NUCLEAR MEDICINE DEPARTMENT

The Register of Clinical Technologists

NUCLEAR MEDICINE EVIDENCE PORTFOLIO

Nuclear Medicine Technologist

March 2018

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Abbreviations List

NM – Nuclear Medicine

SPECT/CT – Single Photon Emission Computed Tomography/Computed Tomography

[redacted]

NMD – Nuclear Medicine Department

RCT – Register of Clinical Technologists

SOP – Standard Operating Procedures

IR(ME)R – Ionising Radiation (Medical Exposures) Regulations

GFR – Glomerular Filtration Rate

MPE – Medical Physics Expert

PET/CT – Positron Emission Tomography/Computed Tomography

ARSAC – Administration of Radioactive Substances Advisory Committee

DRL – Diagnostic Reference Level

RND – Radionuclide Dispensary

QA – Quality Assurance

QC – Quality Control

GMP – Good Manufacturing Practice

LFC – Laminar Flow Cabinets

CRIS – Computerised Radiology Information System

WBC – White Blood Cells

RBC – Red Blood Cells

Beta Negative – β^-

COR – Centre Of Rotation

CT – Computed Tomography

SLN – Sentinel Node

IRR – Ionising Radiation Regulations

MARS 78 – The Medicine (Administration of Radioactive Substances) Regulations 1978

RSA 93 – The Radiation Substances Act 1993

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CDG 2009 – Carriage of Dangerous Goods & Use of transportable Pressure Equipment Regulations 2009

RPA – Radiation Protection Advisor

HSE – Health and Safety executive

RPS – Radiation Protection Supervisor

[redacted]

SICP – Standards for Infection Control Precautions

BSLN – Breast Sentinel Node

COSHH – Control of Substances Hazardous to Health

QMS – Quality Management System

GSP – Good Scientific Practice

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1. Introduction

Throughout my degree, I acquired the theoretical competencies of each study in Nuclear Medicine along with the practical skills, which I developed through attending lectures and internships in different hospitals. I understand the justification for different investigations in Nuclear Medicine (NM), such as renal studies, skeletal studies, neurological studies, endocrine studies, and gastrointestinal studies, among others. As a clinical technologist, I know which radiopharmaceutical to select for each study and why the one chosen is preferred, why the patient should follow a specific preparation and how that will affect the study and which acquisition is the correct for each study (if it is a static image or a Whole-body and not only Single Photon Emission Computed Tomography/ Computed Tomography (SPECT/CT).

I have been employed in my current position as a Band 5 Nuclear Medicine Clinical Technologist at [redacted]) since March 2017. However, I worked in the same department as a locum between August 2015 and February 2017.

During my 4 year degree in Portugal and in my current role, I have developed not only my personal skills but also my professional skills

In this portfolio, I will outline my daily activities within the Nuclear Medicine Department (NMD) of the [redacted] and [redacted] to demonstrate my competency as a clinical technologist, and meet the criteria specified for the Register of Clinical Technologists (RCT) equivalence route for NM technologists. The job description of my current role, the organizational chart, my *Curriculum Vitae* and other relevant documents are submitted along with this portfolio.

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2. Patient Preparation

As a clinical technologist, I have the responsibility to carry out any patient preparation required before a NM procedure. During my four year degree in Portugal, including my internships in different Hospitals and Investigation Centres, I have acquired all the skills required to perform my present role.

To correctly perform the procedures, including the patient preparation, I comply with the Standard Operating Procedures (SOP) of this department and with Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) 2000 (revoked and superseded by The IR(ME)R 17 - More information in the **Legislation and Radiation Control Chapter**) **[A3, A8, C1].**

It is important to realise some scans require special preparation and checks prior to the radiopharmaceutical administration and that these must be thoroughly adhered to, otherwise, the whole study can be compromised. The studies performed at [redacted] and [redacted] with special preparation include **[C1]**:

- Gastric Emptying Studies: The patient should be fasted from midnight (between 8 and 12 hours) before the study. This ensures the results are accurate since the procedure is measuring the emptying speed of the stomach. Also, it is important to give advice to diabetic patients to bring their glucose monitors and insulin with them, which can be taken while ingesting the meal. Medications that cause a delay in the gastric emptying should generally be stopped 2 days before the scan (to prevent false positive test result) and prokinetic agents should also be stopped 2 days before the test unless the scan is performed to assess the efficacy of these drugs. However, at these departments this decision is made by the referrer. **[C1]**.
- Bile Duct and Gallbladder Studies: The patient should be fasted from midnight before the study to avoid a False Positive result **[C1]**.
- Sphincter of Oddi Disfunction Studies: The patient should be fasted from midnight before the study. They should not be driving on the day of the study as the Buscopan is a smooth muscle relaxant and may make their vision less able to adapt quickly, and they should not operate machinery for 6 hours following the test. If the patient has no alternative form of transport the scan will be re-appointed for another day. Buscopan is contraindicated in patients with a history

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of underlying heart disease, heart failure, coronary heart disease, cardiac arrhythmia or hypertension and should not be given. Therefore it is important to check this information with the patient and the referral prior to the study **[C1]**.

- DATScan Studies: The patient should stop some medications (advice from *GE* such as *Benzatropine, Buscopan, Cocaine, etc*) prior to the scan and this should be checked with the patient when the study is booked. Patients under the age of 65 years old should receive thyroid blocking with 2 x 85mg Potassium iodate tablets 1 hour before the administration of the radiopharmaceutical to prevent overexposure of the thyroid to radiation (common biological distribution place of iodine) **[C1]**.
- Thyroid, Parathyroid and Whole Body Iodine Studies: The patient should stop any medication that interferes with the radiopharmaceutical uptake within the thyroid (e.g. *Thyroxine*) usually for three weeks prior to the date of the study. However, the medication suppression periods depends on the drug itself, and if the suppression is needed the patient is informed which drug they need to stop and for how long **[C1]**.
- MIBG Studies: The patient does not need to stop any medication. However, Potassium iodate (2 x 85mg) tablets are given to the patient at least 1 hour before and 24hours after the injection of the ^{123}I-MIBG, for the reason referred before for the DATScans studies. Furthermore, the injection should be given slowly (over 3-5 minutes) as it can cause severe tachycardia, and abdominal pain, amongst other symptoms because MIBG it is an analogue of noradrenaline and guanethidine **[C1]**.
- ^{111}In- Pentetreotide Studies: A check should be made as to whether the patient is receiving *Sandostatin* treatment (*Sandostatin LARS/Octreotide/Octreotide Acetate*). The imaging agent is also *Sandostatin* and therefore uptake of the imaging agent may be inhibited by the therapy. However, at these departments the patients do not need to stop the therapy though as the oncologist want us to test the patient on the drug. **[C1]**.
- Meckles Diverticulum Studies: The patient should not have had barium enema 2 days prior to the scan. At these departments, the patient should take 20mg *Losec*

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(Omeprazole) the day before the scan (20:00 hours), then fast from midnight and another *Losec* should be taken on the morning of the scan (08:00) in order to suppress stomach uptake **[C1]**.

- Glomerular Filtration Rate (GFR) Studies: The patient should follow dietary restrictions including no diuretics (e.g. coffee, tea or cola – from 22:00 hours the evening prior to the study) and light, low protein breakfast (e.g. toast or cereal and milk). If the list of medications the patient is taking contains diuretics, aminoglycoside antibiotics, penicillins, sulphonamides or aluminium, this should be recorded and checked with a Practitioner/Medical Physicists Expert (MPE) prior to the test **[C1]**.

Other studies, such as Cardiac and Positron Emission Tomography/Computed Tomography (PET/CT) studies also need some special preparation; however they are not performed at my current role at [redacted] **[C1]**.

After the special preparations and checks it is important to correctly carry out the general steps (shown on **Table 1**) for patient preparation on the day of the study **[A3, A8, C1]**.

Table 1 - General steps for patient preparation

Patient Preparation	
Patient Identification	Under IR(ME)R, check the full name, date of birth and address to make sure the study is performed on the right patient preventing unnecessary radiation exposure. It Is important to ensure the clinical information present on the request form is in accordance with the study requested.
Female Patients of Childbearing age	Check if the patient is pregnant or breastfeeding (at this hospital, patients between 12-55 years old). If the result is positive, the ratio risk/benefit must be evaluated by a Practitioner in charge. If the study is to be performed,

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	the dose must be reduced to the minimal activity necessary to ensure diagnostic quality. If the patients are breastfeeding, they are required to stop for a period specified in the Administration of Radioactive Substances Advisory Committee (ARSAC) guidelines and they are issued with an instruction leaflet.
Procedure Explanation	All the procedures should be explained in a simple and clear way ensuring the patient understands. Check if special preparations were followed before the administration of radiopharmaceuticals. Patients need to be informed of any preparation between the administration and the image acquisition (e.g. for bone scans, drink at least 1/1.5 litres of fluids and empty bladder often to ensure good image quality – increasing the target/background ratio; and also decreasing bladder radiation exposure).
Additional Information	Questions regarding presence of any symptoms, including pain; if they have had any previous scan; if they had previous fractures and/or bone diseases; etc. This information will help the physician/radiologist when reporting the scans.
Administration of the Radiopharmaceutical	It is important to ensure the dose administered to the patient is dispensed from the correct vial and that the activity is adjusted in accordance with ARSAC levels and Diagnostic Reference Level (DRL). This is important to ensure the minimum radiopharmaceutical activity needed to have good diagnostic quality in the non-imaging or imaging acquisition is used and the maximum activity recommended is not exceeded. When preparing the patient dose, I adhere to the SOP for each study and IR(ME)R 2000 Regulations.

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Precautions after Scan	Advise to avoid contact with young children and pregnant women for a period of time (depending on the activity and should be indicated in the department) of the study for ^{99m}Tc and ^{123}I labelled radiopharmaceuticals, or following 3 to 4 days for ^{111}In labelled radiopharmaceuticals. Regarding other relatives the patient should be at 2 arms length of distance to reduce the radiation exposure of risk groups. To ensure bladder radiation protection and quicker tracer elimination the patients receive advice to ingest more fluids than usual for the rest of the day(s) of the scan and to use the toilet as often as needed.
Paediatrics Patients[1]	The procedure should be explained to the child in the presence of the guardian, who may be able to supply additional information with regards to the child's clinical history. The activity should be adjusted according to the weight of the child as per ARSAC guidelines.

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[1] At [redacted] all the paediatrics scans are perform at [redacted] so I do not perform them in my actual role. However, I have performed Paediatrics studies in my internships during my degree in Portugal.

3. Radiopharmacy

During my radiopharmacy lectures (practical and theory) and internships I was trained to perform radiopharmaceutical preparation and administration. At [redacted] I successfully completed my venepuncture, peripheral Intravenous cannulation and intradermal injections training **(Appendix 12.1.1)**, allowing me to inject patients with radiopharmaceuticals and also to administer intravenous drugs in certain studies **[D1]**. At [redacted] and [redacted] I work under an ARSAC holder and IR(ME)R regulations to perform injections as part of my role. (**Appendix 12.1.2**)(More information in the **Legislation and Radiation Control Chapter**) **[A3]**.

In the [redacted], all radiopharmaceuticals are prepared in a central Radionuclide Dispensary (RND). Therefore, every day the department receive doses, as standing orders, including Tc^{99m} – MDP, Tc^{99m} – MAA and Tc^{99m} – PERT. Other individual patient's doses are ordered with the correct radiopharmaceutical, activity, volume and reference time required for the patients attending the following day (Daily radiopharmaceutical order form at **Appendix 12.1.3**). The Tc^{99m} doses and Cr^{51} can be ordered the day before the dose is required, however, for others isotopes the order needs to be made in advance **[C5]**.

At these departments the daily management of diary is simplified by our ability to pre-order the doses, however it is important to understand when some scans can be performed during the week taking into account the time between the administration and the image acquisition for the study, the time to perform the image acquisition and also if a special preparation prior to the administration is required. When booking an appointment for an Octreoscan study it is necessary to plan the administration time and the dates of the study, since it is a 3 days protocol (including administration and image acquisition at 24 and 48 hours). At [redacted] which is a two camera department, when a lengthy study is booked (e.g. gastric), where possible the other camera is kept for shorter studies to facilitate the appointing of urgent scan requests (e.g. lungs) **[C5]**.

3.1. Radionuclide Dispensary of the [redacted]

The RND currently operates under Specials Manufacturing Licence No. ML/18325/1 and all operations are required to conform to the rules and guidance for pharmaceutical manufacturers and distributors (Medicines & Healthcare products Regulatory Agency 2014)

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and other pieces of legislation (More information in the **Legislation and Radiation Control Chapter**) **[A3].**

Though I do not prepare radiopharmaceuticals on a daily basis I had the opportunity to review my knowledge (acquired previously in Portugal) during a placement at [redacted] and observing all the daily tasks and necessary procedures to delivery doses for 16 NMD around [redacted] On a daily basis, some tasks performed in the RND include **[C7, C8, C9, C10, D2, D3]**:

- **Preparation or replacements trays** – All the trays and their contents, sterile saline, syringes, needles, kits, sterile alcohol wipes, shielding and settle plates should be sprayed with Klercide (sporicidal chlorine) and wiped with sterile alcohol wipes prior to transfer to the hatch and then prior to move inside of the cabinet, to prevent contamination and maintain aseptic environment **[D2]**.
- **Preparation of vials –** the labels of the vials for the individual patient's dose and the kits must be double checked the day prior to the labelling, including the kit batch number and sprayed before transfer to the clean room (**Appendix 12.1.4**) **[D2].**
- **Cabinets and rooms cleaning** – The cabinets and surfaces must be sprayed and cleaned with Klercide before every procedure and re-cleaned after **[D2]**.
- **Mo^{99}/Tc^{99m} Generator Elution** - load elution vial and shielding and record the generator reference number, elution number, saline diluents batch number and the activity of the elution (**Appendix 12.1.4**) **[C7, D3].**
- **Cabinet Daily Checks** – including radionuclide calibrator constancy tests and radionuclide purity of eluate (Mo^{99} breakthrough test) **[B4, C10]**.
- **Calculations and labelling kits** – determine the eluate volume needed to label each kit, label the kit following instructions for the correct preparation using appropriate shielding and tongs to decrease the radiation exposure **[C9, D3]**.
- **Daily Quality Assurance (QA)** – settle plates and finger dabs for environment check and QA/Quality Control (QC) of the final product **[C8, C10]**.
- **Weekly and monthly cleaning –** all cabinets, surfaces and floor must be cleaned every time it is in use and the ceiling and walls must be cleaned and checked with contact plates every two weeks **[C8, D2]**.

