ACPSEM

Australasian College of Physical Scientists & Engineers in Medicine

DIMP Workforce Calculator

Contextualised Australasian Model

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Foreword

Radiology Medical Physicists and Nuclear Medicine Medical Physicists are collectively referred to as Diagnostic Imaging Medical Physicists (DIMPs), who are recognised as a 'small but critical' workforce.

DIMPs provide expert scientific input to multidisciplinary health teams to deliver clinical services that comply with clinical standards. They are vital in optimising image quality and patient doses across various diagnostic and interventional imaging modalities. DIMPS are also qualified experts for consultation on the dosimetry, quality assurance and radiation protection associated with these modalities. Nuclear Medicine DIMPs are also qualified experts for the therapeutic uses of unsealed radioactive substances[1].

- **Radiology Medical Physicists** may be involved with physics applications associated with General X-ray, Digital and computed radiography applications, Fluoroscopy, Mammography, Computed Tomography (CT), Ultrasound and Magnetic Resonance Imaging (MRI). In procedures involving the application of ionising radiation, radiology medical physicists also play a crucial role in ensuring the quality of radiation doses. Their job is to calculate a dose of the minimum amount possible that is still capable of achieving diagnostic images of high quality[2].
- **Nuclear Medicine Physicists** oversee equipment operation, radiation safety and protection of staff, patients and carers, teaching and training of junior scientists and medical staff, advanced IT and computing applications, troubleshooting of artefacts or abnormal appearances in scans, and verifying the results of clinicalstudies where measurements involving radiation are used[3].

Radiation Safety is the responsibility of medical physicists, regardless of their specialty. Other health professionals rely on the medical physicist in radiation safety, advice and policy matters.

This publication presents the ACPSEM DIMP Workforce Model (DWM). This activity-based workforce model has adopted concepts published by the International Atomic Energy Agency (IAEA) in their ‘Medical Physics Staffing Needs in Diagnostic Imaging and Radionuclide Therapy: An Activity Based Approach’[4] and the European Commission’s ‘Radiation Protection No 174: European Guidelines on Medical Physics Expert’[5]. The ACPSEM DWM adapts and contextualises several principles and input variable categories for Australian and New Zealand practices from these two models. Like the IAEA model, the DWM uses a calculation algorithm to predict the Qualified ‘Medical Physics Specialist’ staffing level based on inputs commonly impacting DIMP workloads.

Unlike the IAEA and the European Commission models, the DWM does not explicitly account for Medical Physics Support staff. The model only estimates the number of Medical Physics Specialists required. Individual practices should account for Medical Physics Support staff separately. The IAEA model states, 'The total number of support staff providing medical physics services should be at least equal to the number of medical physicists’.

The ACPSEM wishes to express its gratitude and recognise the contributions of the Project Team, particularly the Working Group (WG)[6], established to guide the delivery of this work.

[1] NSW Health (2014) Diagnostic Imaging Medical Physics Factsheet. Available from: dimps.pdf (nsw.gov.au)
[2] ACPSEM (2022) Radiology Medical Physicists. Available from: https://www.acpsem.org.au/
[3] ACPSEM (2022) Nuclear Medicine Medical Physicists. Available from: https://www.acpsem.org.au/
[4] IAEA (2018) Medical Physics Staffing Needs in Diagnostic Imaging and Radionuclide Therapy: An Activity Based Approach
[5] European Commission (2014) Radiation Protection No 174: European Guideline on Medical Physics Expert
[6] Working Group Members: Leah Biffin, Andrew Blair, Zoe Brady (Chair), Ioannis Delakis, Kevin Hickson, Nick Hille, Anita Reed, Will Ryder, Farshid Salehzahi, David Thiele, Luke Wilkinson (Chair)

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1. Introduction

1.1 Background

The ACPSEM commissioned a study to identify and further develop and contextualise an existing DIMP workforce model (IAEA 2018, AAPM 2017 and the Euro 2014 MPE) for the Australian healthcare environment. This work leverages and further supports the significant amount of work already conducted by the ACPSEM, mainly comprised of:

- A comprehensive site survey which collected data for each site asked about locations, funding sources, total FTE and health service level classifications, and detailed staff compositions, including experience and responsibilities aspects; and
- A subsequent site survey to estimate DIMP FTE requirements, according to existing physicist workforce models, was completed by 13 facilities and collected data about equipment and procedure volumes. It also asked Chief Physicists to estimate their FTE requirements.

A considerable volume of high-quality data was gathered and validated, and several international workforce models were tested before DWG model development started. When modelled according to the six approaches, the site survey data resulted in significant DIMP FTE variances compared to the Chief Physicists' estimates.

Due to the extensive variation, it was concluded that the existing models might not reflect the Australasian context and need modification to reflect the Australian and New Zealand practice. Before now, there has been no attempt to redefine the existing models, for example, by assessing model activity drivers or updating factor and variable values to reflect Australian facility complexity and variation.

Against this backdrop, the DWG model and guidance report will represent an essential reference for the growth and development of the DIMP profession in Australia

1.2 Model objectives

The DWM needs to be robust, highly defensible and fit for purpose and underpinned by broadly accepted methods such as those used by respected overseas authorities.

Following discussions, the WG agreed that the DWM should use IAEA structural underpinnings with updated Australasian definitions, augmented through further alignment to the Euro 2014 model (e.g., training).

The WG considered that the model should reflect DIMP roles and responsibilities according to generally understood best practices under the relevant Australian and New Zealand jurisdictions. Similar to the IAEA model, best practice is not necessarily reflected in national minimum standards, intended to cover regulatory requirements

The DWM modelling tool was developed to be applicable at a site level. Much like the recently published ACPSEM ROMP Workforce Model, its design allows facility managers and workforce planners to have more transparent and flexible DIMP staffing guidelines. The model can be adapted to reflect current and projected patient volumes, workforce practices, available modalities, and technological complexities.

1.3 Scope

This publication describes the characteristics of the DWM, which estimates the recommended staffing levels for clinical medical physics services in medical imaging and nuclear medicine.

Medical physicist and physics staff requirement outputs are based on WG's consideration of best practices identified through lived experience in the context of international guidelines. Much like the IAEA model, the DWM includes general radiation safety duties commonly undertaken by Australian and New Zealand medical physicists. Similarly, the model includes research and development at an itemised component level, allowing the removal of certain aspects from final outputs.

1.4 Structure

The DWM is published as a spreadsheet; users input data reflecting their local workforce practices, procedure and patient volumes, equipment fleet and department types. Model input variables are described using terms familiar to facility managers and workforce planners.

2. Activity-based time estimates

2.1 Approach to the contextualisation of IAEA

The IAEA model is an activity-based algorithm to describe diagnostic imaging and nuclear medicine staffing levels. The DWM adapts and contextualises IAEA activity-based principles for Australian and New Zealand practice at a granular level.

