وزارة الصحة
Ministry Of Health
المديرية العامة للمؤسسات الصحية الخاصة
Directorate General of Private Health Establishments

Health Facility Guidelines of Oman

Nuclear Medicine Department

Briefing & Design

February/ 2025

Document Title	Health Facility Guidelines of Oman Nuclear Medicine Department: Briefing & Design
Document Type	Guidelines
Directorate/Institution	Directorate General of Private Health Establishments
Targeted Group	Nuclear Medicine and Molecular Imaging Center in Private Health Establishments
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Release Date	February/2025
Review Frequency	3 years

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Date	February /2025	**Date**	February/2025

Acknowledgements

The Directorate General of Private Health Establishments would like to acknowledge and recognize the author and the reviewers of this document representatives for their dedication in creating this guideline. The team are:

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Acronyms

Cs-137	Caesium-137
CT	Computed tomography
CPM	Count per minute
DMSA	Dimercaptosuccinic acid
DPM	Disintegration per minute
DTPA	Diethylenetriamine pentaacetic acid
F-18	Fluorine-18
FDG	Fluorine-18 2-fluoro-deoxyglucose
Ga-67	Gallium-67
Ga-68	Gallium-68
Ge-68	Germanium-68
HDP	Hydroxymethan diphosphonate
I-131	Iodine-131
MAG3	Mercaptylacetyltriglycine
Mo-99	Molybdenum-99
MDP	Methylene diphosphonate
MUGA	Multigated acquisition
MIBG	Meta-iodobenylguanidin
MRI PET	Magnetic resonance imaging positron emission tomography
SPECT	Single photon emission computed tomography
Tc-99m	Technetium-99m
Tl-201	Thallium-201
TLD	Thermoluminescent dosimeter. It is a crystal usually Lithium Fluoride which is used to measure the amount of personnel dose.
Xe-133	Xenon-133
FPU	Functional Planning Unit

Definitions

- **Activity:** Spontaneous nuclear transformation from a given energy state at a time interval due to the release of particulate or gamma radiation.
- **Contamination:** The presence of a radioactive substance in or on material or human body or place.
- **Controlled Area:** Any area in which the specific protection measures and safety provisions are or could be required for controlling normal exposures or controlling the spread of contamination and preventing or limiting the extent of potential exposures.
- **Cyclotron:** A machine used to accelerate charged particles to high energies to create radionuclides. Decontamination: Removal or reduction of contamination by a physical or chemical process.
- **Exposure:** A measure of the ionization produced in air by x or gamma radiation. It is the sum of the electrical charges on all ions of one sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in air, divided by the mass of air in the volume element. The special unit of exposure is the roentgen.
- **Gamma Ray:** Very penetrating electromagnetic radiation of nuclear origin. Except for origin, identical to x-ray
- **Half-life:** The length of time it takes for one-half of the radioactive material to decay by emitting radiation.
- **Hot cell:** a heavily shielded enclosure that may be used for handling or processing highly radioactive materials by remote means through lead-glass windows so that the radiation hazard to personnel is minimized.
- **Ionization:** The process by which a neutral atom or molecule acquires either a positive or a negative charge.
- **Ionizing Radiation:** Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter.
  Isotopes: Nuclides having the same number of protons in their nuclei, and hence having the same atomic number, but differing in the number of neutrons, and therefore in the mass

number. Almost identical chemical properties exist among isotopes of a particular element.

- **Justification:** The decision to adopt new or existing practices which involve exposures or potential exposure if it is likely to produce sufficient benefits to an individual or to society to outweigh the detriment or harm to health that they may cause.
- **Millicurie:** One-thousandth of a curie (3.7×10^7 disintegrations per second), abbreviated mCi. Microcurie: One millionth of a curie (3.7×10^4 disintegrations per second), abbreviated µCi. Picocurie: One millionth of a microcurie (3.7 x 10-2 disintegrations per second or 2.22 disintegrations per minute), abbreviated pCi.
- **Monitoring, Radiological:** Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination present in an occupied region as a safety measure for purposes of health protection.
- **Molecular imaging:** Scientific discipline that studies new ways of imaging molecular events and biochemical reactions in a living organism using labeled tracers with high molecular specificity.
- **Nuclide:** A species of atom characterized by its mass number, atomic number, and energy state of its nucleus, provided that the atom is capable of existing for a measurable time.
- **Occupational Exposure:** All exposures of workers incurred in the course of their Optimization work. A system of radiological protection that requires the limiting the dose to as low as reasonably achievable (ALARA) taking into consideration economic and social factors.
- **Optimization:** the process of maximizing the net benefit arising from human activities which lead to exposure to radiation.
- **Positron:** An elementary particle of antimatter that undergoes mutual annihilation with a nearby electron, which produces two gamma rays traveling in opposite directions.
- **Quality Assurance (QA):** Planned and systematic actions necessary to provide adequate confidence that a structure, system or component will perform satisfactorily in service giving optimum diagnostic information at minimum dose to both patients and personnel.
- **Quality Control (QC):** Set of operations intended to maintain or improve quality.
- Radiation: The emission and propagation of energy through space or through a material

medium in the form of waves; for instance, the emission and propagation of electromagnetic waves, or of sound and elastic waves.

- **Radiation Incident:** any unintended or ill-advised event when using ionizing radiation apparatus, specified types of non-ionizing radiation apparatus or radioactive substances, which results in, or has the potential to result in, an exposure to radiation to any person or the environment, outside the range of that normally expected for a particular practice, including events resulting from operator error, equipment failure, or the failure of management systems that warranted investigation.
- **Radionuclide:** An atom with an unstable nucleus that emits gamma-rays, x-ray photons, or positrons, and also known as a radioisotope.
- **Radiopharmaceutical:** Radioactive drug composed of a radionuclide and a pharmaceutical that is used for diagnosis or therapy.
- **Radioactive Material:** Any material (solid, liquid, or gas) which emits radiation spontaneously.

  Radioactive Materials Laboratory: A volume bounded by a floor, a ceiling, and at least four floor-to-ceiling walls or partitions, in which radioactive materials are used or stored.
- **Radioactive Waste:** Material in its physical form remaining from practices or interventions and for which no further use is foreseen that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level for clearance from regulatory requirements.
- **Radiological Survey:** Evaluation of the radiation hazards incident to the production, use or existence of radioactive materials or other sources of radiation under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes using or affecting these materials to predict hazards resulting from expected or possible changes in materials or equipment.
- **Sealed Source:** Radioactive material that is permanently sealed in a capsule or closely bounded and in a solid form.
- **Shielding Material:** Any material which is used to absorb radiation and thus effectively

reduce the intensity of radiation, and in some cases, eliminate it. Lead, concrete, aluminum, water, and plastic are examples of commonly used shielding material.

- **Sievert:** SI unit of dose equivalent, abbreviated Sv. 1 Sv = 100 rem.
- **Smear (Smear, Swipe or Wipe Test):** A procedure in which a swab, e.g., a circle of filter paper, is rubbed on a surface and its radioactivity measured to determine if the surface is contaminated with removable radioactive material.
- **Supervised Area:** Any area not designated as a controlled area but for which occupation exposure conditions are kept under review even though specific protective measures and safety provisions are not normally needed.
- **Tracer, Isotopic:** The isotope or non-natural mixture of isotopes of an element which may be incorporated into a sample to make possible observation of the course of that element, alone or in combination, through a chemical, biological, or physical process. The observations may be made by measurement of radioactivity or of isotopic abundance.
- **Thermoluminescent Dosimeter:** A dosimeter made of certain crystalline material which is capable of both storing a fraction of absorbed ionizing radiation and releasing this energy in the form of visible photons when heated. The amount of light released can be used as a measure of radiation exposure to these crystals.
- **X-rays:** Penetrating electromagnetic radiations having wavelengths shorter than those of visible light. They are usually produced by bombarding a metallic target with fast electrons in a high vacuum. In nuclear reactions it is customary to refer to photons originating in the nucleus as gamma rays, and those originating in the extranuclear part of the atom as x-rays. These rays are sometimes called ‘roentgen rays’ after their discoverer, W. C. Roentgen.

Introduction

Nuclear medicine imaging provides unique information that often cannot be obtained using other imaging modalities and offers the potential to identify disease in its earliest stages. It plays a major role in assessment and diagnosis of various cardiac, bone, endocrine, renal, brain disorders. It is used for the detection and staging of various types of tumors. In addition, it is used for treating some benign and malignant diseases through radionuclide therapy procedures.

Radiotracers are produced either using dedicated devices known as generators and Cyclotron.