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These daily tasks including cleaning are important to ensure the product's quality and sterility, which avoids irregular biological distribution within the body and prevents harm to patient. According to Good Manufacturing Practice (GMP)[2], operators and their garments are potentially the most significant sources of microbial contamination. Therefore, to prevent that, all operators entering the clean room are required, to scrub their hands thoroughly, wear special garments, sterile gloves and face mask, before any dispensing operations **[D2]**.

3.1.1. Radiopharmaceutical production

About 80% of the radiopharmaceuticals prepared and delivered are Tc^{99m} products. Due to the short-life of this radionuclide, activity is bought in the form of a generator system. These are sterile, pyrogen-free devices with a chromatography column, which contains Mo^{99}. Elution of the generator entails sterile saline passing over the column to draw the Tc^{99m} selectively and collection in a sterile vial. At present the RND have three 43GBq generators per week (Monday, Tuesday and Thursday), which provides the activity necessary for the dispensing of approximately 700 patient doses per week. The generators currently in use are supplied by Mallinckrodt. They use fission produced molybdenum and the column holding this material is shielded with lead and these are stored in a secondary lead shield to provide sufficient reduction of surface radiation dose **[D3]**.

To prepare a radiopharmaceutical, the Tc^{99m} must be labelled to another chemical to achieve the required biological distribution, resulting in a "kit". To prepare a radiopharmaceutical and taking into consideration the radioisotope decay factor, the required volume of Tc^{99m}–pertechnetate is withdrawn from the generator eluate and injected into the kit. The vial is then shaken and left until the Tc^{99m} complex is formed. However, with certain kits, a heating stage may be required, for example, MAG3 and SestaMIBI. Once reconstituted the kits are subdivided into individual patient doses before being issued. Many of the long-life radiopharmaceuticals are commercially available as single patient doses (e.g. Tl^{201}, In^{111}-Octreoscan), however, it is also common practice to purchase some radiopharmaceuticals in multi-dose containers (e.g. I^{125} – HSA, Cr^{51} – Chromate/EDTA) and then produce individual patient doses **[C9, D3]**.

[2] Rules and Guidance for pharmaceutical manufacturers and distributors 2017.

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For radiopharmaceuticals preparation and patient dose calculation, it is important to consider a number of factors including **[C9]**:

- **Radioisotope decay factor** – varies with each isotope used.
- **Patient height and weight** – activity adjustment must be done for each patient as the body surface can influence the radiopharmaceutical count rate during image acquisition. Nevertheless, the standard DRL and ARSAC values should not be surpass and if a higher dose needs to be used a suitable justification has to be presented.
- **Study request** – the activities required varies with each study and radiopharmaceutical.

At this RND the method used to calculate the necessary activity for each kit and individual patient doses is based on the radioisotope decay factor, the activities and the volumes requested from the different NMD across the [redacted] **[C9]**.

To calculate the required activity the calculations are based on the regular Radioactive Decay Law Equation **[C9]**:

$$A_t = A_0 e^{(-\lambda t)} \leftrightarrow A_t = A_0 e^{\left(-\left(\frac{0.693}{T\frac{1}{2}}\right)t\right)}$$

A_0 – Initially activity (at t = 0)

A_t – Activity at a certain t time (time passed between the initial time and the time the dose is needed)

$T_{1/2}$ – Radioisotope physical half-life

λ – Radioisotope decay constant

However, during my visit to the RND I tended to work with volume and not only activity. To get the exact quantity of the final volume (V_f) I need to get my A_t I only have to use a simple cross-multiplication calculation. Through this calculation, I get the accurate result of V_f, which represents the volume needed to give the exact activity necessary. As an example, after the eluation of the generator instead of measuring the vial, a small volume (0.2 mL) is drawn in order to determine the total activity (A) present in the vial. This method prevents a huge exposure to radiation.

For example, I need to label a DMSA kit with 750MBq in 5mL and I know I have 209MBq in 0.2mL of generator eluate. Consequently, I need to know the V_f needed to prepare the kit. The calculations to obtain the V_f is shown bellow **[C9, D3]**:

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209 *MBq* (A_0) _____ 0.2 *mL* (V_0)

750 *MBq* _____ V_f *m*L

$$V_f = \frac{750 \times 0.2}{209} \leftrightarrow V_f \approx 0.71\ mL$$

V_0 – Initial volume

V_f – Final volume required

To calculate the amount of activity necessary for a certain *t* when preparing the individual patient dose I use a Tc^{99m} decay table (**Appendix 12.1.5**) present in the RND and the same calculation method. To have a better understanding, the example below shows how to calculate the individual patient dose, including the required information in**Table 2 [C9]**.

Table 2 - Example of the required information to calculate the individual patient dose

DMSA kit	750 MBq in 5 mL
Radiopharmaceutical Required	Tc^{99}m – DMSA
Activity Required	80 MBq
Volume Required	3 mL
Reference time	12:00

The dose is prepared at 09:00 and the reference time is 12:00 (*t* = 3 hours), therefore the A_t required to have a 80 MBq in 3 mL at 12:00 should be 113 MBq (±10%) **[C9]**.

750*MBq* (A_0) _____ 5 *mL* (V_0)

113 *MBq* _____ V_f *m*L

$$V_f = \frac{113 \times 5}{750} \leftrightarrow V_f \approx 0.75\ mL$$

Finally, to achieve the total volume of the patient dose, 2.25 mL sterile saline is added in the vial and then the 0.75 mL of the DMSA kit. The vial must be measured in the dose

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calibrator and the activity recorded in the master dispensing schedule (**Appendix 12.1.6**) **[C7, C9]**.

The patients' doses are double checked to ensure they are within the activity needed, allowing for the decay factor (**Appendix 12.1.7**) a consignor certificate for packages of radioactive material should be completed including information such as package number, package category, transport index, type of package, nuclide, product (and if is liquid, gas or solid), number of doses, activity per dose, reference time, reference date and activity on departure (**Appendix 12.1.8**). To transport the doses to the final destination they are inserted inside of a drum or a tin with polystyrene inserts, a sheet of absorbent material and the correct labels (More information in the **Transport of Radioactive Materials Chapter**) **[E1].**

3.1.2. Quality Control/Assurance

The radiopharmaceuticals intended for clinical use must be of the desired quality and an integral part of the supply of radiopharmaceuticals is the testing for quality, which shows the product to be safe and effective. Due to radiopharmaceuticals very short useful life after preparation, normally they are administered to patients before the results of quality control tests are obtained. To ensure the final product quality, great emphasis must be placed on the procedures used and the in-process controls that are undertaken, such as **[C8, C10]**:

1. **Tests on starting materials and the final product**
    - Measurement of radioactivity (±10%) of the activity stated on the label;
    - Radionuclide identity – gamma ray spectrometry;
    - Radionuclide purity;
    - Radiochemical purity (Example at **Appendix 12.1.9**);
    - Chemical purity;
    - Absence of foreign particulate matter;
    - Particle size;
    - Sterility (Carried out retrospectively);
    - Pyrogenes.
2. **Environmental and process controls**
    - Documentation – if consistently high quality radiopharmaceuticals are to be prepared it is essential that standard procedures are followed. The

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documentation system should allow the complete history of the product to be traced;

- Purchase of radiopharmaceuticals and raw materials - All goods received should be carefully inspected on arrival including labelling and integrity of the packaging. Where possible licensed products should be used;
- Radionuclide calibrator performance – Capintec QC checks;
- Validation of operator performance – includes broth transfer trials and monthly hand hygiene technique.
- Environmental safety and quality – checking overpressures, particulate contamination, air flow rates, air changes, filter efficiency, operator protection tests, microbial contamination of environment and radioactive contamination of surfaces.

3.1.3. Downdraught airflow cabinets and Isolators cabinets

In the design of a radiopharmacy, both pharmaceutical and radiological factors must be considered together with relevant legislation. The areas where unsealed radioactive sources are in use must be suitable for safe working and facilities should also be designed and equipped to carry out the appropriate pharmaceutical procedures especially sterile products. It is important to achieve three important aims as protection of the product from the environment, the operator and other products; protection of the operator from the radioactivity and any other hazards associated with handling of the product, for example blood product; and protection of the environment, including equipment, from radioactive and microbial contamination **[D2]**.

In accordance with the recommended practice in UK, at this RND the process used to dispense radiopharmaceuticals is using unidirectional downdraught airflow cabinets (laminar flow cabinets – LFC[3]) and microbiological safety cabinets. In these units air is taken from the room in which the LFC's are housed and passed over a high efficiency particular filter. Preparation of doses is carried out within these cabinets and the work surface is being continually bathed with sterile particle free air to produce a sterile environment. The LFC's are housed inside a clean room which is a room with a filtered air supply as recognised in

[3] LFC must conform to British Standards including BS5295 for environmental cleanliness in enclosed places. In addition, should conform to BS5726 for microbiological safety, which is a measure of personnel safety.

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Appendix I of the Guidance Notes for Hospitals – Premises and Environment for the Preparation of Radiopharmaceuticals (DHSS 1982) **[D2]**.

Isolator cabinets provide an alternative to the use of conventional aseptic suites for the preparation of radiopharmaceuticals and are microbiological safety cabinets with a filtered air supply complying with the highest standards. Normally, the enclosures are designed to operate in domestically clean rooms rather than pharmaceutical clean rooms as in the case of downdraught workstations. In these units, manipulations are carried out via glove ports and the integrity of the gloves is therefore critical **[D2]**.

In conclusion, the isolators are best suited to departments with a small workload and in situations where potentially hazardous materials such as blood products are handled. For this reason, at both departments, an isolator cabinet is used **[D2]**.

3.2. [redacted] and [redacted] Dispensary

When the doses arrive in the department they are added on the Computerised Radiology Information System (CRIS), and then they are measured in a radionuclide calibrator with the correct radioisotope calibration factor selected and the value is recorded in the daily radiopharmaceutical order form (**Appendix 12.1.3**) **[B6, C7]**. The regular plastic filter of the dose calibrator should be used for the daily QA calibration and all isotopes. For the correct measurement of I^{123}, a Thomson Copper filter must be used to prevent variations from the expected values. The ionisation chamber is sensitive to low energy emissions, such as I^{123} (low energy X-rays range 27-32 keV). The radionuclide calibrator has a calibrator factor for this isotope and the measurements should be reliable for every type of vial or syringe used, but is likely to be for a particular type of vial or syringe. Since the Thomson Copper filter is 0.5 mm thick, it removes these X-ray but only reduces the 159 keV emissions by 14% and the ionisation chamber needs to have a new calibration factor for the measurement of I^{123} **[C9]**.

Even without our own dispensary, I am trained to perform the dispensary tasks and cell labelling. On a daily basis, some tasks performed in dispensary include **[C5, C8, C9, C10, D2, D4, E1, E3]**:

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- **General duties –** ordering the doses and pharmaceuticals, return the empty lead pots to RND with the appropriate label instead of radioactive label (**Appendix 12.1.10**) **[C5, E1]**.
- **Patient related duties -** dispensing doses, performing cell labelling and GFR procedures **[C9, D4]**.
- **Cabinet and radionuclide calibrator checks –** these include cabinets compressor leak test, settle plates for environment check and finger dabs of critical gloves, gloves checked after each session and changed weekly, dose calibrator constancy test (daily and weekly) **[B4, C8, C10]**.
- **Loading trays –** replenish syringes, needles, swabs, etc.
- **Daily clean and monitoring –** clean and monitor the dispensary, labelling room and cabinets (**Appendix 12.1.11** and **12.1.12**) **[D2, E3]**.

I also perform cell labelling, including proper cleaning, preparing the material beforehand and performing QA (settle plates and finger dabs) before and post-labelling. At these departments, white blood cells (WBC) labelling with Tc^{99m} - HMPAO and In^{111} - Chloride, red blood cells (RBC) labelling with $NaTc^{99m}O_4$ and blood volumes studies are also performed. I am fully trained to perform the WBC and RBC labelling. These studies involve different steps and the **Table 3** shows examples of the main differences between them. Although I do not as yet perform Blood Volume studies, I have included the procedure to highlight the different steps involved **[C1, D4]**.

Table 3 - Differences between labellings

	WBC Labelling	**Heat Damaged RBC Labelling**	**RBC Labelling**	**Blood Volume**
Clinical Indication	To assess pyrexia of unknown origin, abscess, source of sepsis or infection, and inflammatory bowel disease	To assess site of splenic tissue. Query Splenuncula, query accessory spleen in Splenectomy	To determine site of active gastric bleed with acute blood loss	To differentiate between True and Relative Polycythaemia
Cell Labelling	In *vitro*: cell labelling occurs outside the	In *vitro*: RBC preparation with	In vivo:	In *vitro*: cell labelling occurs

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method	patient		pyrophosphate and labelling with the agent occurs outside the patient	RBC preparation with pyrophosphates and labelling with the agent occur within the patient	outside the patient
Agent	Tc^{99m} - HMPAO	In^{111} - Chloride	$NaTc^{99m}O_4$	$NaTc^{99m}O_4$	Cr^{51} - Chromate and I^{125} - HSA
Preparation	Not Applicable		Not Applicable	Injection of Sodium Pyrophosphate (PYP) intravenously 15 minutes before the administration of the radiopharmaceutical	Not Applicable
Blood Taking	Syringe prepared with anticoagulant agent (2 ml of Heparin 1000 u/ml) to prevent blood coagulation and 2ml Methocel to assist sedimentation of red cells.		Syringe prepared with anticoagulant agent (2 ml of Heparin 1000 u/ml) to prevent blood coagulation	Not Applicable	Syringe prepared with anticoagulant (0.5 mL of Heparin) to prevent blood coagulation
	50 mL blood sample should be taken to perform the labelling		20 mL blood sample should be taken to perform the labelling		3 mL blood sample should be taken to measure the Haematocrit, plus 20 mL blood sample should be taken to perform the labelling
	Transferred to the isolator cabinet and allow the cells to settle for 30 minutes before starting the labelling		Transferred to the isolator cabinet. Does not need time to settle		Transferred to the isolator cabinet. Does not need time to settle

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Labelling	Centrifuge and isolator cabinet are needed.		Centrifuge, isolator cabinet and a water bath are needed	Not Applicable	Centrifuge and isolator cabinet are needed
	To ensure correct and effective labelling the departmental protocol must be followed				
Max Activity injected	200 MBq	20 MBq	100 MBq	400 MBq	0.8 MBq + 0.2 MBq, respectively
Image acquisition	1, 2.5 hours and 4, 24 hours may be required	4 and/or 24 hours	5 minutes	Immediately following administration of the radiopharmaceutical	Not Applicable

I am able to perform GFR studies including administration of radiopharmaceutical, the sample preparation and counting **[C1, C9, D1, D4]**.