DWM inputs were gathered through several workshops with the WG to converge on a consensus view. The Project Team worked with the ACPSEM and the WG to review existing DIMP Workforce models. WG members first refined IAEA model activities to reflect the Australian and New Zealand context before participating in data collection, validation and consensus meetings to determine representative activity time profiles. The outcome of this process ultimately underpins the DWM.

2.2 Medical Physics Support Staff

The use of support staff in medical physics services varies significantly in Australia and New Zealand. The DWM outputs the number of qualified medical physicists required to complete the outlined activities and does not explicitly separate support staff requirements. The exact staff mix remains a local decision; support staff are often considered critical in-service delivery by the DWM like the IAEA model.

Support staff should be assigned according to individual workplace practices. In some instances, support staff may be:

- entirely supernumerary to DIMP FTE requirements. The IAEA notes that support staff providing medical physics services should be at least equal in number to medical physicists.
- partially supernumerary, whereby support staff may complete aspects of physicist activities under the supervision of qualified medical physicists
- limited in practices that only use qualified medical physicists.

Few WG members reported that their physics services utilised support staff.

2.3 Methodology

Because of jurisdictional practice variation and the profession's relative workforce modelling infancy, the ACPSEM leveraged the IAEA Model along with WG member expertise and experience through focused qualitative workshops and targeted data collections to gather representative activity times. The aim was to ensure that estimated average times represent all Australian and New Zealand Radiology and Nuclear Medicine centres.

After the WG endorsed the IAEA model refinement approach, three critical steps were implemented:

- **DIMP activities workshop:** This step ensured adequate capture of Radiology Medical Physicists' and Nuclear Medicine Medical Physicists' activities and incorporated extensive discussion about activity categories, DIMP duties and input variable (driver) types used in DIMP requirement estimates.
- **Activity time collation:** The WG provided the time estimates for each according to the shortlisted drivers (e.g. annual time per equipment unit, annual time per patient). The data collection tool incorporated live FTE calculations so that respondents could assess their time estimate reasonableness.
- **Validation and Delphi process:** The WG received 25th percentile, Median or 75th percentile summary representative time estimates, determined by response spread and clustering. An algorithm identified activities with significant variation. A subsequent Delphi process converged time estimates reaching consensus through discussions about activity interpretation and requirements.

WG Members also piloted the model with site data to determine the reasonableness of the model output.

3. Key Features of the Model

The model employs an activity-based approach for estimating qualified medical physicist staffing levels and reflects ‘typical’ DIMP workflow. Each activity carries the representative total time to complete one unit of that activity, with time estimates based on WG consensus.

Modelled FTE estimates are expressed as qualified medical physicist FTE. **A site’s estimated total qualified medical physicist FTE requirement may differ from modelled output due to desired physics staff mix (medical physicists, trainees and support staff)**. Sites should consider total medical physics department staff in the context of local workplace practices and support staff ratios.

The model incorporates five factor categories, each having unique variable inputs (i.e., units of equipment, patients, procedure etc.). The main categories are:

- Equipment Dependent Factors
- Patient Dependent Factors
- Practice Dependent Factors (general radiation safety duties and practice staff)
- Medical Physics Service-Related Factors
- Training and Research Factors.

In its simplest form, the algorithm calculates the number of medical physicist FTE required as:

MP FTE* = Equipment FTE* + Patients FTE* + Practice FTE* + Service FTE* + Training FTE*

Equipment FTE*	Patients FTE*	Practice FTE*	Service FTE*	Training FTE*
• 13 Nuclear medicine equipment categories • 18 Diagnostic and Int equipment categories	• 8 Nuclear medicine patient categories • 3 Diagnostic and Int. patient categories	• 16 department specific • 3 staff specific	• 14 Medical Physics service related factors	• 1 CPD units required factors • 1 supervision factor • 4 research and development

** FTE is equal to the total MP hours required per year divided by the available hours per medical physicist (hours available in a year less leave entitlements and overheads (entered by individual users to allow for jurisdiction and workplace differences)).*

4. Overview of ACPSEM Workforce Calculator Factors

The following section provides an overview of the five critical factor categories incorporated into the ACPSEM Model, covering common Medical Physicist duties and considerations. Specific activity notes are detailed in Section 5. ACPSEM DIMP Workforce Calculator Descriptions and Guide.

4.1 Equipment Factors

This section covers duties related to periodic equipment performance testing (also referred to in some jurisdictions as compliance testing). This section's representative times include oversight and evaluation of routine QC programs. The model allows input of a site's equipment and device fleet in nuclear medicine and diagnostic and interventional radiology (respectively). In this section:

- Users should include all equipment tested by the medical physics service (e.g. count equipment in departments or external sites outside the traditional nuclear medicine or radiology department). External sites may include oral health sites, BreastScreen sites, vascular labs and cardiology/catheter labs.
- Suppose the medical physics service does not provide equipment testing for a modality, even though that modality is present at the site. In that case, this equipment should not be included in the count. For example, if no medical physics equipment testing or QC are provided for ultrasound, then do not count any ultrasound units.
- DEXA units may be located in different departments, e.g. Nuclear Medicine, Radiology, or elsewhere. If a nuclear medicine physicist provides equipment testing, include the DEXA unit under nuclear medicine, whereas if a radiology physicist provides it, include the DEXA unit under radiology.

4.2 Patient Factors

This section covers duties related to patient management, patient-specific dosimetry for radionuclide therapy, and individual patient-related dosimetry or risk assessments. These might apply in situations of unintended exposure or where additional considerations are required for the patient because they are a child, pregnant or breastfeeding. Additionally, this section includes troubleshooting issues related to a patient examination (e.g. a specific artefact).

The model allows for input of the number of times a medical physicist is involved in patient related factors in nuclear medicine and in diagnostic and interventional radiology, respectively. If the medical physics service is not involved in any of the items listed, then users of the model have the option to not include this activity for their modelled FTE. For example, if there is no medical physics involvement in I-131 therapies and these are instead handled entirely by nuclear medicine technologists or specialists, then do not provide any inputs for these variables.

Due to its intermittent nature, it may be challenging to quantify interactions with patients, such as counselling. If possible, count the number of occasions a medical physicist has performed this at the site over the past three years and determine an annual amount. This section should also consider instances where it would have been advisable for a medical physicist to be involved, but may not have had the opportunity, resources or support to do so.

4.3 Practice Factors

This section of the Model captures general radiation safety duties provided by medical physics staff. The time required to undertake these duties depends on the complexity of the site but also on efficiencies gained by having oversight of multiple small sites of the same modality. In some instances, these duties are performed by other professionals at a site (e.g. radiographers) and, therefore, should not be counted here. However, suppose the duties encompassed by this section are provided (or intended to be provided) by the medical physics service. In that case, the relevant sites should be counted.