The Nuclear Medicine Department may include the following imaging modalities:

- Single Photon Emission Computed Tomography (SPECT) scanning– formerly known as Gamma Camera. SPECT may be integrated with a CT scanner (SPECT/CT).
- Positron Emission Tomography (PET) scanning– which is either integrated with a CT (PET/CT) or MRI (PET/MRI)
- Bone Densitometry

The Nuclear Medicine Department is provided as a unit within the Medical Imaging Department or as a separate department within a hospital or as stand-alone department without an attached hospital. It must include a Hot Laboratory but may or may not include a Radiopharmacy Laboratory or Cyclotron. The size of the department/ unit in terms of numbers and type of modalities will be determined by the service plan and clinical needs. The planning to be as a stand-alone setting or within a hospital-based setting depends on the range of clinical services to be provided and if radionuclide therapy is planned, a hospital-based setting is required.

The Nuclear Medicine facility is a highly specialized area that involves risk of radiation exposure and deals with radioactive materials. It should have a full time qualified and licensed Radiopharmacist, Medical physicist, nuclear medicine technologists, nuclear medicine nurse and nuclear medicine consultant for at least one of the imaging machines. In case of establishing a nuclear medicine private health facility, it must be managed by an Omani nuclear medicine physician (consultant and above) who is licensed by the Ministry of Health.

Purpose

To provide directions to all healthcare workers working in Nuclear Medicine and Molecular Imaging Center in Private Healthcare establishments.

Scope

This guideline applies to all healthcare workers in Nuclear Medicine and Molecular Imaging Center in Private Healthcare establishments.

Chapter 2

1. Description of modalities

1.1. SPECT: Single Photon Emission Computed Tomography

SPECT is a nuclear medicine tomographic imaging technique using gamma rays that can provide true 3D information. This information is typically presented as cross-sectional slices through the patient but can be freely reformatted or manipulated as required. The most used radioactive isotope for clinical SPECT is:

- Technetium-99m with a short half-life of 6 hours,
- Thallium (Tl-201) with a half-life of 73.1hours
- Iodine-123 with a half-life of 13.2 hours
- Iodine (I-131) with (half-life 8.0197 days) that is used as diagnostic and therapeutic for thyroid disorders.

1.2. SPECT/CT: Single Photon Emission Computed Tomography/Computed Tomography

The incorporation of a CT scanner with a gamma camera for combined SPECT/ CT imaging is designed to give an atomic signpost to clinicians so they can accurately locate and identify the affected tissue in a nuclear image. CT data can also help correct attenuation and be used for calcium scoring.

1.3.PET/CT: Positron Emission Tomography/ Computed Tomography

1.3.1. Positron Emission Tomography (PET) is a nuclear medicine technology that uses short-lived radionuclides (tracers) injected into the body allowing non-invasive imaging of metabolic, biochemical and/or physiological function within the body. The primary radioactive isotopes are used.

1.3.2. For clinical PET is FDG - Fluorine-18 (Fluoro-deoxy glucose) manufactured using a cyclotron and Gallium-68 using a generator. The half-life of an F-18 is around 110 minutes, and the half-life of Ga- 68 is 68 minutes. These isotopes can only be transported relatively short distances before use. Because of the short half-life of the supplied isotopes careful planning is needed with respect to patient scheduling and isotope deliveries that may require more than one delivery per day.

1.3.3. Positron Emission Tomography (PET) with integrated Computed Tomography

(CT) technology is used extensively in cancer assessment and ongoing evaluation of treatment response. Optionally, the CT scan may also be used for radiotherapy simulation with the addition of laser positioning lights in the scanning room.

1.4.PET/MRI: Positron Emission Tomography/Magnetic Resonance Imaging

The PET/ MRI is an emerging hybrid imaging technology incorporating PET scanning with MRI scanning in one procedure. PET/MRI, and to a lesser extent in cardiac and neurology specialties and provides superior anatomical information in certain areas where anatomical delineation by MRI is required, e.g., head and neck, and pelvis.

1.5.Cyclotron and Radio-pharmacy

1.5.1. The Cyclotron is an accelerator that uses proton beams to manufacture radioisotopes (radiotracers)used in nuclear medicine. The Cyclotron may be provided within the health facility or located off site and radioisotopes supplied by an external provider. Hospitals with a Cyclotron must have Radiopharmacy Laboratories for their SPECT/PET use and may provide services to other hospitals.

1.5.2. Design and specific requirements for a Cyclotron and Radiopharmacy are not included in this FPU. If a Cyclotron and Radiopharmacy are to be provided, the location and the spatial requirements will need to be assessed at a very early planning stage with particular emphasis on setting the facility in an access-restricted area and structural requirements to support the weight of the equipment as well as the radiation shielding needs. The shielding requirements for cyclotron and Radiopharmacy facilities will need to be coordinated between the equipment manufacturers and a (Radiation Protection Officer (RPO) and then reviewed and approved by the Ministry of Health (MOH).

1.5.3. The requirements for the SPECT/PET radiotracer production facility, including the cyclotron depends on the radiotracers to be produced and functional requirements of the facility as determined on an individual basis.

1.5.4. The Cyclotron and Radiopharmacy facilities will require compliance with relevant local and national radiation authority standards, guidelines, and licensing requirements.

1.5.5. Nuclear medicine requires high quality radiopharmaceuticals and kits that are safe for administration and efficacious for a given application. Therefore, the used radio-active materials, cold kits and radiopharmaceuticals should be selected from manufacturers that follow GMP (Good Manufacturing Practice), have deep regulatory expertise, have the infrastructure and resources to meet urgent orders, long shelf life, tested before in local nuclear medicine facility and authorized by qualified NM physician, radio-pharmacist, technologist and medical physicist. In case the

product was not used previously, a sample should be requested, tested and approved by a qualified team in the ministry of health (e.g., experts from the Royal Hospital).

1.5.6. The radiopharmaceuticals should be stored according to the manufacturer's recommendations and should not be used beyond the expiration date or time recommended by the manufacturer.

1.5.7. The ready used radio-active materials should be ordered for each patient with specific dose that is calibrated to time of administration and delivered to the nuclear medicine facility on time.

1.5.8. A comprehensive radiopharmaceutical quality control program should be developed and implemented. The scope of the program should be compatible with the type of practice and the availability of equipment and personnel. The parameters to monitor in a radiopharmaceutical quality control program include chemical purity, radiochemical purity, radionuclidic purity, biologic purity (sterility and pyrogenicity), and pharmaceutical purity (e.g., pH).

1.5.9. The transportation of Radioisotopes must follow the requirements of the responsible environmental authorities. The transportation contractors must also follow the environmental regulations by the responsible authorities. All required licenses should be obtained.

2. Functional and Planning Considerations

2.1.Operational Models

2.1.1. The Operational Model will depend on the level of services provided as defined in the service plan and the inclusion of imaging modalities including Bone Densitometry, SPECT, SPECT/CT and PET/CT scanning.

2.1.2. Smaller departments with one or two scanning rooms may be included as Nuclear Medicine Unit within the Medical Imaging Department. Larger centers may provide a discrete department.

2.1.3. Large centers must include a Radiopharmacy Laboratory that will prepare its own radiopharmaceuticals for SPECT/ PET scanning.

2.2.Models of Care

2.2.1. Most patients undergoing Nuclear Medicine studies are treated on an outpatient basis. Unless there is radionuclide therapy (e.g., Iodine therapy and I131-MIBG) that are provided within the department, then these patients are admitted within the Iodine therapy rooms for 3 to 4 days before they are scanned and discharged. Most of Patient appointments are booked in advance to ensure supplies of radionuclides are available at the time needed. Patient instruction, preparation and availability of special meals should be considered prior to calling the patient for an appointment.

2.2.2. Appointments for pediatric patients will need to be coordinated with an anesthetist as these patients require sedation or anaesthesia for PET/SPECT studies to ensure images are not compromised/ distorted by the patient's movement.

2.3.Department Planning Models

2.3.1. A ground floor site is preferred but if this cannot be achieved, consideration should be given to other departments or units above, below and adjoining the proposed location with regards to radiation shielding requirements, the weight of equipment and associated shielding and access for equipment and radioactive isotopes.

2.3.2. The department should not act as a thoroughfare to other departments of the healthcare facility. The location of the department should prevent access by persons such as lost visitors and wandering patients from other units and ensure the security of radioisotopes held within the unit.