For the GFR studies, 5 blood samples must be taken, including the baseline sample and blood samples at 120, 180, 210 and 240 minutes after the Cr^{51} - EDTA injection[4]. It is essential to record in the datasheet the exact time at which the sample was taken, the details of the standard dose, the diluting volume of the standard, the height and weight of the patient. These details are needed to enter into the computer program to produce the final calculated value of GFR. These blood samples should be centrifuged, the plasma should be carefully pipetted and counted in the gamma counter correctly to obtain an accurate result **[D4]**.

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[4] Following the department protocol for GFR studies.

4. Imaging Acquisition and Non-Imaging equipment

As a result of my experience, I am competent in equipment management. I have used different types of Gamma Cameras (in Portugal and UK) and PET/CT systems (only in Portugal) to perform imaging acquisition and also auto-gamma counters for non-imaging studies such as quantitative determination of GFR studies (Competencies Form at **Appendix 12.2.1**) **[C2]**.

In my department, I have been trained to correctly operate all the equipment including the Imaging and non-imaging equipment **[C2]**.

I am able to operate *GE Optima 640* (at [redacted]) and *Siemens Symbia T* Gamma Cameras (at [redacted] and [redacted] correctly, including acquisition workstation and ppm, check the photopeak, use the worklist to select patient details before beginning an acquisition, select the most appropriate protocol, start and terminate an acquisition as necessary, rename a view if necessary, modify a view or add extra view(s) if necessary[5], set the area for an image zoom and acquire images with that zoom factor and change collimators safely. I am competent to independently perform a variety of diagnostic NM studies **[C2]**.

The most commonly performed studies in this NMD are:

- Bone Scans (including Three Phase Bone Scan and late phase only)
- Ventilation/Perfusion Lung Scan
- Renal Studies (Renogram and DMSA scans)
- Brain Scans (Brain SPECT and DATScan)
- Gastric emptying and Hepatobiliary Scans
- Thyroid and Parathyroid Scans
- Tumour Imaging Scans (Octreotide)
- Infection/Inflammation Scans
- Lymphoscintigraphies (Breast, Melanomas and Drainage)

Other scans are available in the department; however, they are not commonly performed (including, SeHCat, gastrointestinal bleeding, dacroscintigraphy scans, gallium scans, perchlorate discharge, salivary glands scans, Meckles Diverticulum scan, etc). My

[5] However, some scans need to be checked by a MPE or a NM Practitioner and only they can authorize a SPECT/CT.

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understanding in performing these studies and the “sign off” of competencies in this NMD is obtainable on a competencies table (**Appendix 12.2**).

The non-imaging equipment include the *Wizard 3’’ 1480* Samples Counter for quantitative determination and the *Amercare Cabinet* for labelling. I have been trained and I am competent to use this equipment. Regarding the sample counter, I am able to perform the QA before sample counting, arrange the samples in the sample rack in the correct order (as defined in the SOP), attach the appropriate flag for the GFR counting protocol to the sample rack, load the racks into the auto gamma counter followed by a STOP rack and start the auto gamma counter. For the Amercare cabinet for labelling, I am able to check, for example, if the cabinet has been cleaned and passed all the relevant quality control checks before use. I use appropriate aseptic and radiation safety techniques at all times and understand the importance of balancing the centrifuge prior to use to ensure the centrifuge does not get damaged **[C2, C4]**.

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5. Therapy

In Portugal, during my placements, I was involved in therapy studies with ^{131}I-NaI for patients with thyroid carcinoma, thyroid follicular adenoma, hyperthyroidism (over-activity of the thyroid gland), etc. I was able to carry out the pre-therapeutic scintigraphy with ^{123}I or ^{99m}Tc Pertechnetate (depending on the department) to determinate the thyroid uptake in order to calculate the therapeutic dose needed for each patient. I was also able to perform the explanation and administration of the therapeutic doses to patients under supervision. **[C3]**.

At my current post, the therapy studies are performed only at [redacted] and only for patients with hyperthyroidism and I am not involved in the therapeutic dose calculation, patient preparation and/or radiopharmaceutical administration but I am able to perform pre-therapeutic scans. These tasks, previously mentioned, should be performed by fully trained operator such as MPE and/or Senior Technologist who has been entitled by the Practitioner to administer the radioiodine **[C3]**.

Although not directly involved with thyroid therapy procedures at the moment, I know the therapeutic procedure and the importance of implementing some follow-up instructions for patients. ^{131}I-NaI has a physical half-life of 8.02 days, is a predominantly gamma-ray emitter of 364 keV and a beta negative (β^-) particle emission of 0.61 MeV. Consequently this radioisotope has a moderate to high Linear Energy Transfer[6] and the β^- particles are responsible for the majority of the local therapy effect. The therapy dose used is much higher than for a diagnostic study performed with this radioisotope and as a result it is important to verify if patients understands all the treatment process (including preparation prior to treatment), instructions to follow during the subsequent weeks after therapy and radiation protection measures to minimise radiation dose post-therapy to other people before starting any therapy (**Table 4**). All procedures and precautions explained prior to treatment are on the information leaflet given to the patient **[A8, C1, C3]**.

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[6] Corresponding to the rate at which energy is transferred from ionizing radiation to soft tissue, expressed in terms of kiloelectron volts per micrometer (keV/µm) of track length in soft tissue.

Table 4 - Precautions prior and post therapy

Prior Therapy	Post Therapy
• Stop thyroid medication if required; • Pregnancy test (blood tests in all fertile women (age 12-55)) and should stop breastfeeding if applicable; • Verify if patients have urinary incontinence;	• Avoid unnecessary contact with people age <21 and minimal contact with children age <5; • Avoid travel by public transport and frequent entertainment places; • Sleep separately from other person/people (for a period of time depending on the activity administered) ; • Advise against procreation for 6 months after therapy; • Advice of possibility of alarms in airports/ports;

After the radioisotope administration, if the patient remains in the hospital, an isolated room is provided. Whenever possible, disposable materials such as cutlery and dishes should be used and the used bed linen is stored before being discarded or washed to prevent any contamination by radioactive body fluids and sweat. Finally, when the patient leaves, the room is monitored, washed and cleaned before the next usage **[A8, B6, C3]**.

The follow up should be done 6-8 weeks after treatment by thyroid blood tests and if necessary the radioiodine therapy should be repeated. If performing a second ^{131}I-NaI administration within any 12 month period a risk assessment should be performed **[A4, C3]**.

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6. Equipment Management

As a NM technologist and an active member of a multidisciplinary team, I am involved in discussing and can give my opinion to my technical manager when the department is undergoing changes in use of equipment and accessories used on a daily basis **[B1]**.

Recently the department were purchasing new syringe shields and I was asked to give my opinion regarding the differences between them including pros and cons as I have worked with different brands between UK and Portugal **[B1]**.

All equipment used in both departments, including gamma cameras, bone densitometer, electrical equipment (e.g. computers and printers) and others (e.g. centrifuges, calibrators, probes and other equipments) are described in the Equipment Inventory System (**Appendix 12.3.1**) which is located in the departmental common disc area and within the QC system **[B2]**. Detailed information for the gamma cameras and bone densitometer are kept in folders in each camera room and has all the instructions and general QC performance schedules. A record of all engineering services and all calibration information for the cameras, dose calibrators and scintillation monitors, is kept by the physicists. An Equipment Inventory System and these folders are helpful to keep a record of all the equipment faults, calibration dates and service dates **[B2, C7]**.

It is part of my duties to be involved in fault finding, not only for NM equipments but also for other equipment present in the department and used regularly, such as oxygen systems, scales, etc. For NM equipment such as gamma cameras, if I find equipment is out of specification and/or has a fault I need to notify the duty physicist and the Technical Manager, to assess the equipment fault; if the fault/error persists the situation is recorded in the equipment diary and the engineers are notified and a service is booked **[B5]**.

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6.1. Quality Assurance

Periodic tests are performed in both NMD including daily, weekly and/or monthly QA tests on gamma cameras, *Amercare* cabinets, gamma counters, radionuclide calibrators, gamma probes, contamination and dose rate monitors. These periodic tests are crucial to verify if the equipment is working under the parameters expected on a daily basis **[B8, C4]**.

The most performed reference test for gamma cameras are the extrinsic uniformity (performed daily and weekly) (see example at **Appendices 12.3.2** and **12.3.3**), the Centre Of Rotation (COR) alignment (this is performed weekly and the same set of collimators is

repeated on a 3 week cycle) (see example at **Appendix 12.3.4**), Computed Tomography (CT) check up and CT phantom (performed daily) (see example at **Appendix 12.2.3**) and intrinsic uniformity verification (performed weekly – if the results are greatly different from results recorded to date I need to inform the duty physicist and perform an intrinsic calibration). The tests guarantee the gamma cameras are working accurately on a daily basis. It is important to mention the scheduling of the QA tests is different for each department and they are performed as often as the department routine allows and, in my opinion, they are performed with a good frequency in one of the departments, however, I would increase the frequency of the CT phantom check and intrinsic uniformity verification in the other department **[B4, B8, C4, C7, C8].**

After performing the QA tests, as part of my daily duties, I need to record the values of all the tests performed, writing down in the correct folder for each gamma camera (with date, collimator used, name the person who performed the test and processed the values) and record in the corresponding *Excel* files the results of the test and compare them with the reference values (available in the same file), ensuring they are within the acceptable range (**Appendices 12.3.2, 12.3.3** and **12.3.4**) **[B4, C4, C7, C8]**. However, if by any chance one or more parameters are out of range, I should go through the following steps **[B4, C4, C7, C8]**:

9. Perform the test a second time - prior to doing the test, I need to identify what may cause the problem, such as distance between collimators was not the standard QC protocol, ^{57}Co flood positioning was not the most appropriate or the activity of the source was greater/lower than usual;
10. If the reference values are still out of range, I need notify my technical manager and the duty physicist, so that other action may be taken, such as other QC tests and evaluations of the software;
11. If the fault persists, the duty physicist will make the decision whether the camera should remain in service and contact the engineers of the company responsible for that equipment to fix the problem to perform a service on the equipment.

Regarding the gamma counter, at both departments, the Good Laboratory Practice (GLP) test and weekly QA are performed using a ^{129}I calibration source and I need to check the peak, efficiency and total CPM. In addition, prior to clinical use the ^{51}Cr peak must be

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checked. If there is a problem with theses values I need notify my manager and/or the duty physicists. Another QA test performed on the gamma counter is the isotope normalisation; this procedure is performed every 6 months (or at least annually) on all isotopes in use in the departments and is carried out by one of the physicists **[B4, C4, C7, C8]**.

As for the *Amercare* cabinets, QA checks (such as microbiological monitoring, cleaning and daily checks, cabinet gloves, particle counting and leak tests) I have been performing them ever since my arrival at both departments and I perform them through the steps showed on the **Table 5 [B4, B8,C4, C7, C8].**

Table 5 - Amercare QA checks

***Amercare* QA checks**	
Microbiological monitoring	Should be performed every time any patient related procedure is performed within the cabinet or at least once per week if no patient procedure has been undertaken, by using agar plates (sent to Microbiology-Bacteriology Department (MBD)). The results are reported about two weeks later. The record should be signed by the chief technologist or MPE and be stored in the correct file. If the report from Bacteriology or Area QC indicates that there is no contamination then the appropriate entry in the weekly check sheet can be ticked off. If the report indicates that there is a degree of contamination, then procedures should be initiated for sterilising the laminar flow cabinet. Also, every six months the laminar flow cabinets are tested to make sure that they are still functioning correctly with the appropriate air flow. A copy of the certificate issued should be laminated and attached to the cabinet; the original copy should be stored in the filing cabinet kept in the Technical Manager's office.
Cleaning and daily checks	A full cabinet clean should be performed at the beginning of each work session including internal cleaning (cabinet, gauntlets/gloves, sterile gloves, centrifuge and other equipment) and external cleaning. At the end of cleaning, I need to check if the air change and pressures are within the acceptable limits, and if the cabinet is out of limits I notify

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	the technical manager and/or duty physicist.
Particle Counting	As part of the QC protocol the cabinet filtration system is checked monthly. This is carried out on a monthly basis at [redacted] by the staff from [redacted] and at [redacted] by the technologists. After checking the cabinet, a report is issued and sent to the technical manager and will be checked and filed in the technical manager's office.
Leak tests	The cabinet automatically performs a daily leak test and the print out should be checked every day. If the result is acceptable, the print-out should be filed in the "current month" envelope attached to the side of the cabinet. If the test fails I need notify the technical manager and/or duty physicist.

If the radionuclide calibrator malfunctions, it can affect the activity given to the patient. Therefore, it is important that all the checks (background and constancy tests) be performed on a daily basis. These checks at [redacted] are performed through the use of a ^{226}Ra standard source for the daily checks for ^{99m}Tc and on a weekly basis for all other isotopes (**Appendix 12.3.5**). At [redacted] I use a ^{137}Cs standard source and the checks are performed for all the isotopes that will be in use that day. The QA is performed through the following steps **[B4, C4, C7, C8, C10]**:

- Check the background at the ^{99m}Tc setting;
- Activity is measured on the ^{226}Ra/^{137}Cs setting;
- Activity is measured on other isotopes settings (as required by the department)
- Values are recorded in the appropriate logbook and compared with the standards values (should be within ± 10%).