Different levels or definitions of imaging (radiology) practices/departments and nuclear medicine departments have been provided to encompass the varying complexity of these sites' health services. These practice/department types are broadly based on Health Service Levels used by health departments in a number of jurisdictions. However, it is essential to note that the input variables provided here are not traditional department definitions. Instead, they have been separated into some key components to allow flexible use of the Model based on the health services provided at a site or group of sites. Although health services such as interventional radiology and/or interventional neuroradiology (IR/NIR) and MRI are typically part of a large radiology department, these have been

4. Overview of ACPSEM Workforce Calculator Factors

kept separate for this Model to support counting of interventional labs that operate independently (IR/NIR) and/or to allow data input only if medical physics support is provided (e.g. MRI).

Where multiple sites are covered by the health physics service, which are geographically separate, it is not unreasonable to count “1” for each type of site represented even when they are governed by the same radiation management plan.

4.4 Medical Physics Service Factors

This section of the Model captures the roles medical physics staff have in ensuring and maintaining service quality and delivery (including compliance and accreditation requirements), service quality oversight and management (including assessing and reporting service activities and typical doses), performing equipment specification, evaluation and acceptance testing and radiation protection planning for new installations.

Whether the medical physics service is provided by one person or a team of medical physicists, overheads or ongoing activities will be required for that service provision. These include general office and business admin (sending monitors for calibration) and involvement in the site’s quality management and auditing. This section of the models aims to capture these activities, as well as:

- The time-intensive work associated with image quality, dose optimisation, and Diagnostic Reference Level (DRL) comparisons. These have been separated into two items, as the number of modalities where DRL surveys are performed due to regulatory requirements can be more readily quantified. Optimisation activities are more challenging to quantify but are essential to recognise and include in the Model. This may include informal dose comparisons/surveys on all modalities. DRLs are counted per modality per site as often geographically separate sites will require extra time involvement, even if it is the same modality (e.g. CT) involved. Staffing and business operations at different sites may be quite different.
- The number of required hours for travel to rural and remote locations in instances where medical physics staff are needed offsite.

4.5 Training, academic teaching and Research Factors

This Model section covers the medical physics staff's function in training other medical physicists and health professionals, carrying out service-led research, participating in research ethics committees, supporting external research projects, and involvement in clinical research. For this Model's purpose, the duties covered in this section only relate to those conducted within the expected FTE of the medical physics service. Privately contracted work should not be counted.

4.6 Miscellaneous

Several activities may be less routine or not widely performed across all jurisdictions. If an activity is not listed in this Model, it does not imply that medical physicist involvement is unnecessary. Instead, the workload involved in such situations can only be quantified locally, and additional FTE should be added to this Model where required. An example would be the duties of a medical physicist relating to RIS/PACS, which are highly variable depending on the local situation and cannot be quantified in a uniform way. Another example is where the medical physicist might be involved in UV-C implementation, testing and advice.

4.7 Derivation of Medical Physicists FTE estimates

The Model estimates the number of qualified DIMP FTEs that a physics service requires based on the individual services’ standard hours. Users enter the number of days worked per week, hours worked per day and standard leave entitlements in Cells D15 to D21 of the 1. DIMP Workday Breakdown Tab.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

5.1 Nuclear Medicine Equipment Dependent Factors

The equipment-dependent factors and estimated annual time requirements (hours) per equipment unit used for the DWM are described in Table 1 for nuclear medicine. Users enter the number of equipment units in their practice in cells E16 to E28 of the **2. Equipment Dependent Factors** Tab.

The Medical Physicist associated duties may include (but are not restricted to the list below):

- A complete range of periodic equipment performance tests with associated documentation.
- Testing after major maintenance procedures that could affect the relevant parameters for assessing patient dose and displayedimage quality.
- Review or evaluation of routine quality controls.

Table 1. Nuclear Medicine Equipment Dependent Factors

Input Variable	Hours	Notes
Planar gamma camera	16.0	Applies to non-SPECT systems.
SPECT systems - simple	60.0	Includes SPECT systems with simple camera orientations and limited number of collimators.
SPECT systems - complex	150.0	Includes cardiac imaging systems.
SPECT/CT	200.0	Applies to the whole system, including CT. If the CT is used for diagnostic purposes, also include unit count in Diagnostic Radiology.
PET/CT	250.0	Applies to the whole system, includes whole body PET/CT. If the CT is used for diagnostic purposes, also include unit count in Diagnostic Radiology.
PET/MR	170.0	Does not include safety aspects of magnetic resonance. If the MR is used for diagnostic purposes, also include unit count in Diagnostic Radiology.
Cyclotron	1,656.0	Safety duties to be included in Section: Practice Related Factors.
Reporting workstations	2.0	Consists of a pair of monitors. Applies only to primary reporting. Does not include monitors used for acquisition or for secondary display.
Dose calibrator	10.5	Includes benchtop or similar dose calibrators. Does not include auto-injectors.
Automated dose infusing systems	10.0	Includes auto-injectors or similar systems.
DEXA (dual-energy X ray absorptiometry) unit	8.0	Include if Nuclear Medicine department is responsible for DEXA (only include once in either Nuclear Medicine or Diagnostic Radiology).
Radiation counters	10.0	Includes liquid scintillation, well counters, gamma counters, survey meters or similar devices.
Other devices	10.0	May include, but not restricted to: thyroid probes, sentinel lymph node probes, or different types of isotope generators.

Activity specific notes:

- A simple SPECT system is one which may not, for example involve quantification.
- For dual modality systems (e.g. SPECT/CT, PET/CT, PET/MR) if the CT or MR component is used for diagnostic imaging then additional time for equipment testing is accounted for by also inputting this system in Section 2b: diagnostic and interventional radiology equipment. For example, if a nuclear medicine department has one PET/CT scanner and the CT scans are of diagnostic quality rather than only for the purpose of attenuation correction and localisation then enter "1" for PET/CT in Section 2a and enter "1" for CT scanner-single source in Section 2b.
- The cyclotron item is for equipment related duties and does not include safety aspects of the cyclotron (e.g. shielding or radiation safety including possible emissions from the site where the cyclotron is run and maintained by others) as this is covered in Section 4: practice related factors.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

5.2 Diagnostic and Interventional Radiology Equipment Dependent Factors

The equipment-dependent factors and estimated annual time requirements (hours) per equipment unit used for the DWM are described in Table 2 for Diagnostic and Interventional radiology. Users enter the number of equipment units in their practice in Cells E39 to E56 of the **2. Equipment Dependent Factors** Tab.

The Medical Physicist associated duties may include (but are not restricted to the list below):

- A complete range of periodic equipment performance tests with associated documentation.
- Testing after major maintenance procedures that could affect the relevant parameters for assessing patient dose and displayedimage quality.
- Review or evaluation of routine quality controls.