2.3.3. The layout and configuration of the Units must provide separation of injected (Hot) patients from non-injected patients (Cold) to ensure patients, staff and visitors are not exposed to radiation. The path of travel of injected patient needs to be carefully planned, including Uptake Rooms, Toilets, Scanning Rooms and Hot Laboratories. Planning and design should consider separate patient and staff corridor systems and provide separate entries for outpatients and for inpatients on beds/ trolleys. Patient flow should be well defined in one clear direction. HOT LAB should not be accessed by any patient or relative and preferred to be at one corner. Controlled access should be well maintained in all required areas.

2.3.4. PET/ SPECT Scanning rooms should be planned in compliance with the manufacturer’s recommendations because area requirements may vary from machine to machine. Since technology changes frequently and from manufacturer-to-manufacturer rooms should be sized larger to allow upgrading of equipment in the future.

2.3.5. If provided, the Bone Densitometry Room should be located near the entry to the Nuclear Medicine Unit to ensure patients do not unnecessarily cross areas of radioactivity. The Bone Densitometry room should be located away from injected patients by distance or shielding to avoid interference to the Bone Density Unit from high ambient radiation levels.

2.4.Future Growth

2.4.1. Planning should consider future growth of PET/ SPECT services which will be dependent on population increase and advances in technology. In cases where it is expected that population growth will require enhanced service capacity within

a five-year period, the following issues need to be addressed with regard to future expansion of the Unit:

- Additional scanning rooms to allow for increased service demand.
- Scanning rooms sized to provide sufficient space for upgrades to the equipment which may also require additional shielding, increased load bearing capabilities and services requirements.
- Access for supply and installation of new equipment.
- Increased numbers of bariatric patients.
- Identificationofexpansionzonesforincreasedstaffingandsupportfacilitiestomeetservice demand and technological changes.

2.4.2. Tertiary facilities may need to be considered for future accommodation for PET/MRI scanning. The design of a scanning room to accommodate a hybrid PET/MRI unit differs substantially from the PET/CT unit, requiring radiation, radiofrequency, and magnetic shielding. Furthermore, the weight of the scanning unit is substantially greater.

3. Functional Zones

The Nuclear Medicine Department consists of the following Functional Zones depending on the Operational Policy and service demand:

3.1 Entry/Reception/Holding, a 'Cold' Zone incorporating:
• Reception desk (which may be shared with Nuclear Medicine Medical Imaging) • Waiting (injected patients and visitors) (two separate patient waiting areas (one for non-injected patient and one for injected patient waiting for Scan SPECT or SPECT/CT) • Office for clerical support. • Interview room/s. • Patient Holding Bays for patients on beds. • Staff Station (with Triage room near the nurse station for preparing the patient and taking the vital signs). • Storage for stationery, files and printing. • Public amenities (Patient toilet in cold zone) (-disable patient needs to be considered).
3.2 Imaging Areas:

- Injection Rooms
- Induction room/ s for patients requiring sedation anesthesia.
- Uptake rooms for PET
- SPECT and SPECT/CT scanning room/s, control room, computer equipment (technical) room
- PET/CT, and PET/MRI scanning room/s, control room, computer equipment (technical) room
- Bone Densitometry room
- Cardiac stress Testing room
- Patient toilets(hot), with direct access to uptake rooms
- Kids play in area (hot zone) for injected pediatric patients near the waiting area, so the parents can observe the kids. due to the long waiting time for some studies.

3.3 Hot Laboratory Areas including:

- Entry lobby for radioisotopes (radiotracers)
  - Separate Hot Labs for Nuclear Medicine (PET & SPECT) with separate bio-safety cabinet for each isotope
  - Radioactive Waste Store (two separate radioactive waste stores in hot zone: one for SPECT used Isotopes and the other for PET used Isotopes)
  - Work stations for quality control processes
  - Ante room for Hot lab with changing area before entering the Hot Lab
  - Pass box between Hot lab and QC room.
  - Two separate radioactive waste stores in hot zones: one for SPECT used Isotopes and the other for PET used Isotopes.
  - Technegas Machine room for ventilation scan in hot zone with exhaust or hood to extract air (optional)
  - I-131 Area including. Separate hot lab for I-131 including dose calibrator, well counter and a shielded fume cupboard with suitable filters that can handle radioactive vapors from I-131
  - I-131 isolation rooms, each with an ante room, radioactive linen store, admission isolation room with toilets that connected to delay tank.
  - Separate radioactive store in the yard of the hospital for domestic waste

3.4 Support areas
• Beverage bay • Emergency shower and eyewash • Clean Storage for linen, resuscitation trolley, mobile equipment, personal protective Equipment (PPE) • Clean Utility • Cleaner's room • Crush trolley area. • Dirty Utility with autoclave machine (optional) • Viewing and Reporting areas
3.5 Staff Areas including
• Office Manager, Nurse In-Charge, Radiographer Supervisor and Medical Physicists. • Staff Room that may be shared. • Meeting room, shared with adjacent areas. • Toilets and lockers • Prayer room. • Changing room.
3.6 The following optional inclusions are dependent on the Operational Policy of the Unit, determining how radioisotopes are to be manufactured, delivered and prepared:
• Cyclotron • Radiopharmacy

These Functional Zones/Areas are briefly discussed below.

3.1.Entry/Reception/Waiting

3.1.1. The reception is the receiving hub of the department where patients first present for their scheduled appointment and should therefore ensure the security of the entire department through access control.

3.1.2. The Reception and Waiting areas will receive and hold patients and visitors prior to injection; these are 'cold' areas and require clear separation from 'hot' areas of the Unit where patients have been injected and are awaiting scanning. Un-

injected outpatients may wait in the general waiting area with their family/supporters prior to scanning procedures. Inpatients may be taken directly into a bed Holding area or Uptake room. Bed waiting areas should be separated from the ambulatory patient waiting areas for patient privacy; prior to injection with radiotracers, the bed holding area is regarded as a 'cold' zone.

3.1.3. Waiting areas may be divided into separate male/ family areas to meet cultural requirements and will require convenient access to public amenities. The Waiting areas should be redesigned for compliance with accessibility standards and be provided with a range of seating options for occupants of varying mobility including bariatric patients. Waiting areas should include a Beverage Bay for patients to prepare refreshments, provisions for prams and a play area for children if paediatric services are included in the Operational Policy.

3.2.Imaging Areas

3.2.1. Uptake Room/s

- The Uptake room is a private, radiation shielded room where patients are injected with the PET radiotracers on a recliner chair or bed and rest until uptake has occurred before the scanning procedure. The Uptake room requires direct access to a 'hot' toilet, preferably without accessing a common corridor and exposing staff and passing traffic to radiation. Following scanning procedures patients will return to the Uptake room to recover or cool down prior to discharge from the Unit. Ideally, the discharge route should not cross un-injected patients or visitors.
- The recommended ratio of Uptake rooms to Scanning rooms is 2 Uptake rooms per 1 Scanning room, if the rooms are also used for 'cool down' additional Uptake rooms will be required to achieve a ratio of minimum 3 Uptake rooms to 1 Scanning room.
- Optionally, based on the patient's volume, for SPECT imaging (only) a common patient injection room may be provided for rapid patient throughput.

3.2.2. Uptake/Induction Room/s

- The Uptake Induction room is provided for administering sedation or anesthetic to patients on a bed prior to scanning procedures including paediatric patients. The room will include an anesthetic machine, medical gas and patient monitoring. Patients may be returned to the Uptake/ Induction room to cool down prior to discharge.
- Uptake/ Induction Rooms/s can be used flexibly as general Uptake/ Recovery

rooms when not usedfortheinductionofpatientsandwillcountaspartofthetotalratioofUptakeroomstotheScanning rooms.

- The Uptake room/s will require access for beds and trolleys.

3.2.3. SPECT and SPECT/CT Scanning Room

- SPECT/CT requires a separate shielded control room and radiation screening in accordance with CT requirements. Installation of equipment should be in accordance with the manufacturer's recommendations. Room size may vary according to the equipment selected but no less than the area shown in the Schedule of Accommodation. Scanning rooms require ready access from the Uptake rooms.
- Scanning rooms may be collocated with shared Control rooms to enable monitoring of two rooms simultaneously as long as the privacy of the patients can be assured (this is optional; however, each scanning room should have a separate control room). This means no line of sight from one scanning room to another via the Control room.

3.2.4. PET/CT Scanning Room

- The scanning equipment will be installed to the manufacturer's specifications and may require service links to the Computer Equipment (Technical) Room and Control Room. Bed and trolley access will be required to the PET/ CT scanning room.
- Visibility to the PET scanner from the Control Room is preferred but not essential if patients are fully monitored via closed circuit television.