Regarding the linearity test of radionuclide calibrators (as a field instrument) this is performed annually in both departments by the physicists to guarantee the calibrators are measuring within specification. To perform the linearity test, 4 vials (2 low, 1 medium and 1 high energy) are measured in the radionuclide calibrator using the appropriate settings and the background is also measured over 3 hours. The activity at a specific calibration time and date is corrected to the testing date taking into account the decay. All values are recorded and a comparison between the measured and theoretical activities is made. The percentage

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differences should be below the 5% tolerance, set for a field instrument, suggesting the linearity of the radionuclide dose calibrator is well within tolerance **[B4, B8, C4, C7, C8, C10]**.

The gamma probes used to identify sentinel nodes (SLN) in theatre should be checked weekly and also after use. The probe needs to be checked for sound, battery and for the number of counts recorded in 10 seconds (should be performed 3 times) and to perform the check I use a ^{57}Co pen and Perspex block. The values are recorded in the Excel QC file **[B4, C4, C7, C8]**.

Concerning the contamination and dose rate monitors, the QA tests are performed both weekly and annually. The weekly checks (which include the battery, speaker, background activity and activity measured with source) are performed by using a ^{90}Sr source (contamination monitors), ^{57}Co pen and ^{226}Ra source (dose rate monitors) and must be recorded in the Excel files. The contamination monitors are checked once a year by [redacted] The checks ensure that the monitors are appropriate for measuring radioactive contamination within the department and are suitable for the various radionuclides within the department. They also indicate the sensitivity of each instrument to radiation. This sensitivity can change from year to year and if it falls below a certain level, the monitor should not be used. As for the dose rate monitors within the department, they need to be checked annually by an external organisation such as Public Health England, to check the monitor's performance at a variety of energies **[B4, B8, C4, C7, C8]**.

Finally, when installing new equipment it is important to guarantee that the equipment meets the technical specifications by the manufacturer and to confirm this, acceptance tests are performed by the manufacturer's engineer and also by the physicists (commissioning checks are not part of my job description). The results should be traceable to National Electrical Manufactures Association (NEMA) performance standards. After any of the acceptances tests have been performed the results are used as a baseline for routinely performed tests such as daily, weekly and monthly quality control to help identify potential equipment failure or loss of image quality. If the equipment does not pass these acceptance tests, it should not be used **[B8, C4]**.

As I mentioned before, this task is not part of my current role, however the protocol used when performing the acceptance testing of a new SPECT/CT system is a Gamma Camera performance assessment protocol. In 1994, the Medical Devices Agency (MDA)

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established the Gamma Camera Assessment Team (GCAT) to evaluate the performance of gamma cameras using the clinically-orientated protocols **[B8, C4]**.

Using the Gamma Camera Performance Assessment Protocol, our clinical scientists perform the following test on a new system **[B8, C4]**:

- Quantitative intrinsic spatial resolution;
- Quantitative system spatial resolution;
- Shield penetration;
- System no-uniformity;
- System sensitivity;
- Count rate performance;
- Variation in uniformity with camera angle;
- Variation in sensitivity with camera angle;
- Rotational performance assessment;
- Tomographic resolution;
- Tomographic non-uniformity;
- Tomographic system performance;
- Wholebody count rate variation;
- Wholebody resolution;
- Wholebody system performance;

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7. Legislation and Radiation Control

7.1. Legislation in Nuclear Medicine

As a clinical technologist I am familiar with the pieces of legislation for the use of radionuclides in NM such as, Ionising Radiation Regulations 1999 (IRR 99), The IR(ME)R 2000, The Medicine (Administration of Radioactive Substances) Regulations 1978 (MARS 78), The Radiation Substances Act 1993 (RSA 93), Carriage of Dangerous Goods & Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009) and The Health and Safety at Work etc. Act1974. However, some of these Regulations have been revoked and/or superseded **[A3]**.

IRR 99 was revoked and superseded by Ionising Radiation Regulations 2017 (IRR 17) which came into force on 1st of January 2018. The Regulations establishes a safe environment for all the working staff and the public through its regulations, by ensuring that the ionising radiation exposure on the workplace is kept "As Low as Reasonably Practicable" (ALARP concept) and provides new dose limits (**Table 6**) to ensure that sufficient measures are made to protect staff and members of the public from ionising radiation **[A3]**.

Table 6 - Annual Limit doses

	Employees and Trainees ≥ 18 years	**Trainees < 18 years**	**Members of public**
	Annual Limit on Equivalent Dose (mSv)		
Eyes (IRR 99)	150	50	15
Eyes (IRR 17)	20	20	15
Skin	500	150	50
Extremities	500	150	50
	Annual Limit on Effective Dose (mSv)		
Whole body	20	6	1

This document also states the Radiation Protection Advisor (RPA) who has suitable knowledge, experience and must hold a valid certificate of competence from an organisation recognised by the Health and Safety Executive (HSE) to provide advice to the NHS Trust (employer) about protection of employees and the public from harmful effects of

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ionising radiation. Also, to individual departments a Radiation Protection Supervision (RPS) should be designated to ensure that local rules are followed. These local rules are drawn up by Heath Physics department in consultation with the local RPS and they provide information such as **[A3]**:

- Dose investigation levels for employees, trainees (aged under, of or above 18 years old) and other persons;
- Description of the controlled area (e.g. injection room, camera room, etc), supervised area (e.g. corridor) and the hazards present in the area;
- Description of contingency plans (in the event of a radiation spill and respective decontamination procedure, in the event of fire, etc);
- Names and contacts details of responsible people including the RPS.

Also, the Regulation regarding the Equipment used for medical exposure (IRR 17, Regulation 33) must be omitted since it is part of the new The IR(ME)R Regulations, (Regulation 15) **[A3]**.

The IR(ME)R 2000[7], was revoked and superseded by The IR(ME)R 2017 coming into force on 6th of February 2018. These Regulations impose duties on employers responsible for administering medical exposures of ionising radiation, such an establishment of general procedures, protocols and quality assurance programmes, clinical audits and accidental or unintended exposure, in order to protect the person undergoing the medical exposure from unnecessary overexposure, such as unjustified or excessive doses **[A3]**.

Consequently, every medical exposure must be justified in terms of an evaluation of the clinical information available, the potential benefits and the risks, not only for each patient but also for the carers and comforters. Also, the medical exposure should be optimised to ensure the minimum dose required to achieve the intended results is used. A practical example of the use of this legislation is the regular performance of V/Q scans on pregnant or breastfeeding women at [redacted]. However, for each patient, the ratio risk/benefit must be done and a decision towards the scan performance made by the Practitioner in

[7] The four duty holders involved in the use of ionising radiation are: employer, referrer, practitioner and operator. Also, the employer must ensure that a suitable MPE is appointed and involved, in relation to every type of exposure to which these Regulations apply.

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charge. As referred previous, the radiopharmaceutical dose for both cases, must be reduced to the minimal activity necessary to ensure diagnostic quality **[A3]**.

MARS 78 has a result of, The IR(ME)R 2017 been revoked and is now included within IRMER, this states that medical exposures and prior-authorisation for the administration of radioactive substances for the purposes of diagnosis, treatment and research. These Regulations provide protection for patients by stipulating that the administration of radioactive substances must be under the direction of an ARSAC certification holder, this is the IR(ME)R practitioner, in order to guarantee the correct use of the radiopharmaceutical and the lowest radiation exposure. In both NMD the practitioner appoints the clinical technologist to act as operator in the administration of such substances. ARSAC certificates issued to a person under the MARS 78 which is valid on 6th of February 2018 is deemed to be a licence issued under these Regulations for as long as that certificate remains valid and to license the employer responsible for the medical radiological installation for the matter specified in that certificate**[A3]**.

The RSA 93 is designated to reduce the effects of radiation on the environment and the general public and is enforced by the [redacted] Under the act it is a requirement that all users of radioactive material, such as a NMD, is registered and must obtain a certificate for holding and an authorisation for disposing from [redacted] Detailed records of all stored and disposed waste must show the date, radionuclide, type and quantities disposed of and the disposal route.[8] This record keeping is required in order to provide suitable evidence of compliance at regular inspections by [redacted] **[A3]**.

The CDG 2009 state the regulations directed to the transport of dangerous goods from, to and within the UK, including radioactive materials [9]**[A3]**.

The Health and Safety at Work etc. Act (HSWA) 1974 is the piece of legislation covering occupational Health and Safety in Great Britain. The HSE was created to investigate accidents which includes nuclear incidents and enforces the IRR 99 described before **[A3]**.

7.2. Radiation Monitoring

As part of my daily duties, at the end of the work day, my colleagues and I are required to monitor (using a scintillation monitor) the injections rooms, acquisition rooms,

[8] Further information in Radiation Monitoring section.

[9] Further information in Transport of Radioactive Materials section

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waiting rooms, dispensary, labelling room, waste disposal and therapy room (**Appendix 12.1.10**) **[B6, E3]**.

This alerts us if any area of the department is contaminated and an appropriate decontamination is necessary (as per local SOP, **Appendix 12.4.1**) **[B3]**. Clear signalization of the area contaminated and a record keeping of the event is required. Also, it is essential to inform all staff, manager and the duty physicist **[B3, B6, C7, E3]**.

The radioactive waste, such as sharps bins should be stored in the Waste Disposal Room and clinical waste bags and/or contaminated linen (with radioactive urine contamination, radioactive blood spillage, etc) should be stored in the designated area, Waste Storage Room, keeping a record on file of waste label, radioisotope, number of counts and date, in the case of contaminated linen **[B6, C7]**.

The sharps bins and the large bins that are in the Waste Storage Room should be monitored weekly[10] to see if they can be disposed. The waste can be discharged and transported as normal if the waste activity is below 1 MBq. If not it must be placed back in the store room to decay further. Following RSA 93 and the local rules, a record of all radioactive waste is kept within a folder in the Waste Storage Room **[A3, B6, E3]**.

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7.3. Leak Test of Sealed Sources

In keeping with IRR 17 Regulation 28, both NMDs have a protocol for performing leak tests on sealed sources. It is a statutory requirement to perform leak test on every sealed sources (^{137}Cs, ^{57}Co, ^{90}Sr and ^{129}I) present in the department at least once every two years, although this procedure should also be performed when a new source arrives in the department and if any visible alteration or damage to the source is observed. This task is performed by the physicists and/or technologists, and the results presented to the RPS for review and to verify the safe performance of the source or instruct further action (see example of the results at **Appendix 12.4.2**). A wipe test is most widely used and removed

[10] The waste is monitored for activity using a calibrated contamination monitor at a fixed distance of 50cm and the background counts are also checked.

activity should not exceed 185 Bq [11]. The instructions for the performance of leak tests on sealed sources at both departments are **[A3, E2]**:

- Using a swab moistened with alcohol (MediSwab)[12] wipe the source or an appropriate area of the surface[13];
- The swab should be assayed, with a detector, appropriate for the type of radiation expected from the source. Samples are assayed using a sodium iodide detector, i.e. an auto gamma counter[14] with an open energy window.

A negative result for leakage is confirmed when no measurable activity above background[15] is detected, so if the value is above background (active swab) further tests should be performed to investigate the result. If the source demonstrates leakage, it is deemed unsafe for use. As a result the source should be taken out of service and stored safely in the Waste Disposal Room until it can be disposed of and an electronic record is kept on the common area of disk[16] **[A3, E2]**.

7.4. Transport of Radioactive Materials

The transport of radioactive material is regulated by the CDG 2009 legislation and in these regulations there are three types of packages (Excepted packages, Type A packages and type B packages) described. These regulations stipulate how the package design should reduce the risk of any radioactive contamination and all external radiation hazards should be kept to a minimum. All shipments should be traceable back to the sender through consignor notes **[A3, E1]**.

In [redacted] all the radiopharmaceuticals and Krypton (^{81}Rb) generator are delivered from the General RND. The majority of transport of radionuclide packages in [redacted] are Type A packages as they are for the transport of intermediate quantities of radioactive

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[11] Specification is British Standard BS 5288 1976, Appendix D but this has been superseded with BS EN ISO 2919:20147

[12] MediSwab is the preferred swab since this should be wet and containing only alcohol to make sure the test is not compromised.

[13] To measure the exact level of contamination, allowance must be made for only a proportion of the leakage being removed by the swab (10%). Therefore all samples should measure under 19Bq.

[14] At both departments the gamma counter is used, which has a higher sensitivity than a gamma camera.

[15] Anything >19 cps above background warrants further investigation

[16] If there is damage to the source details of how the damage occurred should be sought.

material, whose dose rate exceeds 5µSv/hour. These packages have to undergo various performance tests, before the delivery, to ensure each container has the right characteristics, which include: a free drop test from a height of 1.2m for solids and 9m for liquids, a water spray test to simulate rain fall, a stacking test to stimulate storage conditions and a penetration test by a 6kg bar from a height of 1m for solids and 1.7m for liquids. Every morning, the RND's driver delivers the doses for patients' scans and therapies required for the day with the respective consignor note **[A3, E1]**.

At the end of each day, prior to returning a used ^{81}Rb generator (supplied on a Tuesday and Friday) and/or the lead pots kept in the department, I need to monitor the package to ensure that the dose rate of the surface of the package does not exceed 5µSv/hour (Excepted Package). The ^{81}Rb generator is stored in a cardboard box and the lead pots in a metallic drum. Stickers are applied to identify the level of activity or if there is no activity (**Appendix 12.1.8**). Also, they need to be marked with an appropriate UN number and have the consignor or consignee details (**Appendix 12.4.3**). The following morning, the driver collects the packages to return to the RND along with the appropriate consignor notes **[A3, E1, E3]**.