Table 2. Diagnostic and Interventional Radiology Equipment Dependent Factors

Input Variable	Hours	Notes
CT scanner - single source	21.0	Includes fixed and mobile CT scanners used for diagnostic radiology or radiotherapy planning. Includes hybrid units where CT is used for diagnostic purposes. Does not include cone beam CT (CBCT) units for dental or interventional/surgical planning use.
CT scanner - dual source	24.0	Includes CT scanners with two X-ray tubes.
Mammography unit - simple	22.0	Includes 2D acquisition and biopsy units.
Mammography unit - complex	24.0	Includes tomosynthesis units.
Radiography unit - fixed	10.0	Includes fixed general X-ray units and X-ray tubes in fluoroscopy rooms used for general X-ray imaging.
Radiography unit - mobile	5.0	Includes mobile/portable general X-ray units.
Fluoroscopy unit - fixed	16.0	Includes fixed units used for basic fluoroscopy. For combined radiographic/fluoroscopy rooms with two X-ray tubes, include each tube in the appropriate modality.
Fluoroscopy unit - mobile	8.0	Includes mobile fluoroscopy units and mini C-arm units. Does not include interventional/surgical planning CBCT units.
Interventional fluoroscopy unit	18.0	Includes interventional fluoroscopy units and interventional/surgical planning CBCT units. For biplanar systems, include both X-ray tubes separately.
Intra-oral dental X ray unit	2.0	Includes portable and fixed devices.
Panoramic dental x ray unit	4.0	Includes OPG and cephalometric imaging.
Dental CBCT unit	5.0	Includes units capable of producing 3D images.
DEXA (dual-energy X ray absorptiometry) unit	4.0	Include if Radiology department is responsible for DEXA (only include once in either Diagnostic Radiology or Nuclear Medicine).
Computed radiography (CR) readers	5.0	A single unit includes the CR reader and CR cassettes.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

Table 2 (cont.). Diagnostic and Interventional Radiology Equipment Dependent Factors

Input Variable	Hours	Notes
Printing devices	4.0	Includes digitisers and laser printers.
Reporting workstations	2.0	Consists of a pair of monitors. Applies only to primary reporting. Does not include monitors used for acquisition or for secondary display.
MRI scanner	13.0	Safety duties to be included in Section: Practice Related Factors.
Ultrasound unit	4.0	A single unit includes the ultrasound unit and all probes used clinically.

Activity-specific notes:

- Mobile CT scanners (e.g. used for diagnostic imaging such as brain scans) are included in "CT scanner– single source".
- Mobile interventional/surgical planning CBCT units (e.g. O-arms) are included in "interventional fluoroscopy unit".
- For combined radiographic/fluoroscopy rooms with two X-ray tubes where one is used for basic fluoroscopy and one (typically overhead) used for general X-ray imaging, ensure that both X-ray tubes are counted in the appropriate category (one in "fluoroscopy unit – fixed" and one in "radiography unit – fixed").

5.3 Patient-Dependent Factors

The patient-dependent factors and estimated time requirements (hours) per unit *(underlined in notes below)* used for the DWM are described in Table 3 for Nuclear Medicine and Table 4 for Diagnostic and Interventional Radiology. Users enter the number of procedure/patients or physicist involvement in Cells E16 to E23 and E34 to E36 of the of **3. Patient Dependent Factors** Tab.

The Medical Physicist associate duties may include (but are not restricted to the list below):

- Radiation safety for patient management in radionuclide therapy *(Nuclear Medicine only)*.
- Patient-specific dosimetry in radionuclide therapy *(Nuclear Medicine only)*.
- Patient dosimetry and risk assessment for individual patients (unintended exposures and paediatric, pregnant and breastfeeding patients).
- Troubleshooting technical and clinical physics issues related to patient examinations (e.g. sub-optimal image quality, artefacts)

Table 3. Nuclear Medicine Patient Dependent Factors

Input Variable	Hours	Notes
Procedures with no image data	7.5	PER PHYSICIST INVOLVEMENT. Includes procedures such as blood sampling, thyroid uptake, sentinel lymph node mapping. Only count cases requiring physics support since it will not be required for every case.
Imaging procedures	3.0	PER PHYSICIST INVOLVEMENT. Includes imaging procedures for planar, SPECT(/CT), PET/(CT/MR). Only count cases requiring physics support since it will not be required for every case.
Radio-guided occult lesion localisation using I-125 seeds (ROLLIS)	1.0	PER PATIENT.
Outpatient radionuclide therapy (e.g. I-131 for thyrotoxicosis)	1.8	PER PROCEDURE. Includes individual patient dosimetry and radiation safety.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

Table 3 (cont.). Nuclear Medicine Patient Dependent Factors

Input Variable	Hours	Notes
Inpatient radionuclide therapy (e.g. I-131 for thyroid carcinoma)	8.0	PER PROCEDURE. Includes individual patient dosimetry and radiation safety.
Complex radionuclide therapy (e.g. I-131 mIBG, Lu-177, Y-90)	8.0	PER PROCEDURE. Includes individual patient dosimetry and radiation safety.
Risk assessments in paediatric, pregnant or breast-feeding patients	2.3	PER PATIENT. Includes dose assessment and reporting of results.
Counselling of patients	2.0	PER PATIENT. Includes time for preparation, delivery to patient/family/carers and follow-up with clinical staff, as required.

Activity-specific notes:

- Procedures with no image data, such as lymphoscintigraphy and node mapping, are widely variable regarding medical physics input. As a medical physicist may only be involved where there is an issue and this may take some time to resolve, the input for this variable is based on only those procedures where the physicist was involved. Medical physicist time may be required to set up a process, for example, blood sampling, but this process would then be used across all patients. This activity is better captured in Section 5: medical physics service-related factors, potentially as “protocol development”.
- Radio-guided occult lesion localisation (ROLLIS) has been included for those jurisdictions where this procedure is performed. Included in the time allocation is consideration that some patients are simple, whereas others may have a seed come loose with follow-up required. A dose estimate may be required if the patient is ill or if the seed could not be retrieved. Therefore, it is acknowledged that there will be variability in the time required of a medical physicist. The time allocated has been determined in order to cater for simple to complex patients. It does not include the time required for establishing adequate tracking mechanisms which is better captured in Section 5: medical physics service related factors (i.e. considered an overhead for the medical physics service, before becoming routine and the number of patients then becomes the driver).
- Outpatient radionuclide therapies (e.g. I-131) may require varying medical physics input at different sites and based on individual patient situations. Dosimetry may not often be considered for thyrotoxicosis patients. However, in some circumstances it may be required. Furthermore, patient-specific radiation protection precautions and advice may be necessary based on the administered activity and a dose rate measurement to provide appropriate advice. For example, this may involve researching the type of septic tank the patient has at home. Therefore, the time allocation allows for variations in the time required to accommodate these possible scenarios.
- For inpatient and more complex radionuclide therapy (e.g. thyroid cancer treatment), best practice includes the informed calculation of the maximum tolerated administered activity or other endpoints (e.g. blood or marrow absorbed dose). Following the EANM guidelines, multiple time points of image and blood sampling data are obtained. The time to analyse this data and calculate the dose values is included in the time allocation, along with other routine tasks that may be required (e.g. room set-up, patient discussions, dose rate measurements, patient discharge).

