agreement, which specifies* ***generic*** *quality standards requirements for all programmes provided under the contract.*

The ACPSEM will establish, in consultation with the university, guidelines and evaluation procedures for the programme.

In reviewing a programme, the ACPSEM will assess whether the programme meets the objectives set by its professional needs as judged by:

- The number and relevant experience of the teaching staff.
- Teaching loads.
- Rigor, breadth and depth of instructional offerings.
- Adequacy of facilities and supporting personnel.
- The performance of its graduates.

8.0 REPORTING STANDARDS: PROGRAMME SPECIFIC

This section should be read in conjunction with Schedule 1 Part 1 of the CTA Head Agreement*, which specifies* ***generic*** *reporting requirements for all programmes provided under the contract*

8.1 PROGRESS REPORTING

Section 2.4 of the specification details the expected outcomes of the education and training programme.

8.2 QUALITY REPORTING

Reports as described in Schedule 1 Part 1 of the CTA Head Agreement require a summary of the programme. Schedule 1 Part 3 of the Head Agreement requires that you have a quality plan in place for the ongoing monitoring of the training provided. The summary should refer to the outcomes of this internal quality management and make reference to the programme specific quality standards in 7.0 above, particularly supervision.

APPENDIX A

SYLLABUS FOR TAUGHT COMPONENT OF MSc MEDICAL PHYSICS

PAPER 1: ANATOMY AND PHYSIOLOGY FOR MEDICAL PHYSICISTS

Human anatomy including cross-sectional anatomy, organ systems, skeleton
Physiology – nervous system, endocrine system, EEG, EMG, ECG, etc
Pathophysiology
Cell biology including embryology
Cancer including tumour pathology, cell proliferation, carcinogenesis
Physiological measurement – EEG, EMG, ECG, blood pressure etc
Medical terminology

PAPER 2: PROFESSIONAL MATTERS FOR MEDICAL PHYSICISTS

Quality assurance, commissioning and acceptance testing of medical equipment
Electronics, medical instrumentation, control theory & engineering, computer interfacing, sensors
Statistics – errors, distributions, graphic representations, distribution parameters, curve fitting, predictors, hypothesis and significance tests
Research methods
Communication skills
Professional awareness
Medical ethics

PAPER 3: RADIATION PHYSICS

Types of ionising radiation – alpha, beta, gamma etc
Interactions and energy deposition, exponential absorption vs attenuation, coefficients, HVLs, absorption and scattering cross sections, photoelectric effect, Compton effect, pair production, Auger effect, coherent and other types of scattering, energy absorption, broad vs narrow beam, KERMA, energy losses, LET
Nuclear models, half lives, branching ratios, binding energies, radioactive series, radioactive growth and decay
Radiation units – fluence (m^{-2}), energy fluence ($J\ m^{-2}$), Kerma and absorbed dose (Gy), exposure ($C\ kg^{-1}$) dose equivalent (Sv)
Radiation generation
Radionuclide production

PAPER 4: RADIATION BIOLOGY AND RADIATION PROTECTION

Radiation measurement - scintillators, GM, TLD, gel, diodes, film, semiconductors ion chambers and other detectors
Radiation biology – modes of radiation cell kill, cell survival, mutagenicity, time-dose relationships, linear quadratic approach to fractionation, hyperfractionation and

accelerated radiotherapy, combined radiotherapy and chemotherapy, mathematical modelling
Radiation and carcinogenesis – current models, risks
ICRP system of radiation protection – principles, effective dose, dose constraints, reference doses
Radiation safety, protection and legislation – isotope storage, transportation, handling, shielding (including room design for diagnostic radiology, teletherapy and brachytherapy), personnel protection, disposal
Monte Carlo techniques

PAPER 5: RADIOTHERAPY PRINCIPLES AND PRACTICE

Radiotherapy equipment – electron and photon production, linear accelerator etc
Calibration of therapeutic X-ray machines, linear accelerators and cobalt units.
Phantoms for radiotherapy
Radiotherapy dosimetry including calculating dose distributions, machine settings etc
Beam data - % dose, peak scatter factor, tissue-air ratio, tissue phantom ratio, tissue-maximum ratio, scatter derivatives, equivalent squares and circles, beam profiles, isodose curves, beam energy, electron range
Treatment planning – planning systems, algorithms, single beam, multiple beam, isocentric and SSD techniques, conformal radiotherapy, IMRT
Beam modifiers – shielding, wedges, asymmetric collimators, multileaf collimators, bolus, compensating filters
Patient positioning, immobilization, simulators, simulation, portal imaging
Brachytherapy physics – LDR, HDR, implants, sealed and unsealed sources, activity measurement, manual and computer dose calculation

PAPER 6: RADIOLOGICAL IMAGING

Radiographic practice and terminology
Image perception - theory of vision, information theory, psychophysics of image perception, design of display systems, contrast, noise, resolution, MTF, image viewing, ocular response
X-ray – theory, generation, technology, screens, contrast agents, QA
Fluoroscopy – design, theory, QA
CT – theory, multislice, spiral, image reconstruction (Fourier, ART, convolution, backprojection), artifacts, QA
MRI – theory, technology, sequences, flow-sensitive measurement, contrast agents, chemical shift, spectroscopy, artifacts, QA
Ultrasound –theory (inc. doppler), technology, contrast agents, bioeffects and limits, QA, therapy
Digital radiographic image measurement –image specs, DICOM, image compression & storage, networking & data security
Nuclear medicine – theory, radionuclide generators, radiopharmaceuticals, dilution measurement & pool volume assessment, gamma camera, SPECT, PET, QA
Radiation protection for diagnostic X-rays
Patient dosimetry (radiography, fluoro, CT, mammography)
Occupational radiation dose factors and considerations