7.5. Radiation Incident Reporting

In the case of an incident or near miss (such as overexposure, unnecessary and/or unjustified radiation or contamination) an online Datix form should be completed as part of the Hospital policy, to ensure the incident is recorded not only on a Radiology information system but also on the hospital platform. I have observed and I have completed one of these reports in the past **[A5]**.

A patient attended for a bone scan and additional SPECT/CT was requested of lower extremities. The SPECT/CT images were acquired but CT field of view acquisition was incomplete due to unavoidable equipment failure and consequently did not cover the area of interest. Since it was an equipment failure the engineer was contacted by duty physicist and after an investigation a fault was found and the duty physicist received advice not to use SPECT-CT unit for CT scans until the fault was repaired. Therefore we repeated the patient scan on another gamma camera in order to obtain the images required, however, because of the repeat CT, the exposure to radiation increased and a radiation incident report had to be completed **[A5]**.

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Further to this, as a reflection on lessons learned with this incident, staff continue to be encouraged to check all images before the patient leaves the department to ensure a complete data set has been acquired **[A5, A9]**.

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8. Clinical Audits

To allow for quality improvement and to examine if healthcare is being provided in line with standards, to inform the staff and patients how well their services are being performed and where improvements could be made, an audit should be performed **[C6]**.

At both departments there are monthly audit schedules for different subjects, such as hand hygiene audit, cleaning audit, [redacted] QIP ([redacted] Quality Improvement Portal) audit, fire audit and IRMER audits. The hand hygiene, cleaning, LanQIP and fire audit is performed by technologists and nurses and the IRMER audits are normally performed by physicists **[C6]**.

The hand hygiene monitoring audit is important to ensure hand cleaning is performed at the right moments (e.g. before patient contact, before aseptic task, etc) and if compliance with the hand washing standards (e.g. liquid soap applied with hands wet, bin opened using the foot pedal when disposing of towels).

The cleaning audit is performed monthly and is important to guarantee if the rooms are cleaned in compliance with the standards after each patient and at the end of the day. At the end of the month the ratio cleaned/opportunities is analysed.

The [redacted] QIP audit helps us demonstrate our compliance against the Healthcare Quality Strategy for [redacted] and includes Standards for Infection Control Precautions (SICP's). The SICP's consist of 10 key elements (e.g. Personal Protective Equipment, Hand Hygiene, Safe Disposal of Waste, etc) to reducing the risk of infection for patients in all healthcare settings in [redacted] and are relevant in any care environment. This audit should be performed twice a year.

The fire audit assesses where there are deficiencies found in the department, problem/modification with equipment (such as fire extinguishers) and confirms if all staff on duty have received the adequate training and are aware of the emergency procedures **[C6]**.

To perform the IRMER audit, 20 different studies every month are investigated in order to analyse if all the required procedures, pregnancy/ breastfeeding verified, DRL activity, patient signature to consent with the scan and details (activities and scan of the cards), have been entered on CRIS **[C6]**.

In 2015 a review of Breast Sentinel Node (BSLN) imaging procedures at both departments [redacted] was performed and the results showed a large discrepancy

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across sites for successful visualisation of BSLN. Because of this, an audit was carried out to determine the reasons for this discrepancy. The audit data and my comments in detail are presented in **Appendix 12.5 [C6]**.

The aim of these audits is to highlight any areas that require improvement and work on these to provide the best healthcare we can.

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9. Safe Working Practice

[redacted] has mandatory training which all staff must complete yearly, through Learn-Pro and/or face-to-face attendance, such as Basic Life Support and infection control. When I started as a NHS employee in March 2017 I had the induction for all new staff (as show on **Appendix 12.6.1**) and the Learn-Pro statutory courses (**Appendix 12.6.2**), such as Healthy and Safety, etc. This training is essential for everyone working in a hospital environment **[A1, A2]**.

As a multidisciplinary team it is important to follow necessary measures to provide wellbeing not only for the patients but also for the staff. Every day, we deal with different patients with different requirements and it is necessary to do everything in our power to assure service quality without compromising the safety of the patients. Some patients need more attention and understanding of their health problems (including emotional health), specific moving and handling (including lateral transfer from trolley to the gamma camera bed, standing and walking, etc) and/or patients requiring more care to prevent and control infection. Therefore, the mandatory training is essential for all staff to help us to identify existing or possible risks when in contact with a patient. To guarantee patient safety and care, I follow the departments protocols directed to ensure Health and Safety and Risk Management (See examples at **Table 7**) **[A1, A2, A7, B3, B6, E3]**.

Table 7 - Example of actions that ensure Health and Safety and Risk Management

General Infection Control	Use hand disinfectant gel and to prevent infections, wash hands as often as required.
	Use personal protective equipment as often as possible for preventing contamination by fluids, especially with inpatients.
	Carry out equipment decontamination between patients and as often as required.
	Clean positioning equipment, pillows and equipment bed between patients and at the end of the day with wipes (Clinitex®).
	Weekly clean the gamma camera (including gantry and detectors), collimator cart(s) (sometimes dust can impede the collimator changing) and all work surfaces (including all items on desks and all

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	dust gathering surfaces).
Infectious Diseases & MRSA	Gamma camera bed, pillows and all used equipment must be wiped and cleaned with Actichlor®.
	All laundry must be disposed in a red bag and then put this bag inside of a disposable white bag to keep separately from regular laundry.
	Staff must wash hands with water and soap and not only use the hand gel as it is not effective against certain viruses.
Clinical Waste	Separate and dispose the clinical waste (including contamination from blood spills and/or radioactive spills) in the designated places.
Radiation Spillages	Monitor the contaminated area, clean the area with wipes and Actichlor®, monitor again to check if radiation has reached background counts. If necessary cover area with Benchguard® and label appropriately.

9.1. Risk Assessment

The risk assessments are performed in both departments and in accordance with the IRR and HSWA. Clinical technologists and physicists are allowed to perform and write risk assessments although they must be checked by the RPS and the RPA if include exposure to radiation. At present, I have not be involved in a risk assessment, however, although not directly involved in the execution of these, I know the importance of them and I present detailed comments on a risk assessment about Sharps and Needlestick Injury (**Appendix 12.6.3**) and Control Of Substances Hazardous to Health (COSHH) risk assessment for Actichlor Tablets (**Appendix 12.6.4**) **[A4]**.

9.2. Clinical Practice

As a member of a team, I need to have effective communication and organisational skills since these are crucial when working within a multidisciplinary team. I have developed these competences not only throughout the internships and my actual work experience but also being a member of the organisational committee of the NM Seminars and being involved in volunteer projects **[A6]**.

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As mentioned before, every day we work with patients with different needs and as a result our communication needs to be effective and understandable. Most of the patients do not have any knowledge of NM before coming to the department and therefore it is important to explain the procedures and what is going to happen during the acquisition of the images to help them to understand. I try to avoid technical terms when explaining the procedures. In addition, to make them as comfortable as possible it is important to inform the patient they would not be left on their own in the scanning room. For claustrophobic patients it is essential to find techniques to help the patient to comply with the scan, telling them to close their eyes and think of their favourite place and if necessary one member of staff can stay close to the patient during the acquisition of the images; if these techniques do not work, depending the procedure, protocol alterations can be made, for example, turn the head for one side when performing whole body scans or use a tissue paper to prevent the body contouring system coming too close to the patient when imaging head and chest **[A6, A7, A9]**.

Communication with patients and carers should be at appropriate level demonstrating empathy, support and conveying all the relevant information required. If patients suffer from deafness, blindness, age related medical condition, learning difficulties or if their first language is not English, they may have some difficulties in understanding. It is therefore appropriate to provide an explanation of the procedure and aftercare information for inpatients and outpatients to the staff and carers at the ward and home, respectively, in order to alleviate any concerns. For those whose first language is not English an interpreter should be booked for the patient, however, for patients of Portuguese native language I can provide help with the explanation of the procedure if they struggle with English **[A6]**.

This approach builds a relationship based on trust and effective communication with the patients and is essential to perform our role with the expected professionalism. At both departments we have satisfaction questionnaires about “what we did well”, “what we could have done better” and “overall how satisfied were you with your experience today” and apart from theses questionnaires, we also receive a great deal of positive feedback from patients for the help during the procedure. However, it is important to not be involved excessively and keep the information to the minimum to respect confidentiality **[A6, A7]**.

As part of my learning process, I strongly believe the reflective practice is important to improve my skills and also to prevent recurrence of the same mistakes in future situations.

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However, I tend to learn from not only the negatives aspects but also the positives aspects of everyday situations.

These reflective practices include simple actions such as (**Table 8**) **[A9]**:

Table 8 –Examples of reflective practices actions

For patients performing whole body bone scans who have a collecting urine system	**For claustrophobic patients**
This bag should be positioned between patient's lower legs, to avoid overlapping bone structures. Previously I had a patient without mobility in the legs and I could not proceed with the normal protocol. The only solution was to put the collecting system to one of the side of the hip, checking it was not overlapping the hip or femur.	As mentioned previously, use of paper when performing imaging on the face or chest of the patient.

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As part of my reflective practice I would like to include a situation which occurred about 2 years ago, when I still working as a locum. One of my colleagues and I were performing an Indium White Cell Scan on a patient who was receiving oxygen through a nasal cannula from a mobile oxygen cylinder. After the whole body scan we checked the images with one our physicists and SPECT/CT of the chest was required. At the end of the SPECT image the bed moved to perform the CT scan, however, for some unknown reason, the oxygen tube was trapped under the bed of the camera gamma and became wrapped around the patient's neck. To try to help the patient we had to hold the oxygen tube that was around the neck and try to release the part of the tube that was caught under the bed. In order to remove the patient we had to click on the button to unload the camera and bring the bed to the initial position. However, after the bed moved to the initial position, the detectors started rotate. The oxygen cylinder was very near the detectors resulting in a collision between the detectors and the oxygen cylinder. Reflecting on this, even if I know I have to give priority to the patient's needs, I am now more attentive to my surroundings and ensuring the area around the gamma camera is safe. As a direct result of this incident, the department introduced an "exclusion zone" around the camera which had an area of

flooring a different colour from the rest. This is to ensure that nothing is placed within this zone and therefore avoiding a repeat of this type of incident **[A9]**.

These skills acquired when working in a Hospital environment are important not only for the patients but also for the employee's personal improvement and safety. When working in a multidisciplinary team a good relationship and interaction between members of the staff contributes to a good environment as a team and consequently a better service delivery with the best diagnostic quality **[A6, A7]**.

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10. Quality Management System

A Quality Management System (QMS) can be described as "a very powerful business tool, helping to ensure the best results or outcomes are achieved consistently, whether this relates to the organisation itself, an individual task, a process, products or services."[17] A QMS process provides integration of the organisation structure, procedures, processes and resources needed to fulfil a quality policy **[B7]**.

Even though both departments do not have an official QMS accreditation (ISO 9001), theses departments follow an in-house Quality System, which every member of the staff contributes to regularly to improve it. All acquisition protocols, QA procedures, equipment inventory, etc are available in the Q-Pulse (formal QMS - online platform) and electronic folders in a common area of disk. The implementation of our in-house QMS ensures all employees receive applicable training to their daily tasks and duties, ensures all requirements are documented, and updated if necessary, within the system, and produces proof that such requirements have been complied with. It also includes all updated protocols and audits, analyzing and correcting them when necessary which will improve the implemented system **[B7]**.

To guarantee the service delivery is to the maximum quality for our clients and to safeguard the patients and also the staff it is essential to have a QMS. The employment of trained technologists working under current legislation, training and certified protocols is important in order to ensure the correct implementation of a QMS **[B7]**.

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[17] Sentences in quotes extracted from QMS - Management Specialists [redacted] accessed 01/11/2017).

11. Good Scientific Practice

The Good Scientific Practice (GSP) is a document written by Academy of Healthcare Science and sets out the principles and values on which good practice is undertaken by the Healthcare Science Workforce. As a clinical technologist I perform my daily activities complying with GSP to ensure I conduct myself as a better professional at all times and in all aspects of my work. The domains of GSP are **[F1]**:

- Professional Practice (The patient is our first concern and should be treated with good standards of professional practice including ethical and conduct codes with the patients and also with work colleagues and trainees.)
- Scientific Practice (Keep the scientific and technical knowledge up to date to allow the development and investigation of new procedures, provide technical advice to ensure a safe and effective delivery of the services following quality standards.)
- Clinical Practice (Keep the clinical skills up to date and undertake the clinical duties appropriate to our role and understand the importance of them.)
- Research, development and innovation (To help meet all the daily challenges it is important to develop, evaluate, validate and verify new scientific, diagnostic, treatments, technical procedures, etc.)
- Clinical Leadership (Everyone has the right to expect the services are managed efficiently and effectively to meet the services needs.)

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12. Appendices

12.1. Radiopharmacy

12.1.1. Cannulation and Venepuncture certificate

ACUTE SERVICES DIVISION
Practice Development

[redacted]

Certificate of Completion
Cannulation

[redacted] has received education regarding the infection control, health and safety and theoretical aspects of peripheral venous cannulation and has undertaken a period of supervised practice in this skill.

Signed _____ Practice Development Date 2nd June 2017

This certificate confirms 2 hours participatory learning for CPD

Figure 1 - Cannulation Certificate

ACUTE SERVICES DIVISION
Practice Development

Certificate of Completion
Venepuncture

has received education regarding the infection control, health and safety and theoretical aspects of peripheral venepuncture and has undertaken a period of supervised practice in this skill.