Table 4. Diagnostic and Interventional Radiology Patient Dependent Factors

Input Variable	Hours	Notes
Individual patient dosimetry for high dose procedures	4.0	PER PATIENT. Includes calculation and reporting of results for procedures leading to high patient doses such as radiation incidents or high skin doses from interventional procedures.
Risk assessment for paediatric and pregnant patients	3.5	PER PATIENT. Includes dose assessment and reporting of results.
Counselling of patients	1.0	PER PATIENT. Includes time for preparation, delivery to patient/family/carers and follow-up with clinical staff, as required.

Activity specific notes:

- Individual patient dosimetry for high dose procedures (e.g. high skin doses) may be undertaken in a variety of ways ranging from manual to fully automated. The time that has been allocated is representative of the range of durations that may be involved with this task.
- Counselling of patients in diagnostic and interventional radiology may not be directly to the patient. On some occasions the medical physicist may provide patient-specific information to a clinician (e.g. radiologist) who will then provide the risk assessment and/or advice to the patient.

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5.4 Practice Type Dependent Factors

The practice type dependent factors and estimated annual time requirements (hours) per number of sites per practice type used in the DWM are described in Table 5. Users enter the number of sites within a practice type in Cells E16 to E31 of the **4. Practice Dependent Factors** Tab.

The Medical Physicist's general radiation safety duties may include (but are not restricted to the list below):

- Providing advice and ensuring compliance with local and national regulations and accreditation requirements, including regular inspections.
- Administration related to radiation licensing and registration, etc.
- Development and implementation of relevant radiation management plans.
- General protection aspects for ionising and non-ionising radiation in a hospital, including risk assessments and radiation protection surveys.
- MR safety considerations and advice.
- Environmental impact assessments.
- Ionising and non-ionising safety advice for new installations e.g. PPE requirements, MRI static field survey, laser safety audit for new theatres.
- Radioactive waste management.
- Control and calibration of monitoring and measuring equipment.

Table 5. Practice Type Dependent Factors

Input Variable	Hours	Notes
Nuclear medicine department	65.0	Limited diagnostic nuclear medicine studies such as bone scans, static imaging and has no hot lab to prepare pharmaceutical kits (or uses unit doses) and usually operates during business or limited hours.
Intermediate nuclear medicine department	100.0	Range of diagnostic nuclear medicine studies including SPECT studies and has more than one imaging system and offers standard outpatient I-131 therapies. It usually has a small hot lab to prepare limited pharmaceutical kits in house such as reconstituting cardiac and renal kits.
Comprehensive nuclear medicine department EXCL PET	275.0	Has the capacity to offer a complete range of nuclear medicine procedures, including a comprehensive hot lab for preparing pharmaceutical kits and may offer radioactive blood products in-house. May operate 24 hours and uses on-call staff. EXCLUDES PET
Comprehensive nuclear medicine department INCL PET	358.0	Has the capacity to offer a complete range of nuclear medicine procedures, including a comprehensive hot lab for preparing pharmaceutical kits and may offer radioactive blood products in-house. May operate 24 hours and uses on-call staff. INCLUDES PET
PET/CT standalone	83.0	One or more PET hybrid systems.
Theranostics and/or comprehensive radionuclide therapy	350.0	Includes inpatient and outpatient radionuclide therapies.
Cyclotron	450.0	Includes only the radiation protection responsibilities associated with the operation of a cyclotron.
Single modality imaging practice	50.0	Includes limited X-ray service and may have point of care ultrasound and/or proceduralist-led image intensifiers, for example: - Mobile or fixed general X-ray unit (may be predominantly delivered by X-ray operators, not radiographers); or - Stand-alone dental or DEXA practice; or - Depending on the range of services provided at the facility (e.g. day hospital), a mobile image intensifier may be the only modality available. May be supported by a sole radiographer.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

Table 5 (cont.). Practice Type Dependent Factors

Input Variable	Hours	Notes
Dental	20.0	Includes one or a group of dental practices (e.g. health service).
BreastScreen	82.0	Includes one or more BreastScreen mammography units at one or multiple sites (e.g. health service).
Intermediate imaging practice/ radiology department	130.0	Range of imaging services available on site, or may be a stand-alone CT or provide basic fluoroscopically guided procedures or mammography. May provide imaging to theatres. Note that MRI is included as a separate item.
Comprehensive radiology department	180.0	Wide range of imaging services available on site with inpatient and outpatient services with full imaging capacity inclusive of 24/7 CT services, provision of imaging services to theatre and basic interventional fluoroscopically guided procedures. Note that specialised interventional radiology, catheterisation laboratories and MRI are included as separate items.
Interventional radiology and/or interventional neuroradiology	70.0	Specialised interventional fluoroscopically guided services, including dedicated vascular labs.
Catheterisation laboratory	70.0	Specialised cardiac interventional fluoroscopically guided services.
MRI services	150.0	One or more MRI scanners. Only include if medical physics support is provided.
Lasers	32.5	Use of surgical lasers typically in an operating theatre setting. Only include if medical physics support is provided.

Activity-specific notes:

- Comprehensive nuclear medicine departments may also provide services for PET and molecular procedures. This would include a dedicated PET hot lab and a PET suite (scanner and uptake rooms). The option has been given to input a comprehensive nuclear medicine department based on whether it has one or more PET scanners (INCL PET) or alternative has none(EXCL PET). The category that includes PET simply adds the time allocation for the standalone PET/CT to the comprehensive nuclear medicine department (EXCL PET) time allocation.
- A comprehensive nuclear medicine department may also provide theranostics and/or comprehensive radionuclide therapy. In this case, “1” should be entered against the relevant “comprehensive nuclear medicine department item” (i.e. with or without a PET scanner) and “1” also entered against “theranostics and/or comprehensive radionuclide therapy” to adequately allow for the time required to provide radiation safety duties across these specific areas.
- If medical physics services are provided across a number of dental services or across BreastScreen services, these have been grouped together. For the radiation protection duties which are relevant to this section there are efficiencies gained in providing medical physics support to a number of sites of the same modality (e.g. a radiation management plan).
- If a non-BreastScreen mammography unit is included at a practice and is RANZCR MQAP accredited, then “1” should be entered against the “BreastScreen” item.
- For a cyclotron, only the radiation protection responsibilities associated with the operation of a cyclotron have been included in this section of the model. A cyclotron may be incorporated as part of a comprehensive nuclear medicine department with complex synthesising processes and dispensing systems internally or distributed externally. A radiopharmacist is required to support the practice along with a medical physicist undertaking radiation safety duties.

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5.5 Practice Staff Related Factors

The patient staff related factors and estimated time requirements (hours) per unit *(underlined in notes below)* used the DWM are described in Table 6. Users enter the number of staff or cases in Cells E42 to E44 of the **4. Practice Dependent Factors** Tab.

The Medical Physicist associated duties may include (but are not restricted to the list below):

- Occupational dose monitoring of staff.
- Investigation of high occupational doses and other radiation incidents.
- Counselling of pregnant staff.