3.2.5. PET/MRI Scanning Room

- The requirements are very similar to the PET/CT with the added requirements of MRI room. For technical details, refer to the equipment manufacturer's instructions.

3.2.6. Bone Densitometry Room

- The room may have radiation shielding to walls and/or glazing as advised by Radiation Consultant and approved by the MOH.

3.3.Hot Laboratory Area

3.3.1. Hot Laboratory/Dispensary

- The Hot Laboratory will be required for receipt, delivery, storage and dispensing/ preparation of radiotracers. These may be supplied as unit doses from an external provider, internal preparation from generator or from a Cyclotron facility within

the campus. They are drawn up or prepared ready for administration of the patient in the Hot Laboratory. The Hot Laboratory should have separate rooms for PET, SPECT and radionuclide therapy like I-131. The Hot Laboratory requires ready access from a service corridor for delivery of radiotracers. The radiotracer delivery room should be close to the HOT Lab and it should be controlled so the delivery person cannot access the HOT LAB. It also needs to be readily accessible to the Uptake rooms. The hot lab should have an Ante room and enough space for a biosafety cabinet and medical refrigerator.

- The Hot Laboratory rooms require radiation shielding. Space and equipment are required for dose calibrators, computerized record keeping and quality control activities. A lead glass screen may act as a barrier behind which dispensing, and calibration occurs.

3.3.2. Radioactive (Hot)Waste Store

- The Radioactive (Hot) Store is a secure, radiation shielded room for the storage of sealed sources and radioactive waste, particularly sharps. The Waste Store requires ink and basin with hands- free taps for hand washing and equipment decontamination.
- The Hot Waste Store should be located with convenient access from Uptake rooms, Hot Laboratory and exit for removal of waste when it is safe for disposal.
- The Hot Laboratory and Hot Store will need to be accredited by the relevant environmental authorities.
- The Waste Store may be centralized and remotely located, for example in a basement or in an outbuilding on the campus. If the main Waste Store is remotely located, as a minimum a small Waste Store must be co-located with the hot lab for immediate disposal purposes.

3.3.3 Cardiac stress Testing room (Treadmill room)

- Cardiac stress testing is usually required as part of the Nuclear Medicine services. Cardiac stress testing rooms should have convenient access to the Uptake and Scanning rooms. The treadmill room should have a treadmill machine inside it, crush trolley, infusion pump for pharmacological stress. It also has enough space for an ECG technician computer that will be attached to the treadmill. The room should be shielded as per the local guidelines.

3.4.Support Areas

Support areas include the following provisions:

3.4.1. A beverage Bay for light refreshments for patients undergoing SPECT/PET and myocardial perfusion studies, due to the length of time patients are required to fast.

3.4.2. An emergency Shower and eyewash facility is required for radioactive and chemical spills.

3.4.3. Dirty Utility Room may require radiation shielding if hot waste is held in this room; refer to local radiation safety regulations.

3.4.4. Storage is required for:

- Collimators and scanning phantoms, within the scanning rooms.
- Mobile equipment such as resuscitation trolleys, wheel chairs, trolleys, lifters, and ultrasound scanners.
- Technegas unit and large argon cylinder/s that may be in an equipment bay; the Technegas unit and trolley is taken to patients in holding bays or in the camera rooms for patients to inhale Tc99m.
- Linen, medical consumables and sterile stock
- Stationery and records/ files.
- A staff station with supervision of Uptake rooms and bed holding areas.

3.4.5. Viewing and reporting, is an optional area for reviewing images and reporting and may be located within Control rooms or shared with an adjacent Unit.

3.5. Staff Areas

3.5.1. Staff will need access to the following:

- Toilets, shower, and lockers
- Staff room with beverage facilities
- Meeting room/s for meetings, education and training.
- Offices for the Manager and senior staff

3.5.2. Staff are as may be shared with a collocated Unit (Medical Imaging).

3.5.3. Teaching, research, and student facilities may be required depending on the role delineation and service plan of the facility including offices, workstations, dry laboratories, wet laboratories, student discussion areas and meeting rooms.

3.6. Optional Areas

3.6.1. Radio-pharmacy Laboratory

- The Radiopharmacy Laboratory is used for preparation, compounding, quality control NOTE: hot lab cannot be used for QC of the Prepared Radiopharmaceuticals. Separate area is needed for QC and preferably to be attached to HOT LAB). and dispensing a range of radiopharmaceuticals used in diagnosis and treatment under strict controls and sterile manufacturing techniques or preparation of radiopharmaceuticals supplied from an adjacent Cyclotron. Inclusions in the Laboratory will be largely dependent on the range of radiopharmaceuticals to be produced.
- This laboratory is not covered in detail by this FPU and requirements need to be assessed on a case by case basis . Only designated units will have an in-house Radio-pharmacy Laboratory where cold kits are prepared for use in the hospital or supplied to other Nuclear Medicine and PET Units. The procedures performed in the field of hospital radiopharmacy be classified into three broad categories: operational levels 1, 2 and 3. Each category can be further subdivided to provide essential advice on staff qualifications, training, facilities, equipment, types of procedures, record keeping, QA and QC essential at that level. Refer to IAEA. "Operational guidance on hospital radiopharmacy." (2008).

a. OPERATIONAL LEVEL 1a

Operational level 1a is the dispensing of radiopharmaceuticals purchased or supplied in their final form from recognized and/or authorized manufacturers or centralized radiopharmacies. This includes unit doses or multiple doses of prepared radiopharmaceuticals for which no compounding is required like iodine capsules.

b. C.OPERATIONAL LEVEL 1b

Operational level 1b is the dispensing of radioiodine and other ready to use radiopharmaceuticals for radionuclide therapy or palliation. This includes ready to use injections of strontium and samarium for pain palliation.

c. OPERATIONAL LEVEL 2a

Operational level 2a is the preparation of radiopharmaceuticals from prepared and approved reagent kits, generators and radionuclides (closed procedure). This is the most common activity in nuclear medicine departments, with routine use of a technetium generator and reconstitution of pre-sterilized radiopharmaceutical cold kits.

d. OPERATIONAL LEVEL 2b

Operational level 2b is the radiolabeling of autologous blood cells. This includes radiolabeling of red blood cells, platelets and white cells commonly used for infection or inflammation imaging.

e. OPERATIONAL LEVEL 3a

Operational level 3a is the compounding of radiopharmaceuticals from ingredients and radionuclides for diagnostic application (including open procedure); modification to existing commercial kits; in-house production of reagent kits from ingredients, including freeze dried operation; related research and development.

f. OPERATIONAL LEVEL 3b

Operational level 3b is the compounding of radiopharmaceuticals from ingredients and radionuclides for therapeutic application (including open procedure) together with related research and development. Examples include radio-iodination of meta-iodobenzyl guanidine (MIBG-iobenguane) and rhenium labeled lipiodol.

g. OPERATIONAL LEVEL 3c

Operational level 3c is the synthesis of positron emission tomography (PET)radiopharmaceuticals. This includes the increasingly popular fludeoxyglucose(18F) injections (FDG) and gallium (68Ga).

3.6.2. Cyclotron

The Cyclotron accelerator manufactures radioisotopes and inclusion in the facility will be dependent on the service plan, operational policies and business case. Details of the Cyclotron are not covered in this FPU, but an approximate square meter area is given in the Schedule of Accommodation to facilitate early planning where inclusion is proposed.

Installations will require compliance and registration with the appropriate local or national radiation and nuclear authority.

The Nuclear Medicine Unit should be located with ready access to the Medical Imaging Unit, Emergency Unit, Operating Unit and Critical Care areas. It requires easy access for ambulant patients and beds/ stretchers.

4. External Relationships

4.1. Externally the Nuclear Medicine Unit should have good access to:

- The entry point of the Hot Laboratory for delivery of externally provided radioisotopes in route as direct as possible.
- Radiation Oncology Unit and Chemotherapy Unit
- Inpatient Units particularly Oncology, Neurology and Cardiology
- Medical Imaging Unit
- Support Units including Clinical Information, Housekeeping, Linen, Laboratories, Pharmacy and Supply

4.2. The optimum external functional relationships are demonstrated in the diagram below including:

- Ambulant patients and outpatient access from a main circulation corridor with a relationship to the Main Entrance
- Separate entry and access for inpatients on beds and Medical Imaging Unit
- Access for service units via a service corridor with entry to the ‘cold’ area of the unit.