Signed Practice Development Date 13th April 2017

This certificate confirms 2 hours participatory learning for CPD

Figure 2 - Venepuncture Certificate

12.1.2. Entitlement Letter

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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Figure 3 - Entitlement Letter – Part 1

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Figure 4 - Entitlement Letter – Part 2

12.1.3. Record of Tc99m daily activities and standing orders

[redacted]

[redacted]

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Figure 5 - Record of Tc^{99m} daily activities and standing orders at [redacted] – Part 1

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Figure 6 - Record of Tc^{99m} daily activities and standing orders at [redacted] – Part 2

12.1.4. Daily Production Data Form

[redacted]

[redacted]

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Figure 7 - Data production form at [redacted]

12.1.5. Tc^{99m} Decay Table

Technetium-99m decay chart (Record/Decay1 : 3.65)

Authorised [illegible] Date 23-03-07

Activity (MBq)	10	40	80	120	160	200	300	500	600	700	800	900	1000	1200	5000
Time (h)															
0	10	40	80	120	160	200	300	500	600	700	800	900	1000	1200	5000
0.5	10.6	42.4	85	127	169	212	318	530	635	741	847	953	1059	1271	5296
1	11.2	44.9	90	135	179	224	337	561	673	785	897	1010	1122	1346	5609
1.5	11.9	47.5	95	143	190	238	356	594	713	832	951	1069	1188	1426	5941
2	12.6	50.3	101	151	201	252	378	629	755	881	1007	1133	1258	1510	6292
2.5	13.3	53.3	107	160	213	267	400	666	800	933	1066	1200	1333	1599	6664
3	14.1	56.5	113	169	226	282	424	706	847	988	1129	1271	1412	1694	7058
3.5	15	59.8	120	179	239	299	449	748	897	1047	1196	1346	1495	1794	7476
4	15.8	63.3	127	190	253	317	475	792	950	1109	1267	1425	1584	1900	7918
4.5	16.8	67.1	134	201	268	335	503	839	1006	1174	1342	1510	1677	2013	8386
5	17.8	71.1	142	213	284	355	533	888	1066	1244	1421	1599	1776	2132	8882
5.5	18.8	75.3	151	226	301	376	564	941	1129	1317	1505	1693	1882	2258	9408
6	19.9	79.7	159	239	319	399	598	996	1196	1395	1594	1794	1993	2391	9964
6.5	21.1	84.4	169	253	338	422	633	1055	1266	1477	1689	1900	2111	2533	10553
7	22.4	89.4	179	268	358	447	671	1118	1341	1565	1788	2012	2236	2683	11178
7.5	23.7	94.7	189	284	379	474	710	1184	1421	1657	1894	2131	2368	2841	11839
8	25.1	100.3	201	301	401	502	752	1254	1505	1755	2006	2257	2508	3009	12539
8.5	26.6	106.2	212	319	425	531	797	1328	1594	1859	2125	2391	2656	3187	13281
9	28.1	112.5	225	338	450	563	844	1407	1688	1969	2251	2532	2813	3376	14066
9.5	29.8	119.2	238	358	477	596	894	1490	1788	2086	2384	2682	2980	3576	14898
10	31.6	126.2	252	379	505	631	947	1578	1894	2209	2525	2840	3156	3787	15779

Figure 8 - Tc^{99m} decay table at [redacted]

12.1.6. Master Dispensing Schedule

MASTER DISPENSING SCHEDULE

NUCLIDE	PRODUCT	No. OF DOSES	ACTIVITY (MBq)	VOL. (ml)	REF. TIME	REF. DATE	USER	GENERATOR No.	KIT No.	CALIBRATOR READING (MBq)	DISPENSED BY	DOSE No.
Te99m	DMSA	1	50.00	2.0	10:00	09/11/17	AYR-NM					229550
Te99m	DMSA	1	50.00	2.0	10:00	09/11/17	GGH-N M					229551
Te99m	DMSA	1	50.00	2.0	10:00	09/11/17	ROYAL-N M	29958		56	[redacted]	229552
Te99m	DMSA	1	80.00	3.0	12:00	09/11/17	AYR-NM	29958		~~105~~		229553
Te99m	DMSA	1	80.00	3.0	12:00	09/11/17	ROYAL-N M	29958		108		229554
Te99m	DMSA	1	80.00	3.0	13:00	09/11/17	GGH-N M					229555
Te99m	PERT	3	3000.00	3.0	10:00	09/11/17	WIG-DISPENSARY	Stock vials				229556
Te99m	PERT	1	50.00	0.5	11:00	09/11/17	AYR-NM					229559
Te99m	PERT	1	50.00	0.5	11:00	09/11/17	GGH-N M					229560
Te99m	PERT	1	50.00	0.5	11:00	09/11/17	ROYAL-N M	29958		62		229561
Te99m	PERT	1	200.00	2.0	12:00	09/11/17	AYR-NM					229562
Te99m	PERT	1	200.00	2.0	12:00	09/11/17	GGH-N M					229563
Te99m	PERT	1	200.00	2.0	12:00	09/11/17	ROYAL-N M	29958		285		229564

RADIOACTIVE Te99m 229558
PERTECHNETATE
INTRAVENOUS INJECTION
3000.00 MBq in 3.0 ml
Ref. Time 10:00 hr on 09/11/2017
Expiry 2 HOURS
POM
WIG RADIOPHARMACY DISP WESTERN INF GLASGOW

MASTER DISPENSING SCHEDULE

NUCLIDE	PRODUCT	No. OF DOSES	ACTIVITY (MBq)	VOL. (ml)	REF. TIME	REF. DATE	USER	GENERATOR No.	KIT No.	CALIBRATOR READING (MBq)	DISPENSED BY	DOSE No.
Te99m	MDP	1	200.00	3.0	11:00	09/11/17	AYR-NM					229565
Te99m	MDP	1	200.00	3.0	11:00	09/11/17	GGH-N M					229566
Te99m	MDP	1	200.00	3.0	12:00	09/11/17	ROYAL-N M	29958		301	[redacted]	229567
Te99m	MDP	1	200.00	3.0	13:00	09/11/17	AYR-NM					229568
Te99m	MDP	1	200.00	3.0	13:00	09/11/17	GGH-N M					229569
Te99m	MDP	1	200.00	3.0	13:00	09/11/17	ROYAL-N M	29958		318		229570

Figure 9 - Master Dispensing Schedule at [redacted]

12.1.7. Master Dispensing Schedule Checked

MASTER DISPENSING SCHEDULE

NUCLIDE	PRODUCT	No. OF DOSES	ACTIVITY (MBq)	VOL. (ml)	REF. TIME	REF. DATE	USER	AT TIME OF CHECKING: TIME	CALIBRATOR READING (MBq)	CHECKED BY	DOSE No.
Tc99m	DMSA	1	50.00	2.0	10:00	09/11/17	AYR-NM	9.42		[redacted]	229550
Tc99m	DMSA	1	50.00	2.0	10:00	09/11/17	GGH-NM				229551
Tc99m	DMSA	1	50.00	2.0	10:00	09/11/17	ROYAL-NM	9.42	517.		229552
Tc99m	DMSA	1	80.00	3.0	12:00	09/11/17	AYR-NM				229553
Tc99m	DMSA	1	80.00	3.0	12:00	09/11/17	ROYAL-NM	9.43	101		229554
Tc99m	DMSA	1	80.00	3.0	13:00	09/11/17	GGH-NM				229555
Tc99m	PERT	3	300.00	3.0	10:00	09/11/17	WIG-DISPENSARY	Stock vials			229556
Tc99m	PERT	1	50.00	0.5	11:00	09/11/17	AYR-NM				229559
Tc99m	PERT	1	50.00	0.5	11:00	09/11/17	GGH-NM				229560
Tc99m	PERT	1	50.00	0.5	11:00	09/11/17	ROYAL-NM	9.44	58		229561
Tc99m	PERT	1	200.00	2.0	12:00	09/11/17	AYR-NM				229562
Tc99m	PERT	1	200.00	2.0	12:00	09/11/17	GGH-NM				229563
Tc99m	PERT	1	200.00	2.0	12:00	09/11/17	ROYAL-NM	9.45	274.	[redacted]	229564

RADIOACTIVE Tc99m 229554
DMSA
INTRAVENOUS INJECTION
80.00 MBq in 3.0 ml
Ref. Time 12:00 hr on 09/11/2017
Expiry 2 HOURS
POM
W of S RADIOPHARMACEUTICAL DISP WESTERN INFIRMARY

RADIOACTIVE Tc99m 229564
PERTECHNETATE
INTRAVENOUS INJECTION
200.00 MBq in 2.0 ml
Ref. Time 12:00 hr on 09/11/2017
Expiry 2 HOURS
POM
W of S RADIOPHARMACEUTICAL DISP WESTERN INFIRMARY

RADIOACTIVE Tc99m 229552
DMSA
INTRAVENOUS INJECTION
50.00 MBq in 2.0 ml
Ref. Time 10:00 hr on 09/11/2017
Expiry 2 HOURS
POM
W of S RADIOPHARMACEUTICAL DISP WESTERN INFIRMARY

RADIOACTIVE Tc99m 229561
PERTECHNETATE
INTRAVENOUS INJECTION
50.00 MBq in 0.5 ml
Ref. Time 11:00 hr on 09/11/2017
Expiry 2 HOURS
POM
W of S RADIOPHARMACEUTICAL DISP WESTERN INFIRMARY

MASTER DISPENSING SCHEDULE

NUCLIDE	PRODUCT	No. OF DOSES	ACTIVITY (MBq)	VOL. (ml)	REF. TIME	REF. DATE	USER	AT TIME OF CHECKING: TIME	CALIBRATOR READING (MBq)	CHECKED BY	DOSE No.
Tc99m	MDP	1	200.00	3.0	11:00	09/11/17	AYR-NM				229565
Tc99m	MDP	1	200.00	3.0	11:00	09/11/17	GGH-NM			[redacted]	229566
Tc99m	MDP	1	200.00	3.0	12:00	09/11/17	ROYAL-NM	9.46	283		229567
Tc99m	MDP	1	200.00	3.0	13:00	09/11/17	AYR-NM				229568
Tc99m	MDP	1	200.00	3.0	13:00	09/11/17	GGH-NM				229569
Tc99m	MDP	1	200.00	3.0	13:00	09/11/17	ROYAL-NM	9.47	299		229570

OTHER Tc99m 229567
METHYL DIPHOSPHONATE
INTRAVENOUS INJECTION
200.00 MBq in 3.0 ml
Ref. Time 12:00 hr on 09/11/2017
Expiry 2 HOURS
POM
W of S RADIOPHARMACEUTICAL DISP WESTERN INFIRMARY

RADIOACTIVE Tc99m 229570
METHYL DIPHOSPHONATE
INTRAVENOUS INJECTION
200.00 MBq in 3.0 ml
Ref. Time 13:00 hr on 09/11/2017
Expiry 2 HOURS
POM
W of S RADIOPHARMACEUTICAL DISP WESTERN INFIRMARY

Figure 10 - Master Dispensing Schedule Checked at [redacted]

12.1.8. Consignor Certificate for delivery of packages

[redacted]

[redacted]

SAMPLE PORTFOLIO

[redacted]

Figure 11 - Consignor certificate for delivery of packages

12.1.9. Radiochemical Purity

Figure 12 - Example of Tc^{99m}-DMSA radiochemical purity at [redacted]

12.1.10. Labels for transport

Figure 13 - Labels used for transport

SAMPLE PORTFOLIO

12.1.11. Daily Clean Form (Dispensary - [redacted])

SAMPLE PORTFOLIO

Figure 14 - Dispensary daily clean form at [redacted]

12.1.12. Contamination Monitoring Form

[redacted]

SAMPLE PORTFOLIO

Figure 15 - Contamination monitoring form at [redacted] – Part 1

[redacted]

[redacted]

SAMPLE PORTFOLIO

Figure 16 - Contamination monitoring form at [redacted] – Part 2

12.2. Imaging Acquisition and non-imaging equipment

12.2.1. Competencies Form

[redacted]

[redacted]

[redacted]

SAMPLE PORTFOLIO

[redacted]

[redacted]

Figure 17 - Competency assessment form – Part 1

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

SAMPLE PORTFOLIO

Figure 18 - Competency assessment form – Part 2

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

SAMPLE PORTFOLI

Figure 19 - Competency assessment form – Part 3

SAMPLE PORTFOLIO

Figure 20 - Competency assessment form – Part 4

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

SAMPLE PORTFOLIO

Figure 21 - Competency assessment form – Part 5

12.3. Equipment Management System

12.3.1. Equipment Inventory System

Table 9 - Equipment Inventory System at [redacted]

Equipment	Name of manufacturer	Model	Serial number	Year of manufacture	Year of installation
Gamma camera	GE	Optima 640	00162NUC11 HP 6600, 6601,6602	2013	2013
Gamma camera	Siemens	Symbia T	NMS0011919 HP 009608	2007	2007
Bone Densitometer	Hologics	Horizon A QDR series	HP xxxx 200846	2016	2016
Isotope calibrator	Capintec	CRC-25R	253213	2015	2015
Sample counter	Wizard 3”	1480	4800615	2007	2007
Centrifuge	MSE	Centaur 2	MSE MO 627	2013	2013
Smartvent Generator	Diagnostic Imaging	Smartvent		2005	2005
Amercare cabinet	Amercare		A1115	2016	2016
Isotope calibrator	Capintec In Amercare	CRC-25R	253373	2015	2016
Computing System	GE	Xeleris	C2C2300DCZ	2013	2013
Computing System	Nuclear Diagnostics	Hermes	-	2005 Updated 2015	2005
Radiation Monitor	Tracerco	PED Blue		2015	2015
Radiation Monitor (Wall mounted)	Berthold	LB124	HP 6899	2014	2014
Radiation Monitor (wall	Berthold	LB123	6578	2007	2007

SAMPLE PORTFOLIO

mounted)					
Radiation Monitor (wall mounted)	Berthold	LB123	6578	2007	2007
Radiation Monitor (wall mounted)	Berthold	LB123	6578	2007	2007
Radiation Monitor	HandHound	RadHound	HP 5395	2012	2012
Radiation Monitor (wall mounted)	Berthold	LB123	6578	2007	2007
Radiation Monitor	Mini Instruments	900	5273 HP 5383	2011	2011
Dose Rate Meter	SmartIon		L000762	1997	1997
Theatre Probe	Navigator GPS	GPS	200412003	2004	2004
Theatre Probe	NeoProbe	2000	073864228 Probe: 110-02149	2007	2007
Laser printer	Xerox	Phaser 8550	WYP146165	2007	2007
Technegas Generator	Imaging Equipment Ltd		TP 093602	2011	2011
Uptake counter	Ortec	Digibase NAI(Tl) detector	13066788 60013-01299-I	2013	2013
Water Bath	Grant		80916	unknown	unknown

SAMPLE PORTFOLIO

12.3.2. Extrinsic Uniformity

Weekly floods should be acquired following instructions given in the SOP. Each collimator is checked approx every 3 weeks.