Table 6. Practice Staff Related Factors

Input Variable	Hours	Notes
Personal radiation monitoring of staff	0.9	PER STAFF. Number of monitored staff. Includes administration and reporting.
Staff exposure incident evaluations	3.0	PER CASE. Includes incident management (e.g. for personal contamination) or in the case of occupational dose, exceeding a defined limit.
Risk assessment for staff	3.0	PER CASE. Examples are reports of the cumulated doses or evaluation of fetal dose in pregnant workers.

Activity specific notes:

- It is acknowledged that it may be difficult to quantify the staff exposure incident evaluations or risk assessments for staff. If possible, count the number of instances where this has been required at the site over the past three years and determine an annual amount. Also consider instances where it would have been advisable for a medical physicist to be involved, but may not have had the opportunity, resources or support to do so.

5.6 Medical Physics Service Factors

The Medical Physics services dependent factors and estimated time requirements (hours) per count of specified drivers *(underlined in notes below)* used the DWM are described in Table 7. Users enter the counts of each driver in Cells E16 to E29 of the **5. MP Service Related Factors** Tab.

The Medical Physicist general radiation safety duties may include (but not restricted to the list below):

- General office and business administration.
- Radiation dose surveys for comparison with DRLs.
- Quality management, including clinical audits.
- Equipment specification and evaluation (e.g. tenders).
- Equipment acceptance testing.
- Shielding design, assessment and reporting in nuclear medicine or diagnostic and interventional radiology.
- Image quality and dose optimisation
- Protocol development.
- Travel.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

Table 7. Medical Physics Dependent Factors

Input Variable	Hours	Notes
Medical physics administration	200.0	PER MEDICAL PHYSICS SERVICE. Including internal meetings for budget, planning of activities and staffing issues.
Image quality and dose optimisation	40.0	PER MODALITY PER SITE. Modalities where medical physics services are provided in optimisation activities
Radiation dose surveys for comparison with DRLs	40.0	PER MODALITY PER SITE. For each modality (e.g. CT or NM) where DRL surveys are performed
Quality management, including clinical audits	237.5	PER PRACTICE. Documentation development and review of quality assurance policies, procedures and associated records, participation in quality assurance and safety committees, preparation and participation in audits and accreditation processes. E.g. DIAS
Equipment specification and evaluation (e.g. tenders)	40.0	PER PROCUREMENT. Assuming a unit of average complexity.
Equipment acceptance testing	36.0	PER UNIT. Includes acceptance testing and development of quality assurance baseline values. Assuming a unit of average complexity.
Shielding design, assessment and reporting in nuclear medicine - PET	130.0	PER EQUIPMENT INSTALLATION. including associated laboratory, uptake and treatment areas. Including the shielding plan and confirmation for an average installation.
Shielding design, assessment and reporting in nuclear medicine - SPECT	130.0	PER EQUIPMENT INSTALLATION. including associated work areas. Including the shielding plan and confirmation for an average installation.
Shielding design, assessment and reporting in nuclear medicine - Therapy	130.0	PER TREATMENT AREA. may include multiple rooms, including associated laboratory, uptake and treatment areas. Including the shielding plan and confirmation for an average installation.
Shielding design, assessment and reporting in diagnostic and interventional radiology	48.0	PER EQUIPMENT INSTALLATION. Including the shielding plan and confirmation for an average installation.
Protocol development	40.0	PER PROTOCOL. Includes development of equipment testing protocol, associated software development, development of phantoms.
Multiple sites supported within same metro area	45.0	PER METRO SITE. Do not include main site of operation. Includes time required for organisation and travel where sites are geographically separate.
Multiple sites supported in a regional location	60.0	PER REGIONAL SITE. Do not include main site of operation. Includes time required for organisation and travel where sites are geographically separate.
Multiple sites supported in a remote/interstate location	60.0	PER REMOTE/INTERSTATE SITE. Do not include main site of operation. Includes time required for organisation and travel where sites are geographically separate.

Activity-specific notes:

- The provision of formal shielding designs has been included in this section. This activity is expected to include the calculations for a radiation shielding design, provision of a formal report and follow-up review of the installed shielding to ensure that it meets the minimum requirements specified. Provision of these designs, especially for equipment such as a PET scanner, may be intermittent due to the life-cycle of the equipment. To account for this it is advised that an average over a 5-10 year period be used for the annual amount.
- There are situations where time is required to provide advice or assist in setting up and implementing a new process. This activity will have an initial overhead and then ongoing activities will be incorporated into more routine requirements (e.g. under patient dependent factors for nuclear medicine processes). Some examples may include the initial time investment to set up a protocol for testing digital detectors in radiography; establishing a validation method for clinical implementation of AI reconstruction methods; assessing focused collimators for cardiac imaging in nuclear medicine.
- Many healthcare institutions have multiple campuses either within a metropolitan area or associated sites within a regional catchment area. To account for the necessary travel that will occur in providing on-site medical physics services such as annual equipment testing the model provides inputs for different scenarios. If it is a metropolitan site only been modelled then each site excluding the main hospital are accounted. For example if a tertiary hospital has three satellite sites located in surrounding suburbs then the input would be “3”. If the tertiary hospital had an additional regional site that medical physics services are provided to then the site would be accounted for in the next line item.

5. ACPSEM DIMP Workforce Calculator Descriptions and Guide

5.7 Training, Academic Teaching and Research Factors

The training, academic teaching and research-dependent factors and estimated time requirements (hours) per unit *(underlined in notes below)* used in the DWM are described in Table 8. Users enter the units of each driver in Cells E16 to E24 of the **6. Training & Research Factors** Tab.

The Medical Physicist general radiation safety duties may include (but are not restricted to the list below):

- Delivering academic teaching.
- Carrying out research led by the service.
- Providing radiation risk assessments for ethics committees.
- Participation in research ethics committees.
- Providing support to external research projects.
- Involvement in clinical research (e.g. additional quality assurance and dosimetry requirements, modelling, data management, medical statistics).

Table 8. Training, Academic Teaching and Research Factors

Input Variable	Hours	Notes
Participation in CPD requirements	50.0	PER REGISTERED MEDICAL PHYSICIST.
Ongoing supervision and training of internal TEAP registrars	352.0	PER REGISTRAR.
Delivering informal training to external TEAP registrars and internal junior or support staff	3.0	PER HOUR OF TRAINING. Includes organisation and preparation (e.g. new staff inductions).
Delivering training to health professionals	3.0	PER HOUR OF TRAINING. Includes delivery and preparation (e.g. ionising and non-ionising radiation safety, tutoring of RANZCR registrars, organised TEAP registrar group events).
Delivering academic teaching	2.0	PER HOUR OF TEACHING. Includes delivery and preparation (e.g. university level). Does not include privately contracted work (e.g. casual university contracts).
Radiation risk assessments for applications to Human Research Ethics Committees	4.8	PER APPLICATION.
Clinical trial with trial specific QA requirements	16.3	PER TRIAL. Includes time for commencement and ongoing trial requirements.
Research and development including clinical research in nuclear medicine	195.0	PER DEPARTMENT. Does not include work funded by grants (e.g. NHMRC).
Research and development including clinical research in diagnostic and interventional radiology	195.0	PER DEPARTMENT. Does not include work funded by grants (e.g. NHMRC).