5. Internal Relationships

5.1. Internally, the Nuclear Medicine Unit will be arranged in functional zones.

5.2. There caption will provide an access control point and there will be clear separation of non-injected (Cold) and injected (Hot) areas of the Unit . There should be a clear path of travel for patients who arrive and wait in non-injected waiting, then are transferred to Uptake rooms dosing, wait for uptake followed by scanning procedures, then return to Uptake rooms for a cool-down period waiting for radioactivity to dissipate prior to discharge, preferably through a separate exit, and not through areas where non-injected patients and visitors are waiting.

5.3. The ideal relationships are demonstrated in the diagram below including:

- Reception at the entrance providing access control, with directive of Waiting areas.
- Nurse station with directive of bed holding are as for non-injected patients.
- Separation and access control between non-injected are as and injected areas of the unit
- Supportroomslocatedcentrallytothescanningandpatientareasformaximumconvenience.
- Emergency Shower located with close access to all ‘hot’ areas.

6. Design Considerations

6.1. General

Consideration need stobe given to the following gduring design:

- Rapid access and path of travel for isotope deliveries and disposal of radioactive waste
- Separation of outpatients' and inpatients' entries with entrances easily observed from the Reception and Staff Station
- Separation of 'cold' areas from 'hot' areas within the Unit

6.2. Car Parking

6.2.1. An identified parking area for vehicles delivering isotopes is required to enable rapid access to the Hot Lab. Patients and visitors will use the public parking facilities with access to drop-off areas and disabled parking.

6.3. Construction Standards

6.3.1. Construction Standards for a Nuclear Medicine Unit include the following:

- Structural support for equipment; floors must be able to support the weight of equipment and shielding which is significant (the weight may range from approximately 3 tons (PET/ CT) to approximately 9 tons (PET/ MRI)
- Level floor for equipment positioning and safe patient movement.
- Walls should contain necessary support systems for either built-in or mobile oxygen and vacuum and vents for radioactive gases.
- Floors and walls should be constructed of materials that are easily decontaminated in case of radioactive spills.
- Provision for cable support trays, ducts or conduits may be made in floors, walls, and ceilings and the impact on room space of large diameter electrical cable trays (to floors or surface mounted on walls)
- Ventilation for heat generating equipment and extraction for Hot Labs
- Procedure timing (clocks)
- Task lighting/dimming and room blackout, as required.
- Ceiling heights shall suit the equipment to be installed but shall not be less than 3000 mm for ceiling tube mount installations; ceilings may be higher if required.
- Ceiling mounted equipment should have properly designed rigid support structures located above the finished ceiling; tailed ceiling should be considered for ease of

installation, service and future remodeling.

6.4. Patient Treatment Areas

6.4.1. Patient Monitoring

Injected patients are alone in Uptake rooms and during the scanning process and should be always under observation in case of emergency via closed circuit TV cameras (CCTV)with monitors in the Control Room and/ or Staff Station. Cameras should be located at both the head and foot of the SPECT/ PET scanner.

7. Environmental Considerations

7.1. Acoustics

7.1.1. Sound attenuation should be provided in the following areas:

- Uptake and Uptake/Induction rooms
- Scanning rooms (hybridunitsmaybe noisy)
- Viewing/Reporting room
- Consulting rooms
- Nurse Station

7.1.2. In addition, acoustic separation should be provided between Offices, Meeting Rooms, Consult Rooms, and adjacent corridors to reduce transfer of noise between rooms and minimize conversations being audible outside the room.

7.2. Natural Light/Lighting

Natural light is desirable in all patient areas, Offices and Staff Room to be provided for patient and staff comfort. Lighting should be controllable in reporting rooms to allow for work with high resolution images on screens. External windows provided in scanning and uptake rooms will need assessment by a Radiation Consultant for shielding requirements. In practice, it may be difficult to shield windows equal to wall shielding levels.

7.3. Privacy

Visual patient privacy is an important consideration to be addressed in the design of imaging rooms and waiting spaces. Doors to imaging and screening rooms should be located to avoid patient exposure to circulation areas. Change rooms should be located adjacent to imaging rooms so that a patient is not required to cross corridors to access them. If patients change in the Uptake Rooms, privacy from CCTV cameras while getting changed will be required. Privacy screening is required in all Patient Bed Bays.

7.4. Interior

Interior décor refers to color, textures, surface finishes, fixtures, fittings, furnishings, artworks, and atmosphere. It is desirable that these elements are combined to create a calming, non- threatening environment.

Colors should be used in combination with lighting to ensure that they do not mask skin colors in Scanning and Uptake rooms where patients are under direct observation and are compatible with CCTV monitoring of patients.

7.5. Space Standards and Components

7.5.1. Interventional Imaging rooms

The size of imaging rooms will be influenced by the following:

- Ease of move mentioned around the room for patients, staff, equipment, bed and trolley access
- The number of staff required in and around the room to operate the equipment and support the patient.
- The equipment to be installed; design will need to consider the manufacturer's recommended room sizes, equipment place ment and services requirements.

  Potential future upgrading of equipment.
- Scanning rooms should be sized to allow a clear dimension of 920 mm around three sides of the imaging table for patient access and transfers.

7.5.2. Accessibility

Wheelchair access is required in all patient areas including Waiting, Consult, Uptake and Scanning Rooms. Waiting areas should include space and power outlets for charging electric mobility equipment along with suitable seating for patients with disabilities so mobility aids and bariatric patients.

7.5.3. Doors

a. Special consideration should be given to the width and height of doorways to ensure delivery and removal of equipment is not impeded or prevented, and that patient trolley, bed movement and wheelchair access is not hampered.

b. Doors to Uptake rooms should permit trolley and bed access and should be a minimum of 1200 mm wide. Doors to Scanning rooms should be a minimum of 1500 mm clear opening for equipment access.

c. Where provided, vision panels in doors to Up take, Scanning Rooms and Hot Labs must have the same level of shielding as the adjoining walls.

d. Also refer to Part C -Access, Mobility, OH&S of these Guidelines.

7.5.4. Ergonomics/OH&S

a. Consideration should be given to ergonomic functionality in the Nuclear Medicine Unit. Workstations, sinks and Hot Lab oratory ben Ches should be provided at suitable working heights, whether seated or standing positions. Adjustable-height workstations are recommended where possible.

b. The following occupational health and safety issues should bead dressed during planning and design for staff safety and welfare:

- Location and handling of radionuclides and provision of safety shower and eyewash facilities for radioactive spills (refer to local regulations); design should ensure patients, staff and visitors are not unnecessarily exposed to radiation hazards.
- Manual handling of heavy equipment; storage of heavy equipment closest point of use recommended.
- Scanning rooms must be sized to suit the design requirements of the equipment to be used, to provide a safe working environment and to allow the effective movement of staff and patients.

Refer to Part C–Access, Mobility, OH&S of these Guidelines for more information.

7.5.5. Size of the Unit

The size of the Nuclear Medicine Department is dependent on the level of service and determined by the clinical service plan and Operational Policies.

Schedule of Accommodation has been provided for a typical Nuclear Medicine Uniting hospital at role delineation Level 2 (Less complex services) to 6 (teaching and research facilities).

8. Safety &Security

8.1. Safety

The Nuclear Medicine Unit shall include a safety shower with an eyewash station for use in the event of radioactive spills. Design should consider the following issues:

- Access control to the unit which may be provided at Reception.
- Zones within the unit should be organized to allow patients to access the intended area only and prevent patients and visitors entering unrelated areas.
- CCTV camera surveillance of Scanning rooms, Hot Labs, waiting areas, access, uptake rooms and exit points. All uptake rooms CCTV cameras should be connected to nurse station and control room.
- Reception area and staff station must have duress alarm buttons in obscure but easily accessible locations; there should be a combination of fixed and personal duress

alarms.

- Radiation monitoring equipment required like survey meters and area monitors.
- Provision of personal dosimetry
- Doors to the perimeter of the Unit and all offices should be loc.
- Rooms used for storing equipment and files and records should be lockable.

8.2. Radioactive Isotopes-Delivery

8.2.1. SPECT/ PET Units will receive radioactive isotopes delivered to a licensed person and will be required to handle and store these as described within the local Radiation Protection guidelines by the environmental authorities.

8.2.2. Deliveries of isotopes for SPECT/PET studies with their short half-life will usually be once or twice daily depending on workload, direct to the Hot Laboratory in the Unit for dispensing by technologists. In some facilities, unit doses may be supplied from an on-site Radiopharmacy.