All weekly floods should be processed on Hermes system using HQUAL programme.

A 90% square flood FOV should be used and the UFOV values recorded

LEHR

	Head 1 Limits				Head 2 Limits			
	SD %	Unif Index	Int Unif	Diff Unif	SD %	Unif Index	Int Unif	Diff Unif
Lower	0.953	0.767	2.046	1.038	0.709	0.534	2.136	1.328
Upper	1.609	1.509	4.082	2.376	2.414	2.352	4.691	2.347

Date Acquired	Operator	Head 1 Results					Head 2 Results				
		Cnts/Pix	SD %	Unif Index	Int Unif	Diff Unif	Cnts/Pix	SD %	Unif Index	Int Unif	Diff Unif
05/01/2017	DT	29785	1.329	1.196	3.036	1.493	31395	1.447	1.332	3.584	1.939
17/01/2017	CR/AS	29781	1.38	1.252	3.22	1.58	31520	1.486	1.375	3.594	1.797
06/02/2017	AS	26257	1.463	1.327	3.849	1.885	23525	2 211	2.113	5.81	2.659
01/03/2017	BM/AS	33098	1.364	1.248	3.4	1.981	30162	2 255	2.181	5.734	2.467
27/03/2017	RSM	32063	1.418	1.303	3.693	1.621	30124	1.791	1.696	4.836	2.877
11/04/2017	CR	31749	1.268	1.138	2.776	1.953	30346	1 239	1.098	2.424	1.805
05/05/2017	AS	31201	1.441	1.325	3.89	1.675	30105	1.646	1.542	3.993	2.196
23/05/2017	AS	30802	1.433	1.315	3.818	1.652	30084	1.624	1.518	4.144	2.285
13/06/2017	AS	30595	1.399	1.277	3.861	1.688	30065	1.605	1.497	4.218	2.281
26/06/2017	GA-McL	30356	1.437	1.317	4.029	1.58	30058	1.626	1.52	4.557	2.019
04/07/2017	CR	30262	1.406	1.283	3.832	1.719	30045	1 578	1.468	4.153	2.031
17/07/2017	AS	30123	1.409	1.286	3.828	1.578	30048	1 535	1.422	3.987	2.066
28/08/2017	AL	29765	1.445	1.323	3.66	1.508	30057	1 534	1.422	4.288	2.128
18/09/2017	RSM/AS	29799	1.332	1.2	3.143	1.892	30030	1.58	1.471	4.507	2.15
09/10/2017	AS	29744	1.301	1.165	3.042	1.726	30159	1 557	1.446	4.481	2.086

LEAP

	Head 1 Limits				Head 2 Limits			
	SD %	Unif Index	Int Unif	Diff Unif	SD %	Unif Index	Int Unif	Diff Unif
Lower	1.152	1.026	2.171	1 371	1 399	1.296	2.442	1.590
Upper	1.400	1.298	3.620	2 267	1.631	1.544	4.441	2.890

Date Acquired	Operator	Head 1 Results					Head 2 Results				
		Cnts/Pix	SD %	Unif Index	Int Unif	Diff Unif	Cnts/Pix	SD %	Unif Index	Int Unif	Diff Unif
10/01/2017	AS	35936	1.307	1.196	2.819	1 857	35912	1.454	1.355	3.1	2.145
02/02/2017	CR	35987	1.356	1.25	2.675	1 906	35925	1 388	1.284	2.804	1.981
21/02/2017	AS	36081	1.43	1.33	3.212	1 582	36059	1.625	1.538	3.446	2.274
13/03/2017	RSM	36096	1.35	1.243	3.099	1 547	36050	1.68	1.595	3.554	2.538
04/04/2017	AS	36076	1.4	1.297	2.825	1.452	36032	1 598	1.508	3.16	2.353
04/05/2017	BM	35961	1.355	1.249	2.678	1.619	36025	1.455	1.356	3.19	2.329
18/05/2017	CR	35963	1.265	1.15	2.131	1.484	36303	1.621	1.534	3.351	2.616
06/06/2017	Dw/BM	35904	1.231	1.112	2.315	1 347	36183	1 568	1.478	3.251	2.376
10/07/2017	RSM	35898	1.285	1.171	2.388	1.436	36080	1 398	1.295	2.684	1.969
21/08/2017	DW/AS	36281	1.293	1.182	2.612	1.628	36008	1 553	1.461	3.49	2 38
11/09/2017	AS	35930	1.465	1.367	3.42	1 594	36223	1 523	1.43	3.184	2.095
10/10/2017	CR										
16/11/2017	RSM/AS	36010	1.447	1.347	2.709	1.779	36007	1.437	1.337	3.272	1.853
07/12/2017	AS	35940	1.495	1.399	2.985	1.761	36033	1.4	1.297	2.917	1.814
28/12/2017	bm	35913	1.533	1.44	3.339	1 828	36048	1.36	1.254	2.833	1.937

Figure 23 - Record of weekly extrinsic uniformity (LEAP collimators) for *Siemens Symbia T* at [redacted]

12.3.3. Co^{57} Flood and CT Check Up

A Co 57 flood and a CT warm up should be performed daily.

When performing these tests please follow the manufacturers procedures.

Once a test is performed please put your initials in the box to show system is acceptable for use.

Week Commencing	Co57 Flood					CT Warm Up					Comments
	Mon	Tues	Wed	Thurs	Fri	Mon	Tues	Wed	Thurs	Fri	
02/01/2017	n/a	n/a	AS	AS	AS	n/a	n/a	AS	AS	AS	
09/01/2017	AS	AS	AS	AS	AS	AS	AS	AS	AS/CR	AS	
16/01/2017	AS	AS	AS	AS	AS	AS	AS	BM	BM	BM	
23/01/2017	AS	AS	AS	AS	AS	AS	AS	AS	AS	BM	
30/01/2017	AS	AS	AS	AS	AS	CR	CR	CR	CR	CR	
06/02/2017	AS	AS	AS	AS	AS	CR	CR	CR	CR	CR	
13/02/2017	AS	AS	dw	dw	dw	AS	AS	dw	dw	dw	
20/02/2017	AS	AS	AS	AS	AS	AS	AS	AS	BM	BM	
27/02/2017	AS	*	JG	AS	BM	AS	*	BM	BM	BM	Siemens engineer in all day - service
06/03/2017	AS	DW	DW	JG	JG		RSM	RSM	BM	BM	
13/03/2017	AS	AS	AS	AS	AS	RSM	CR	CR/BM	CR	CR	
20/03/2017	AS	AS	AS	AS	JG	RSM	CR	CR	BM	BM	
27/03/2017	AS	AS	AS	AS	AS	AS	AS	AS	CR	CR	
03/04/2017	AS	AS	AS	AS	AS	AS	*	*	*	AS	*ct not working
10/04/2017	DW	RSM	AS	DW	PH	RSM	RSM	DW	CR	PH	t
17/04/2017	PH	AS	*	*	*	PH	RSM	*	*	*	*Siemens carrying out head
24/04/2017	*	*	*	*	*	*	*	*	*	*	*Siemens carrying out head
01/05/2017	*	**	AS	AS	AS	*	**	BM	BM	GEServ	** Accept Test
08/05/2017	AS	AS	AS	DW	AS	AS	AS	AS	CR	CR	
15/05/2017	AS	AS	AS	AS	AS	AS	AS	CR	AS	AS	
22/05/2017	AS	AS	AS	AS	*	RSM	RSM	DW	BM	*	* Not in Use due to error
29/05/2017	*	*	*	AS	AS	*	*	*	BM	BM	* Not in use due to fault
05/06/2017	AS	AS	AS	AS	AS	DW	DW	Dw	DW	DW	
12/06/2017	SERVICE	AS	AS	AS	AS	SERVICE	RSM	CR	Cr	BM	
19/06/2017	AS	AS	DW	AS	As	RSM	CR	CR	Cr	CR	
26/06/2017	AS	AS	AS	*	*	CR	CR	CR	*	*	* Not in use to to Fault
03/07/2017	*	*	CR	FH	FH	*	*	FH	FH*	FH*	* Siemens Engineer in
10/07/2017	CR	CR	CR	CR		RSM	RSM	BM	BM		
17/07/2017	*	AS	FH	AS	AS	*	FH	FH	CR	CR	* Siemens Engineer in
24/07/2017	CP	*	*	*	*	FH	*	*	*	*	* Siemens Engineer in
31/07/2017	*	*	*	*	CR	*	*	*	*	CR	* Siemens Engineer in
07/08/2017	DW	AS	AS	DW	FH	DW	AS	AS	DW	FH	
14/08/2017	FH	AS	AS	DW	DW	RSM	RSM	BM	BM	BM	
21/08/2017	DW	DW	AS	AS	AS	RSM	RSM	RSM	BM	BM	
28/08/2017	AS	AS	AS	AS	AS	AS	CR	CR	DW	CR	
04/09/2017	AS	AS	AS	AS	DF	AS	AS	DW/CR	AS	AS	
11/09/2017	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	
18/09/2017	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	
25/09/2017	PH	*	as	as	as**	*	*	*	*	**	* Ct Broken ** Engineer In
02/10/2017	AS	*	DW	DW	AS	CR	*	RSM	BM	BM	*Seimens Engineer
09/10/2017	AS	AS	AS	AS	CR	CR	CR	CR	DW	CR	
16/10/2017	AS	AS	AS	AS		CR	FH	RSM	CR		
23/10/2017	AS	FH	AS	AS	AS	AS	FH	FH	FH	AS	
30/10/2017	AS	AS	AS	AS	AS	AS	AS	FH	AS	AS	
06/11/2017	AS	AS	AS	AS	AS	RSM	RSM	BM	BM	BM	
13/11/2017	AS	FH				RSM	RSM				
20/11/2017	AS	AS	AS	JG	CR	CR	FH	AS	CR	CR	
27/11/2017	AS	AS	AS	AS	AS	CR	FH	RSM	BM	CR	
04/12/2017	AS	AS	n/a	AS	AS	AS	AS	n/a	AS	AS	
11/12/2017	CR	AS	DW	AS	AS	AS	AS	AS	AS	AS	
18/12/2017	AS	FH	DW	AS	DW	RSM	DW	BM	BM	BM	
25/12/2017			DW	BM	DW			BM/DW	BM	BM	

Colour Key	
Red	No entry in book
Yellow	Entry but no initials

Figure 24 - Record of Daily $C0^{57}$ flood and CT check up for *Siemens Symbia T* at [redacted]

12.3.4. COR Alignment[redacted]

The COR 180° test should be performed on a weekly basis. The COR 90° test should additionally be performed for the LEHR collimator

Analysis should be performed using the Hermes COR Application for 180° and the in-house COR analysis for 90°

Follow the procedure for acquisition and processing as stated in the SOP

LEHR

	LEHR 180° Limits					LEHR 90° Limits				
	COR offset (pixels)	COR offset (mm)	ChiSquare	SD Y Offset (pixels)	Pixel Size	X COR Offset	X Std Dev	X Chi-Squared	Y Std Dev	Y Chi-Squared
Lower Limit	-0.11	-1.00	0.31	-0.11	8.84	-0.50	-0.12	-5.87	0.02	-0.76
Upper Limit	0.11	1.00	0.63	0.11	8.84	0.40	0.40	11.13	0.18	3.46

Limits set as of 18/03/2017 by [redacted] If values are outwith tolerance please le[redacted] know.

Date Acquired	Operator	LEHR 180° Results					LEHR 90° Results				
		COR offset (pixels)	COR offset (mm)	ChiSquare	SD Y Offset (pixels)	Pixel Size	X COR Offset	X Std Dev	X Chi-Squared	Y Std Dev	Y Chi-Squared
16/01/2017	CR/AS	0.009	0.080	0.724	0.080	8.839	0.020	0.110	0.507	0.083	0.763
10/02/2017	AS	0.016	0.140	0.472	0.072	8.839	0.068	0.070	1.145	0.102	0.517
11/04/2017	CR	0.004	0.033	0.604	0.088	8.839					
05/05/2017	AS	0.021	0.183	0.400	0.039	8.839	0.100	0.104	1.276	0.071	0.433
12/05/2017	BM	0.017	0.149	0.063	0.052	8.839					
22/05/2017	CR/AS	0.002	0.015	0.514	0.025	8.839	-0.125	0.196	2.344	0.101	2.039
13/06/2017	AS	0.017	0.155	0.353	0.042	8.839					
04/07/2017	CR	0.006	0.056	0.525	0.046	8.839	0.087	0.070	0.775	0.083	0.900
17/07/2017	AS	0.006	0.049	0.404	0.039	8.839					
29/08/2017	AS	0.016	0.142	0.445	0.020	8.839	0.101	0.173	4.675	0.088	0.462
19/09/2017	RSM/AS	0.035	0.307	0.232	0.053	8.839	0.101	0.084	0.805	0.059	1.285
09/10/2017	AS	0.018	0.157	0.433	0.016	8.839	-0.003	0.081	0.970	0.071	1.329
03/11/2017	BM/AS	-0.003	-0.029	0.362	0.053	8.839					
20/11/2017	AS/Bm	0.019	0.164	0.438	0.071	8.839					

MEGP

	MEGP Limits				
	COR offset (pixels)	COR offset (mm)	ChiSquare	SD Y Offset (pixels)	Pixel Size
Lower Limit	-0.11	-1.00	0.06	-0.11	8.84
Upper Limit	0.11	1.00	0.44	0.11	8.84

Limits set as of 18/03/2017 by [redacted] If values are outwith tolerance please let [redacted] know.