Activity-specific notes:

- It is essential to include time allocation for CPD activities for the medical physics staff. In accordance with ACPSEM requirements for medical physicists listed on the Register, time has been allocated per registered physicist.
- Under the item for "ongoing supervision and training of internal TEAP", the number of registrars enrolled in TEAP should be counted. Although a TEAP registrar ideally completes training in three years, it is expected that a TEAP accredited department will have ongoing supervision and training requirements long-term. Departments may not have a registrar appointed at all times, but it is anticipated that training departments will have an ongoing commitment to training and supervision. Ongoing supervision and training of internal TEAP registrars apply to registrars within an ACPSEM-accredited department.
- Delivering informal training to external TEAP registrars applies to ad hoc time spent supporting/training registrars at other sites. Whereas, delivering training at formal TEAP registrar group events involves more time in preparation and is therefore included under "delivering training to health professionals". Training of junior and/or support staff within the medical physics service includes ongoing instructions required for local protocols and processes.

6. Worked Examples

Several WG Members tested the ACPSEM DIMP Workforce Model. They compared the Model's result to the current expectations of Medical Physicist requirements based on workload mix and activity composition for the physics service. Overall, WG feedback indicates alignment with their expected Medical Physicist FTE requirements based on 'best practice'.

However, there are some factors to consider when using the Model:

- **Differences in practice:** The physics time required per task is based on the interquartile range of time estimates supplied by WG Members. When comparing with individual user experience, jurisdictional/legislative differences and/or physics service preferences, there will be instances where the Medical Physicist FTE estimates may fall outside the modelled bounds. In those instances, the Model will underestimate or overestimate DIMP FTE requirements for a particular activity.

- **Differences in equipment requirements:** : Similarly, annual equipment QA time is also based on the interquartile range of time estimates supplied by WG Members. Time estimates are not unit or manufacturer-specific; therefore, interval variations and time intensity would vary across different physic services. Some physics services may have equipment requiring less routine activity due to the age of their fleet or the manufacturer's specification or requirements. Therefore in some instances, the time needed may also result in under/ overestimated DIMP FTE requirements.

The remainder of the paper explores three worked examples showing how the Model could help understand DIMP workforce requirements. The worked examples consider the following:

1. **Example 1. Small Institution**
2. **Example 2. Large Institution**
3. **Example 3. To be developed**

Example 1: Small Institution

Small Institution: The following is an example of a small health care service that provides normal working hours outpatient imaging and a single mobile fluoroscopy unit for theatre support. Nuclear Medicine is a range of diagnostic imaging studies offered five days per week. This site has no significant research commitments and is not included in ACPSEM TEAP training activities.

Standard Work Hours:
Typical working hours with medical physics staff; working 8 hours a day, 5 days per week. Allow for 25 days annual leave per year, 12 accrued or rostered days off, 11 public holidays, 5 days conference and study leave equivalent to: 1656 hours per year over 207 working days.

Radiology Specific Inputs

Equipment:
- 1 CT scanner,
- 2 X-ray rooms with fixed digital equipment,
- 1 digital mammography unit,
- 1 portable mobile fluoroscopy,
- 1 portable mobile x-ray and
- 10 primary reporting workstations

Patient Dependent:
- Expect 5 pregnancy calculations per year
- Expect up to 5 patient counselling sessions per year

Practice Dependent:
- Intermediate imaging practice/radiology department
- 30 Staff for radiation monitoring
- 1 pregnant risk assessment for staff per year
- 1 occupational limit review per year

Nuclear Medicine Specific Inputs

Equipment:
- 1 planar
- 1 SPECT/CT gamma camera
- 1 activity calibrator and
- 2 primary reporting workstations

Patient Dependent:
- Expect 10 paediatric/pregnancy/breastfeeding calculations per year
- Expect up to 10 patient counselling sessions per year

Practice Dependent:
- Intermediate nuclear medicine department
- 5 Staff for radiation monitoring
- 1 risk assessment for pregnant staff per year
- 1 occupational limit review per year

Combined DIMP Inputs

Medical Physics Service Dependent:
- 2 Image Quality and dose optimisation (1 for NM and 1 for CT)
- 2 DRL (1 for NM & 1 for CT)
- 1 Clinical audit
- 0.4 Procurement (4 every 10 years for NM and Radiology combined)
- 0.4 Acceptance Testing
- 0.2 NM Shielding (2 every 10 years)
- 0.2 Radiology Shielding (2 every 10 years)

*Note – have not included medical physics administration as MPE is to be considered part of imaging department and all administration etc is maintained by departments operations manager.

Training, Teaching and Research:
- 1 x Participation in CPD
- 7 x radiation safety inductions per year (2 for NM and 5 for Radiology)

DIMP FTE Requirement

0.6FTE

Example 2: Large Institution

Large Institution: The following is a worked example of a large tertiary metropolitan teaching hospital with a secondary health care service/community hospital that is co-located approximately 5 kilometres away. The imaging department provides the full range of CT and Interventional Radiology service and the Nuclear Medicine facilities provide a range of diagnostic imaging studies, PET and a therapeutic treatment services, including theranostics. The hospital also has interventional vascular services in theatre and a interventional cardiology unit that operates four catheterisation laboratories. The site has significant research commitments and is included in ACPSEM TEAP training activities and hosts two TEAP registrars.

Standard Work Hours:
Typical working hours with medical physics staff; working 8 hours a day, 5 days per week. Allow for 25 days annual leave per year, 12 accrued or rostered days off, 11 public holidays, 5 days conference and study leave equivalent to: 1656 hours per year over 207 working days.

Radiology Specific Inputs

Equipment:
- 7 single source CT scanner (this also includes the CT associated with PET scanner and mobile CT)
- 1 dual source CT scanner
- 1 digital mammography tomosynthesis unit
- 15 X-ray rooms with fixed digital equipment,
- 11 mobile x-ray units
- 3 fixed fluoroscopy units – basic imaging
- 13 mobile fluoroscopy units (this includes one mobile 3D volumetric imager (O-Arm))
- 7 Interventional fluoroscopy units (this includes one bi-plane unit)
- 2 intra-oral dental units
- 1 dental CBCT unit
- 1 DEXA unit
- 20 Reporting Workstations
- 5 MRI scanners (including one mobile MRI)
- 10 Ultrasound units

Patient Dependent:
- 15 skin dose reviews
- 5 pregnancy calculations per year
- 10 patient counselling sessions per year

Practice Dependent:
- 1 x Dental
- 1 x MQAP accredited Mammography service (equiv. to BreastScreen)
- 1 x Intermediate imaging practice – for secondary health service.
- 1 x comprehensive radiology department – for main imaging dept.
- 2 x interventional radiology - one operated by MID, one operated by theatre (vascular surgeons).
- 1 x interventional catheterisation lab (covers 4 units at primary site)
- 1 x MRI service
- 1 x Laser Service
- 500 Staff for radiation monitoring
- 15 staff exposure/incident evaluation per year
- 10 exposure evaluation for pregnant staff per year