8.3. Radiation Protection and Monitoring-Personnel

8.3.1. Staff should be monitored with an approved dosimeter badge like TLD or OSL attached to clothing and ring dose meter especially during injection and Hot lab work. Electronic personal dosimeters maybe worn to allow dosage received during the day from specific activities to be assessed and minimized. These are particularly useful during the training of new staff. Eye dosimeter is also recommended to wear while dealing with radioactive materials.

8.3.2. In addition to fixed radiation shielding in walls, mobile lead screens may be provided for use in I-131 therapy, Up take Rooms for administering radio pharmaceuticals Andin the SPECT/PETS canning rooms for positioning the patient.

8.4. Radioactive Waste Management

8.4.1. Radioactive waste is waste that contains radioactive substances and may be solid, liquid or gaseous. The radioactivity diminishes with time, so waste products may be held until considered safe for routine disposal. Radioactive waste is no longer deemed to be radioactive once lead shielded and allowed to decay to a safe level as set by the regulatory authority (Environment Authority).

8.4.2. Due to the rapid decay of radioisotopes used for SPECT/ PET studies, very little solid waste will need to be stored except for syringes, needles, cannula etc. Specially designed e-dead-lined sharps bins are commercially available and should be readily accessible for use by the clinicians and renovation costs.

8.4.3. Scanning equipment will require services and installation according to manufacturers' specifications, in particular:

- Space requirements may vary according to the equipment selected.
- Space requirements for maintenance of equipment must be considered.
- Structural assessment will be required.
- Doors will need to be sized to allow passage of equipment.

8.4.4. All furniture, fittings and equipment selections for the Unit should be made with consideration of ergonomic and Occupational Health and Safety (OH& S) aspects.

Refer to Part C-Access, Mobility, OH&S of these Guidelines for further information.

9. Building Service Requirements

9.1. Information and Communications Technology

The Nuclear Medicine Unit requires reliable and effective IT/Communications service for efficient operation of the service. The IT design should address:

- Patient booking, appointment and queuing systems
- Patient or Clinical Information Systems and electronic records
- Picture Archiving Communication Systems (PACS) and storage for digital archives
- Voice/data cabling and outlets for phones, fax, computers
- Networkdatarequirementsandwirelessnetworkrequirementstosupportremotereporting.
- Video and teleconferencing capability, including connection to imaging rooms for educational purposes.
- Reporting and recording system that may include dictation voice recognition system for reporting.
- CCTV surveillance If indicated.
- Patient, staff, emergency call, duress alarms and paging systems
- Communication rooms and server rooms

9.2. Staff Call

9.2.1. Patient, Staff Assist and Emergency call facilities shall be provided in all patient areas (e.g. Holding bays, Recovery bays, Preparation rooms, Change rooms, Toilets and Imaging rooms) in order for patients and staff to request for an urgent assistance

9.2.2. The individual call but tons shall alert to an annunciator system. An enunciator panels should be located in strategic points visible from Staff Stations, circulation corridors

and audible in Staff Rooms, and Meeting Rooms. Annunciator panels in corridors must be located for optimum viewing.

9.3. Heating, Ventilation & Air conditioning

9.3.1. The Nuclear Medicine Unit should be air-conditioned to provide a comfortable working environment for staff, patients, and visitors.

9.3.2. Additional cooling and ventilation will be required to Scanning Rooms and associated computer equipment rooms as the equipment is sensitive to excessive ambient heat, but outlets should not be placed directly over partially undressed patients on beds or trolleys. Some scanners may require chilled water cooling. Large temperature changes (greater than400Cper hour) within scanning rooms need to be avoided to reduce the risk of crystal fracture in gamma cameras.

9.3.3. Additional air extraction or exhaust may be required to Camera Room/s where ventilation agents such as Technegas are administered.

9.3.4. In the restricted areas of Patient Examination Room and Storage and Preparation areas, if radioactive gas Xenon is being used, special ventilation is required. Ventilation requirements would be in accordance with relevant Guidelines. The restricted area should be kept under negative pressure by exhausting at least15%moreairthansupply air. Recirculation of air from these spaces should not be permitted.

9.3.5. It is recommended that the Storage and Preparation areas be generally equipped with a special radioisotope fume hood. This system may need to be fabricated from non-ferrous materials.

9.3.6. Exhaust registers should be located at floor and ceiling levels.

9.3.7. General air conditioning in inpatient and staff areas needs to be adjustable for patient and staff comfort; the temperature of the Unit should not exceed 25°C.

9.3.8. Smoke detectors in treatment rooms should be sensitive to radiation.

9.3.9. Hot Lab room air should be negative pressure and exhausted, not recirculated. The Hot Lab may include a fume cabinet/bio-safety cabinet which will require exhaustion. The Hot lab needs an ante room between Hot Lab and the corridor.

9.3.10. Rooms in which Technegas is used should be negatively pressured on the rest of the Unit.

Refer to Part E-Engineering Services in these guidelines and to the Standard Components, RDS and RLS for further information.

9.4. Medical Gases

9.4.1. Medical gas is that which is intended for administration to a patient in anaesthesia, therapy, or diagnosis.

9.4.2. The Unit requires oxygen and suction in patient holding bays, Uptake Rooms

and Scanning rooms. The Provision of medical air to patient holding/recovery bays and Uptake rooms is optional.

9.4.3. Full anesthetic capability is required within Uptake/ Induction rooms, including systems for the delivery of nitrous oxide and the 'scavenging' of gases that have been exhaled by the patient that should not be breathed in by any medical personnel.

Refer to Part E-Engineering Services in these guidelines and to the Standard Components, RDS and RLS for further information.

9.5. Radiation Shielding

9.5.1. All rooms that are used for dosed injected patients or for undertaking imaging procedures require radiation shielding including:

- Reception and rooms adjacent to dosed injected patient rooms.
- Dosing/Consult Exam Rooms
- Scanning Room/s–SPECT, SPECT/CT, PET/CT, or PET/MRI
- Hot Labs/Dispensing room, Hot Stores and Radiopharmacy, QC room
- Pre-scan uptake rooms/ injected waiting areas, and patient toilets
- Cardiac Stress Testing Room
- Post-scanning waiting areas.
- Bone Densitometry Room (need to be checked with RPO)
- Holding areas for patients injected with radionuclides.
- SPECT patient injection area
- Technegas machine room
- Radioactive stores
- Iodine Patient therapy room including toilet and store for Iodine patients.

9.5.2. A certified Radiation Protection Officer (ROP) or qualified expert needs to assess the plans and specifications for radiation protection as required by the MOH. A radiation protection assessment will specify the type, location and amount of radiation protection required for an area according to the final equipment selections, the layout of the space and the relationship between the space and other occupied areas.

9.5.3. The radiation protection requirements are to be incorporated into the final specifications and building plans. Radiation requirements should be reassessed if the intended use of the room changes during the planning stages, equipment is upgraded, or surrounding room occupancy is altered. Consideration should be given to the provision of floor and ceiling shielding when rooms immediately above and below are occupied.

9.6. Hydraulic Services

Ceiling spaces above SPECT cameras and specialty scanning units should not be used for hydraulic services or air-conditioning ducts, to avoid damage to equipment from leakages.

Technicians in the Nuclear Medicine Unit as required by relevant authorities. Radioactive waste will be held in the Hot Store until decayed and removed to general waste holding areas.

The requirement for delay holding tanks for effluent from patient toilets in the uptake areas will need to be assessed by the Radiation Protection Officer.

9.7. Security

Security of radioactive material is important and subject to radiation safety regulations. Security measures for the Nuclear Medicine Unit will include the following:

- Access control to the Unit and the 'Hot' areas within the Unit, the Hot Lab and Hot Store with a combination of reed switches, electric strike/ magnetic locks and card readers.
- Controlled staff access after hours

9.8. Finishes

9.8.1. The Nuclear Medicine Unit finishes including fabrics, floors, walls, ceilings, cornices, door protection, fittings and joinery should be selected with consideration to the following:

- Infection control and cleaning
- Fire safety of the materials
- Durability, replacement of materials
- Acoustic properties of the materials
- Movement of equipment

9.8.2. Floor finishes and junctions should be smooth, impervious, and non-absorbent in case of radiation spills.

9.8.3. Wall protection should be provided where bed or equipment movement occurs including corridors, bed bays and imaging rooms.

Refer to Part C-Access, Mobility, OH&S of these Guidelines and Standard Components for more information on interior finishes.

9.9. Fixtures, Fittings & Equipment

Due to the complexities of tendering for and purchasing significant items of high technology equipment, there can be a 12–18-month timeframe before the final equipment selection takes place. As the equipment is not generally known at the time of the initial design, a generic design should be undertaken whereby all major manufacturers' equipment can be accommodated. This also allows for easy future replacement without major The need for delayed holding tanks within the Nuclear Medicine Unit will require assessment by the

Radiation Consultant.