Example 2: Large Institution *(cont.)*

Nuclear Medicine Specific Inputs

Equipment:

- 2 SPECT systems
- 2 SPECT/CT gamma camera
- 1 PET /CT
- 5 activity calibrator
- 1 auto dose injector
- 10 reporting workstations
- 4 Radiation counters
- 2 sentinel lymph node probes

Patient Dependent:

- 20 procedures (no image data) requiring physics review/input
- 25 procedures (with image data) requiring physics review/input
- 20 outpatient I-131 therapies per year
- 20 inpatient I-131 therapies per year
- 80 complex radionuclide therapies per year
- 5 paediatric/pregnancy/breastfeeding calculations per year
- 10 patient counselling sessions per year

Practice Dependent:

- 1 x Comprehensive nuclear medicine department INCL PET
- 1 x Theranostics and or comprehensive radionuclide therapy
- 5 Staff for radiation monitoring
- 1 risk assessment for pregnant staff per year
- 1 occupational limit review per year

Combined DIMP Inputs

Medical Physics Service Dependent:

- 1 x Medical Physics Service
- 12 Image Quality and dose optimisation (Covers (1 x NM, 1 CT in NM, 2 X CT, 3 x int. rad (IR & cat lab), 2x fluoro, 2 x gen, 1 x mammo) for main and secondary site
- 5 DRL (1 x NM, 1 CT in NM, 2 x CT over 2 sites & 1 Cath. Lab)
- 1 Clinical audit
- 5 Equipment tenders/procurements per year
- 5 Acceptance Testing
- 0.2 x NM Shielding -PET (2 every 10 years)
- 0.3 x NM Shielding – SPECT (3 every 10 years)
- 1 x NM Shielding – Therapy
- 6 Radiology Shielding
- 2 x Protocol Development
- 1 x travel time to secondary metro site.

Training, Teaching and Research:

- 4 x Registered Physicist participation in CPD
- 2 x TEAP Registrar (Training and Support)
- 40 hours informal training to external TEAP registrars (providing imaging lectures to ROMP TEAP registrars and providing NM sign off for other Radiol registrars through MOU arrangements)
- 65 hours training to health professionals (includes 30 hours of RANZCR registrar tutorials in-house, regular 30 minute radiation safety sessions for theatre staff, cath lab staff, radiology and NM staff, I-131 nurses, neurolite nurses, UVC operators, laser safety)
- 100 radiation risk assessments for HREC applications
- 1 x General Research & Development in NM
- 1 x General Research & Development in Radiology Imaging

DIMP FTE Requirement

5.6FTE

Example 3: Medium Institution with Regional Centres

Medium Institution with Regional Centres: The following is a worked example of tertiary hospital in a medium-sized city, which also has three satellite regional community based health services spread over a geographically large area. Two of the regional centres are within 50 km of the tertiary centre and one centre is 150 km away. The tertiary imaging department provides the full range of CT and Interventional Radiology services. The tertiary site includes a BreastScreen centre. The site has ultrasound and a MRI scanner but no medical physics support is provided to these modalities. The Nuclear Medicine facilities provided at the tertiary centre cover the range of diagnostic imaging studies during business hours Monday to Friday with occasional outpatient I-131 treatments provided as well as a PET scanner. Additional to the medical imaging requirements the medical physics service assists with laser safety in the theatres and maintains an accredited department for radiology ACPSEM TEAP training.

Standard Work Hours:
Typical working hours with medical physics staff; working 8 hours a day, 5 days per week. Allow for 25 days annual leave per year, 12 accrued or rostered days off, 11 public holidays, 5 days conference and study leave equivalent to: 1656 hours per year over 207 working days.

Radiology Specific Inputs

Equipment:
- 4 single source CT scanner (1 at main hospital and 3 smaller regional sites)
- 1 2D mammography unit at tertiary centre
- 12 X-ray rooms with fixed digital equipment (6 at main hospital and 2 at each of smaller regional sites)
- 6 mobile x-ray units (3 at main hospital and 1 at each of smaller regional sites)
- 1 fixed fluoroscopy unit – basic imaging (main hospital)
- 6 mobile fluoroscopy units (3 at main hospital and 1 at each of smaller regional sites)
- 4 Interventional fixed fluoroscopy units (all at main site: 2 x cath labs, DSA lab, hybrid suite)
- 8 intra-oral dental units (spread across the health service, some mobile)
- 1 DEXA unit (main hospital)
- 16 Reporting Workstations (10 at main hospital and 2 at each of smaller regional sites)

Patient Dependent:
- 5 skin dose reviews
- 5 pregnancy calculations per year
- 5 patient counselling sessions per year

Practice Dependent:
- 1 x dental
- 1 x BreastScreen
- 3 x intermediate imaging practices
- 1 x comprehensive radiology department
- 2 x interventional radiology / DSA lab
- 1 x cath lab
- 1 x Laser service
- 50 Staff for radiation monitoring
- 5 staff exposure/incident evaluation per year
- 5 exposure evaluation for pregnant staff per year

Example 3: Medium Institution with Regional Centres *(cont.)*

Nuclear Medicine Specific Inputs

Equipment:
- 1 SPECT/CT gamma camera
- 1 PET /CT
- 1 isotope generator
- 1 Dose Calibrator
- 2 Reporting Workstations

Patient Dependent:
- 5 outpatient I-131 therapies per year
- 2 imaging exams requiring additional physics follow-up
- 5 paediatric/pregnancy/breastfeeding calculations per year
- 5 patient counselling sessions per year

Practice Dependent:
- 1 x intermediate nuclear medicine department
- 1 x PET
- 5 Staff for radiation monitoring
- 1 risk assessment for pregnant staff per year
- 1 occupational limit review per year

Combined DIMP Inputs

Medical Physics Service Dependent:
- 1 x Medical Physics Service
- 10 Image Quality and dose optimisation (1 for NM, 4 for CT over 4 sites, 1 x int. rad & 4 x gen over 4 sites)
- 4 DRL (1 for NM, 4 for CT over 4 sites & 1 Int. Rad)
- 1 Clinical audit/Quality Management
- 1 Equipment tenders/procurements per year
- 1 Acceptance Testing
- 0.1 x NM Shielding -PET (1 every 10 years)
- 0.1 x NM Shielding – SPECT (1 every 10 years)
- 2 Radiology Shielding
- 1 x protocol development
- 2 x travel time to 2 x regional sites
- 1 x travel time to 1 x remote site

Training, Teaching and Research:
- 2 x Registered Physicist participation in CPD
- 1 x TEAP Registrars (one Radiology)
- 20 hours training to health professionals
- 5 radiation risk assessments for HREC applications

DIMP FTE Requirement

2.5FTE