10. Infection Control

Infection control measures include prevention of cross infection between patients, visitors and staff. Paths of travel for inpatients should be separated from outpatients as far as possible.

10.1. Hand Basins

10.1. Hand hygiene is an essential element of infection control and hand basins will be required in:

- SPECT/PETS canning Room/s
- Uptake and Uptake/Induction Room/s
- Clean and Dirty Utility Rooms
- Bed Holding areas in aratioof1basinper 4bed bays.
- Corridors and adjacent to Staff Station

10.2. Handbasins should comply with Standard Components for Bay -Hand washing. Refer to the Standard Components, RDS and RLS of these guidelines for additional information.

For further information, refer to Part D–Infection Control in these Guidelines.

10.2. Antiseptic Hand Rubs

10.2.1. Antiseptic hand rubs should be located so they are readily available for use at points of care, at the end of patient beds and in high traffic areas, in the scanning room and in the control room.

10.2.2. The placement of antiseptic hand rubs should be consistent and reliable throughout facilities. Antiseptic hand rubs are to comply with Part D-Infection Control, in these guidelines. Antiseptic Hand Rubs, although very useful and welcome, cannot fully replace Hand Wash Bays, both are required.

For further information related to Infection Control refer to Bays; D –I Bays; ion Control in these Guidelines.

11. Components of the Department/Unit

11.1. Standard Components

11.1.1. Standard Components are typical rooms within a health facility, each represented by a Room Data Sheet (RDS) and a Room Layout Sheet (RLS).

11.1.2. The Room Data Sheets are written descriptions representing the minimum briefing requirements of each room type, described under various categories:

- Room Primary Information; includes Briefed Area, Occupancy, Room

Description and relationships, and special room requirements)

- Building Fabric and Finishes; identifies the fabric and finish required for the room ceiling, floor, walls, doors, and glazing requirements.
- Furniture and Fittings; lists all the fittings and furniture typically located in the room; Furniture and Fittings are identified with a group number indicating who is responsible for providing the item according to a widely accepted description as follows:

Group	Description
1	Provided and installed by the Builder/Contractor
2	Provided by the Client and installed by the Builder/Contractor
3	provided and installed by the Client

- Fixtures and Equipment; includes all the serviced equipment typically located in the room along with the services required such as power, data and hydraulics; Fixtures and Equipment are also identified with a group number as above indicating who is responsible for provision.
- Building Services; indicates the requirement for communications, power, Heating, Ventilation and Air conditioning (HVAC), medical gases, nurse/ emergency call and lighting along with quantities and types where appropriate. Provision of all services items listed is mandatory.

11.1.3. The Room Layout Sheets (RLS's) are indicative plan layout and elevations illustrating an example of good design. The RLS indicated are deemed to satisfy these Guidelines. Alternative layouts and innovative planning shall be deemed to comply with these Guidelines provided that the following criteria are met:

- Compliance with the text of these Guidelines
- Minimum floor area is as shown in the schedule of accommodation.
- Clearances and accessibility around various objects are shown or implied.
- Inclusion of all mandatory items identified in the RDS.

The Nuclear Medicine/PET suite will contain Standard Components to comply with details in the Standard Components described in these Guidelines. Refer to Standard Components Room Data Sheets and Room Layout Sheets.

11.2. Non-Standard Components

Non-Standard rooms are identified in the Schedule of Accommodation as NS and are described below.

11.2.1. Uptake Room

The Uptake room is for patients to receive intravenous radiopharmaceuticals and rest until uptake has occurred before transfer from the scanning room or to 'cool-down' following scanning procedures waiting for the radiation to dissipate prior to discharge. Patients will change into a hospital gown for scanning procedures within this room. The room will be radiation shielded and a mobile lead screen may also be used by staff when attending to patients. CCTV will be used to monitor patients who have been injected and waiting for scan. The Uptake room should have direct access to a shielded patient toilet to prevent injected patients from accessing common corridors unnecessarily and exposing staff to radiation. A communications system between the Uptake Room/s and the nurse station may be included as required.

The Uptake room should be a minimum of $9m^2$andinclude:

- Privacy screening to the doorway allows the patient to change in the room.
- A recliner chair or bed; doors must allow bed access.
- Hand basin with paper towel and soap fittings in the toilet.
- Services panel including
    - Oxygen and suction outlets
    - Patient Call, Staff Assist call and Emergency call buttons.
    - General power outlets include power for motorized beds/chairs.
    - Internal Telephone.
- Dimmable lighting to allow the patient to rest.
- Ceiling mounted examination light
- Lead shielded sharps and waste containers for radioactive waste.
- Normal non-radioactive bin or patient use

11.2.2. Uptake/Induction Room

The Uptake/Induction room is an Uptake Room that may also be used to administer anesthetics or sedation to patients, particularly paediatric patients. The Uptake/ Induction room should be a minimum of $15m^2$ with a nad joining shielded patient toilet and have close access to the Scanning room.

In addition to requirements for an Uptake room the Uptake/Induction room will include:

- Patient bed/trolley
- Services for administering an aesthetics and sedation:
    - Oxygen, Suction, Medical Air, Nitrous Oxide and an aesthetic gas scavenging outlets
    - Anesthetic machine with patient monitor
    - Bench with cupboard and drawers for storing supplies and stock.

11.2.3. Bone Densitometry

The Bone Densitometry Room is for bone density imaging studies. The rooms should be located in the 'Cold Zone' to avoid patients entering 'Hot' areas with ready access to Waiting Areas. The room will require radiation shielding as assessed by a Radiation Consultant.

The room includes:

- A control console and computer workstation
- Hand washing basin with fittings
- Shelving for gowns, pillows etc.
- Changing room inside the BMD, in case the patient needed to change.

11.2.4. Radioactive Waste/Hot Store

The Hot Store will hold waste radionuclides awaiting decay in order to return to general waste. The rooms will ideally be located with a direct entry from the corridor. The room may be sized to accommodate the space requirements for radionuclide holding and storage.

The Room Requirements Include:

- Doors with access control and radiation shielded glazing as required.
- Radioactive warning signs on doors
- Lead-shielded sharps bins and a bin for general radioactive waste may be located under a bench in shielded cupboards.
- A wall or ceiling-mounted hoist for lifting heavy transport containers from floor to bench, if required

11.2.5. Radiation laboratory

a. A Radiopharmacy Laboratory may be provided for the manufacturing of sterile radiopharmaceuticals that have been produced in a cyclotron or from a generator, according to national/international standards.

b. The room will be sized according to the scope of the service and the range of radiopharmaceuticals to be manufactured and may be located directly adjacent to a Cyclotron.

The Laboratory will comprise:

- General work area with benches and shelving
- Sterile Manufacturing area incorporating a Clean Room for cell labelling and in-house manufacture, including biosafety cabinets Class A

- Kit production area (PET Hot Lab)
- Quality Control Lab
- Radioactive supplies store
- Emergency shower and eye wash station and spill kit in the event of radioactive chemical spills

Refer to local authority's requirements and standards.

12. Schedule of Accommodation

The Schedule of Accommodation (SOA) provided below represents generic requirements for this unit. It identifies the rooms required along with the room quantities and the recommended room areas. The simple sum of the room areas is shown as the Sub Total. The Total area is the Subtotal plus the circulation percentage. The circulation percentage represents the minimum recommended target area for internal corridors in an efficient and appropriate design. Within the SOA, room sizes are indicated for typical units and are organized into functional zones. Not all rooms identified are mandatory therefore, optional rooms are indicated in the Remarks. These guidelines do not dictate the size of the facilities such as the total number of Scanning rooms. Therefore, the SOA provided represents a limited sample based on assumed unit sizes. The actual size of the facilities is determined by Service Planning or Feasibility Studies.

Quantities of rooms need to be proportionally adjusted to suit the desired unit size and service needs.

The table below shows two alternative SOAs for 2 cameras and 4 cameras, both including one

PET/CT

Scanning room, with role delineations from RDL 4 to 6.

Any proposed deviations from the mandatory requirements, justified by innovative and alternative operational models may be proposed within the departure forms included in Part A of these guidelines for consideration by the health authority for approval

Nuclear Medicine Unit

ROOM/SPACE Size	Standard Component Room Codes	RDL5-6 Qtyxm2 2SPECT/1PET			RDL5-6 Qtyxm2 4SPECT/1 PET			Remarks
Entry/Reception/Holding								'Cold' areas– non-injected Patients
Reception	recl-10-orecl-15-osimilar	1	x	10	1	x	12	
Waiting	wait-15-owait-20-o	2	x	15	2	x	20	Separate Male/ female waiting
Interview Room-Family	intf-o	1	x	12	2	x	12	Patient Consultation
Office-2PersonShared	off-2p-o				1	x	12	Optional, Administrative support
Patient Bay-Holding	pbtr-h-10-o	2	x	10	4	x	10	non-injected patients on beds
Nurse Station	sstn-5-osstn-14-osimilar	1	x	5	1	x	10	For Bed Holding area
Store-Stationery/Photocopy	stps-8-osimilar	1	x	8	1	x	10	Printing, stationery storage
Store- Files	stfs-10-osimilar	1	x	10	1	x	10	Optional
Toilet- Accessible	wcac-o	1	x	6	1	x	6	

ROOM/SPACE Size	Standard Component Room Codes	RDL5-6 Qtyxm2 2SPECT/1PET			RDL5-6 Qtyxm2 4SPECT/1 PET			Remarks
Toilet- Patient	WCPT-o	2	x	4	2	x	4	
Scanning Areas								‘Hot ‘Areas –Injected Patients
Uptake Room	NS	4	x	12	8	x	12	Radiation shielded; withreclinerchair;2Uptakeroomsperscanning room
Uptake Induction Room	NS	2	x	15	4	x	15	For administering anesthetics or sedation to a patient on a bed or for recovery
SPECT or SPECT/ CT Scanning Room	SPECT-CT-o	1	x	48	2	x	48	
SPECT/CT Control Room	ancrt- osimilar	2	x	14	4	x	14	Maybesharedbetween2scanning rooms
SPECT/CT Computer Equipment Room	coeq- osimilar	2	x	18	2	x	18	Sharedbetween2scanningrooms

ROOM/SPACE Size	Standard Component Room Codes	RDL5-6 Qtyxm2 2SPECT/1PET			RDL5-6 Qtyxm2 4SPECT/1 PET			Remarks
Bone Densitometry	ns	1	x	16	1	x	16	Locate near the entry in the 'Cold– non-injected' area
Cardiac Stress room	strt-o	1	x	15	1	x	15	
PET/CT Scanning Room	pet-ct-o	1	x	48	1	x	48	Size according to manufacturer's specifications
PET/CT Control Room	ancrt-osimilar	1	x	14	1	x	14	
PET/CT Computer Equipment room	coeq-osimilar	1	x	18	1	x	18	Size according to manufacturer's specifications
Toilet-Patient, Hot	wcpt-osimilar	3	x	4	5	x	4	Radiation shielded, direct access to uptake rooms
Treatment Room	trmt-14-o	1	x	14	2	x	14	Optional; maybe located close to Hot lab
Hot Laboratory Areas								'Hot' Area
Entry Lobby- Isotopes	airl-6-osimilar	1	x	6	1	x	9	Radiation shielding, external access to Hot Labs
Hot Lab-SPECT	htlb-osimilar	1	x	8	1	x	12	Adjacent to Uptake rooms
Hot Lab-PET	htlb-osimilar	1	x	8	1	x	12	Adjacent to Uptake rooms
Radioactive Waste/Hot Store	NS	1	x	6	1	x	9	With external entry, holding of waste
Office-Workstations	off-ws-o	1	x	5.5	2	x	9	Quality Control of radionuclides
Support Areas								
Bay- Beverage	bbev-op-o	1	x	5	1	x	5	Located close to Waiting and Bed Holding areas
Bay-Emergency Shower & Eyewash	bese-1-o	1	x	1	1	x	1	Accessible to all' Hot' areas
Bay-Handwashing, TypeB	bhws-b-o	1	x	1	1	x	1	ForBedHolding;1per4bays

Bay- Linen	blin-o	1	x	2	1	x	2	
Bay-Mobile Equipment	bmeq-4-oorbmeqe-4-o	1	x	4	2	x	4	Optional; opened or enclosed bay

ROOM/SPACE Size	Standard Component Room Codes	RDL5-6 Qtyxm2 2SPECT/1PET			RDL5-6 Qtyxm2 4SPECT/1 PET			Remarks
Bay- PPE	bppe-o	1	x	1.5	3	x	1.5	Radiation protection equipment,(aprons)
Bay-Resuscitation Trolley	bres-o	1	x	1.5	1	x	1.5	
Bay-Wheelchair Park	bwc-osimilar	1	x	2	1	x	2	Optional
Cleaner's Room	clrm-6-o	1	x	6	1	x	6	May be shared with adjoining unit
Clean Utility/Medication	clum-14-osimilar	1	x	14	1	x	14	
Dirty Utility	dtur-s-o	1	x	8	1	x	8	Radiation shield edif holding 'hot' waste
Store-Equipment/General	steq-10-osimilar	1	x	6	1	x	10	Equipment and supplies
Viewing and Reporting	xrrr-osimilar	1	x	15	1	x	20	Optional;3or4workstations
Staff Areas								
Meeting Room	meet-l-15-o				1	x	15	Maybe shared
Office,SinglePerson	off-s9-o	1	x	9	2	x	9	Manager/Radiographer/Physicist
Office–Workstation	off-ws-o	1	x	5.5	2	x	5.5	Qty as required
Property Bay-Staff	prop-3-o	2	x	3	2	x	3	Separate Male& Female
Staff Lounge	srm-15-o	2	x	15	2	x	15	Maybe shared
Toilet- Staff	wcst-o	2	x	3	2	x	3	Separate Male &Female may be shared
Sub Total		497			692			
Circulation%		35			35			
Area Total		670.95			934.2			

Please note the following:

- Areas noted in Schedules of Accommodation take precedence over all other areas noted in the Standard Components.
- Rooms indicated in the schedule reflect the typical arrangement according to the sample bed numbers.
- Exact requirements for room quantities and sizes shall reflect Key Planning Units (KPU) identified in the Clinical Service Planned the Operational Policies of the Unit.
- The room sizes indicated should be viewed as a minimum requirement; variations are acceptable to reflect the needs of individual Unit.

Offices are to be provided according to the number of approved full-time positions within the Unit.

13. Future Trends

Future trends for PET/CT scanning are centered on advances in technology including:

- Increasing use of molecular imaging
- Improved tracer chemicals to allow more precise scanning of tissues and diseases. Improved PET/CT scanning with better image quality, identifying smaller tum ours and monitoring the response to therapy.
- PET/MRI is an emerging technology that will increase in application and use in the future. This advance intechnologyoffersamoreprecisediagnosisofdiseasesofthebrainandorgan cancers and can be used to study how drugs and tracers are taken up by tum ours. The combination of PET and MRI enables imaging of organs in motion, which was not previously possible. This will contribute to major advances in cancer treatment in future.
- Advances on the ragnostic with newly emerging radiotracers and FDA approved clinical uses of emerging radionuclide therapies.

Document history and version control table

Version	Description	Author	Review date
1.	Initial Release	Dr Khalsa Zahran Al Nabhani	January 2024

References

In addition to iHFG Sections referenced in this FPU, i.e. PartC-Access, Mobility, OH&S and PartD- Infection Control, readers may find the following helpful:

- AHIA, Australasian Health Facility Guidelines, PartBHealth Facility Briefing and Planning , HPU 0500-Nuclear Medicine / PET Unit, Revision 6, 2016, refer to website: https://healthfacilityguidelines.com.au/health-planning-units
- Canadian Nuclear Safety Commission, Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms, (May2010);CanadianNuclearSafetyCommission,May2010,refer to website: http://nuclearsafety.gc.ca/pubs_catalogue/uploads/GD-52_Design_Guide_for_Nuclear_Substance_Laboratories_and_Nuclear_Medicine_Rooms.pdf
- DepartmentofHealthUK,NHSEstates,HBN14-01Designingpharmacyandradiopharmacy facilities, 2013, Refer to website: https://www.gov.uk/government/publications/guidance-on-the-design-and-layout-of-pharmacy-and-radiopharmacy-facilities
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- Department of Veteran Affairs, US,VADesignGuideNuclearMedicine,2008referto website https://www.cfm.va.gov/til/dGuide.asp
- Guidelines for Design and Construction of Hospitals and Outpatient Facilities ;The Facility Guidelines Institute, 2014,refer to website www.fgiguidelines.org
- PET-MRI Challenges and new directions, A Daftary, Indian Journal of Nuclear Medicine. 2010 Jan- Mar; 25(1)