Date Acquired	Operator	MEGP Results				
		COR offset (pixels)	COR offset (mm)	ChiSquare	SD Y Offset (pixels)	Pixel Size
11/01/2017	BAJ/HJW	0.029	0.256	0.141	0.034	8.839
01/02/2017	AS	0.003	0.025	0.193	0.036	8.839
22/02/2017	CR	0.015	0.131	0.224	0.030	8.839
14/03/2017	BM	0.001	0.012	0.199	0.033	8.839
24/03/2017	BM	0.018	0.161	0.263	0.064	8.839
27/04/2017	CR	-0.005	-0.046	0.373	0.092	8.839
19/05/2017	BM	-0.001	-0.008	0.156	0.055	8.839
05/06/2017	AS	0.005	0.047	0.168	0.045	8.839
13/07/2017	CR	0.017	0.155	0.353	0.042	8.839
02/08/2017	AS	0.000	0.004	0.086	0.048	8.839
15/09/2017	CR	-0.006	-0.052	0.287	0.046	8.839
16/11/2017	CR/AS	0.024	0.208	0.348	0.042	8.839
30/11/2017	As					
07/12/2017	BM	-0.022	-0.191	0.212	0.026	8.839

ELEGP

	ELEGP Limits				
	COR offset	COR offset	ChiSquare	SD Y Offset	Pixel Size
Lower Limit	-0.11	-1.00	-1.59	-0.11	8.84
Upper Limit	0.11	1.00	2.42	0.11	8.84

Limits set as of 18/03/2017 by [redacted] If values are outwith tolerance please let [redacted] know.

Date Acquired	Operator	ELEGP Results				
		COR offset (pixels)	COR offset (mm)	ChiSquare	SD Y Offset (pixels)	Pixel Size
06/01/2017	CR	0.017	0.146	0.339	0.043	8.839
25/01/2017	AS	0.013	0.118	0.299	0.053	8.839
14/02/2017	CR	0.036	0.319	0.248	0.061	8.839
09/03/2017	CR/AS	0.004	0.035	0.369	0.061	8.839
20/04/2017	CR/AS	-0.006	-0.050	0.310	0.079	8.839
29/05/2017	CR/AS	-0.002	-0.021	0.250	0.058	8.839
19/06/2017	RSM	-0.025	-0.219	0.093	0.037	8.839
08/09/2017	AS	0.005	0.047	0.150	0.039	8.839
29/09/2017	CR/AS	-0.003	-0.026	0.279	0.076	8.839
16/10/2017	AS/BM	0.047	0.416	0.087	0.040	8.839
10/11/2017	CR/AS	0.013	0.111	0.222	0.085	8.839
23/11/2017	DW	0.000	0.002	0.209	0.067	8.839
30/11/2017	AS	0.010	0.084	0.155	0.029	8.839

Figure 25 - Record of weekly COR for *GE Optima 640* at [redacted]

12.3.5. Weekly Checks dose calibrator [redacted]

[redacted]

SAMPLE PORTFOLIO

[redacted]

Figure 26 - Record of weekly dose calibrator QC at [redacted]

12.4. Legislation and Radiation Control

12.4.1. **Protocol** used In the event of a Radiation Accident and/or Spill

In all accidents involving radioactive materials the radiation protection supervisor must be informed as soon as possible.

In the event of a spill of radioactive materials, the order of priorities is as follows:

1. Protection of other personnel
2. Confinement of contamination
3. Decontamination of personnel
4. Decontamination of the area involved.

All non-contaminated staff should be evacuated and re-entry forbidden. These persons should inform the RPS regarding the incident. The RPA should also be informed where the count-rate cannot be reduced below the action levels given on the calibration certificate for the contamination monitor.

With respect to the NMD, there are two categories of spillage:

For *serious spillage* which involve the breakage of a dose vial containing either therapeutic or diagnostic radionuclide. In this case the area should be cleared of staff not directly involved and personnel checked for contamination. The RPS and senior scientific staff should be contacted **immediately**.

For smaller *spills including drips etc*, the spillage should be contained and personnel checked for contamination. If contamination is found, procedures for removing it should be instituted immediately. The spillage should be cleaned up utilising protective clothing and possibly remote handling tools. Waste materials should be double-bagged and placed in the storage area for radioactive waste. Any areas of floor or bench still contaminated after cleaning procedures should be covered with Benchcote secured with radioactive warning tape. The RPS should be informed.

Decontamination procedures

- Hands and other skin areas: - Wash thoroughly with soap and water. Do not use detergents, abrasive materials etc. Take great care not to injure the skin. Even if contamination has not been sufficiently reduced, do not proceed to the stage of breaking the skin.

SAMPLE PORTFOLIO

- Eyes, cuts: - Irrigate with water, but take great care to prevent the spread of contamination to or from other areas.
- Clothing: - Contaminated garments should be removed immediately and placed in a sealed container. They should not be removed from the room until the contamination has been monitored.
- Working surface: - The surplus liquid should be mopped up with absorbent tissues, and then the area washed with detergent and water. Place all contaminated materials in a separate sealed container and keep till monitored. Entry to the area must be restricted until monitoring has been carried out and the radiation level has been assessed. The radiation protection supervisor will arrange monitoring.

SAMPLE PORTFOLIO

12.4.2. Leak Test Sealed Sources

31/08/2017 - recount of same samples

RACK #	Sample #	Source Number	Counts (600s)	BKG Corr	Counts per second
1	BKG	1	1523	1519	0.0
			1542	23	
	BKG	3	1537		0.1
			1566	47	
	BKG	4	1550		0.1
			1567	48	
	BKG	5	1526		0.0
			1540	21	
	BKG	6-1	1459		0.0
			1529	10	
2	BKG	6-2	1508	1509	0.0
			1488	-21	
		6-3	1520	12	0.0
	BKG	7-1	1510		0.0
			1521	13	
		7-2	1450	-59	-0.1
			1524	16	0.0
		7-3	1531		
	BKG	8	1528	20	0.0
	BKG		1485		
3	BKG	9	1511	1517	-0.1
			1429	-88	
	BKG	10-1	1555		0.0
			1517	0	
		10-2	1557	40	0.1
		10-3	1488	-29	0.0
	BKG	11-1	1486		0.0
			1567	50	0.1
		11-2	1488	-29	0.0
		11-3	1499	-18	0.0
4	BKG	21	1503	1530	-0.1
			1496	-34	
	BKG	2-1	1523		0.1
			1562	32	
		2-2	1545	15	0.0
		2-3	1518	-12	0.0
		2-4	1542	12	0.0
		2-5	1532	2	0.0
		2-6	1447	-83	-0.1
	BKG		1563		
5	BKG	2-7	1488	1485	0.0
			1491	7	
		2-8	1497	13	0.0
		2-9	1493	9	0.0
	BKG		1481		

BKG Ave	1514.06	
ST Dev	28.61	
(+/)2*SD	57.23	

*Counts outwith 2xSt Dev

Previously high samples

Flood positions

Top Edge

1st Q	2nd Q	Rt Edge
3rd Q	4th Q	sticker

Q1-4: sticker side
Q5-8: reverse side
Q9 = edges

Source Nb	Isotope	Activity*	Description
1	Cs137	8.1 MBq	Vial
2	Co57	740 MBq	Flood
3	Cs137	0.7 kBq	Sample tube
4	Sr90	0.09 kBq	Mini plate
5	I-129	0.982 kBq	Sample tube
6-1	Co57	4.4 kBq	old pen (in box) - body
6-2			old pen (in box) - lid
6-3			old pen (in box) - tip
7-1	Co57	38 kBq	old pen (red body) - body
7-2			old pen (red body) - lid
7-3			old pen (red body) - tip
8	Sr90	100 Bq	Larger plate
9	Co57	57 kBq	Point Source
10-1	Co57	3.7 MBq	pen - body
10-2			pen - lid
10-3			pen - tip
11-1	Co57	3.7 MBq	new pen - body
11-2			new pen - lid
11-3			new pen - tip
12	Co57	15 MBq	L-marker

*As last measured or as referenced

Notes on Wipe Test Results

Notes: Under IRR99 Regulation 27, there is a statutory requirement to leak test all sealed sources at least once every two years.
The wipe test is most widely used and removed activity should not exceed 185Bq (specification is British Standard BS 5288 1976, Appendix D)

Procedure: Using a MediSwab, an approriate area of the surface should be wiped (note that to measure the exact level of contamination, allowance must be made for only a proportion of the leakage being removed by the swab (~10%). Therefore all samples should measure under 19Bq.

Pass/Fail criteria: anything >19cps above background warrants further investigation

SAMPLE PORTFOLIO

Figure 27 - Record of leak test sealed sources results at [redacted]

12.4.3. Consignor Note to Return Packages

[redacted] [redacted]

SAMPLE PORTFOLIO

[redacted]

C [redacted]

Figure 28 - Consignor note to return Krypton Generator

[redacted]

[redacted]

[redacted]

[redacted]

SAMPLE PORTFOLIO

[redacted]

Figure 29 - Consignor note to return tins and drums with empty lead pots

12.5. Clinical Audit - BSLN

This aim of this audit was to determinate the reasons for the discrepancy between the results from both sites for successful visualisation of the BSLN, comparing demographics, clinical status and imaging outcome of patients imaged at [redacted] and imaging outcomes at both sites against EANM/BNMS standards[18]. The CRIS reports and minimum of 60 images were reviewed for this audit. The data for the audit was recorded in 2015 in 30 patients per site (total of 60 patients) and all patients are females. Investigation of results found that Sentinel Node (SLN) were only visualised in approximately 80% of the patients at [redacted] whilst SLN were visualised in approximately 94% of patients attending at [redacted] which means the results at the [redacted] were falling short of this target.

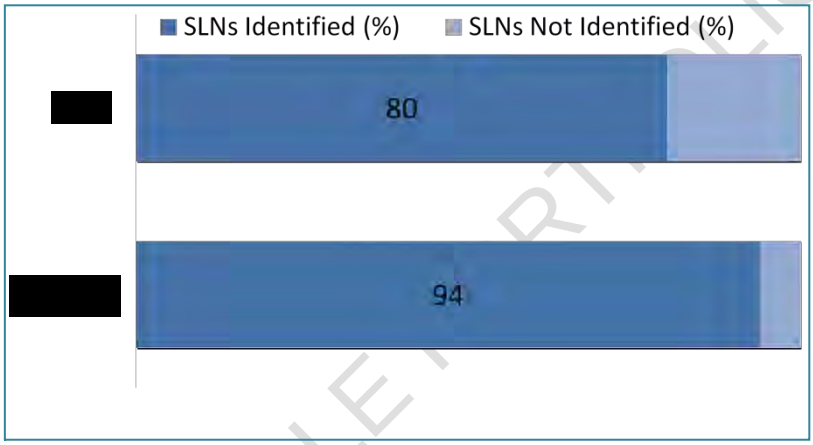

Figure 30 - Results of SLN identified and not identified between [redacted]

In order to determine why the [redacted] site was not hitting the 95% target, all literature for SLN imaging and imaging technique at each site was investigated. Initially demographics and clinical history of the patients (age of patients, tumour stage, date of imaging)[19] and procedure performed (SACH only performs day surgery and [redacted] more complex cases) were investigated and compared.

The reviewed literature recommend to acquire an anterior image (patient in supine), lateral image (patient on side) and anterior oblique image (patient propped at 45 degrees). The images must be acquired at 15-30 minutes pos injection and at 1 & 2-4 hours as

[18] EANM/BNMS Standards – SLNs should be identified in 95% of patients and 20-30% of SLNs should contain metastatic cells.

[19] To determine whether the two groups were significantly different.

required for 3-5 minutes (256 x 256 matrix). The Co^{57} flood must be used underneath the patient to provide outline. However the procedures used at both sides are slightly different if compared with the literature recommendations.

Table 10 - Differences between [redacted]

	[redacted]	[redacted]
Radiopharmaceutical	Tc^{99m} - Nanocolloid	
Activity	20 MBq if surgery is on the same day or 40MB if surgery is on the next day	
Time of acquisition	20 minutes after injection	
Images acquired	Anterior and Lateral statics views for 5 minutes per view. 256 x 256 matrix	
Patient positioning	Patient imaged lying supine on bed **Anterior Image** – arm is out to side **Lateral Image** – arm is above head	Patient imaged in standing position **Anterior image** – arm is angled (hand on hip) **Lateral Image** – arm is above head
	Masking of the injection site as required	
	Patients outline produced using a cobalt flood	

SAMPLE PORTFOLIO

There are differences in the imaging method used across sites. The reason for this is because [redacted] patients attend as a group, typically with 3 patients, all due to go for pre-surgery preparation then straight to theatre. For this reason, it is important that the scanning for all patients is performed within an hour. If no nodes are seen, patient is sent back to the waiting area to allow more time for uptake, whilst another patient is taken into the camera room to start the scan, therefore having the patient standing aides this process. Initially, the difference in the results could be due to patient positioning with those at [redacted] having breast tissue overlying any SLN and the scanning was not being extended if no SLN observed.

In the next step, a review was performed to analyse if the difference could be down to frequency of performing the study and staff experience. At [redacted] the BSLN procedures were

performed up to 6 per week, consequently when performing so frequently and going straight to surgery we will be aware very quickly if it is a problem with technique. However, at [redacted] the BSLN procedures were typically performed once a week and for that reason it could take longer to notice a problem.

Table 11 - Frequency of BSLN procedures at both sides

	[redacted]	[redacted]
Date of Imaging	23/06/15 – 14/08/15	06/03/13 – 23/02/15
Number of Patients	30	30
Age Range (Mean)	41-79 (59.4)	31-79 (54.2)

Regarding the investigation of patients groups no significant differences between the groups was found. Nodes positive for metastatic cells were seen in 30% of patients at [redacted] and 18.8% of patients at [redacted][20] and no significant difference in tumour stage or grade between the two patients groups.

Table 12 - Comparation of different procedures at both departments

Procedure	[redacted]	[redacted]
Wide Local Excision & SLN Biopsy	6 (20%)	28 (88%)
Mastectomy & SLN Biopsy	24 (80%)	3 (9%)
SLN Biopsy	0 (0%)	1 (3%)

Based on investigation results, the scanning procedures were changed at [redacted] to ensure all images checked prior to patient leaving the department. If no nodes seen the next steps would be followed:

- Establish if masked/unmasked images are required;
- Remove cobalt flood and acquire image;
- Consider delayed imaging.

The new changes were implemented and both departments decided to re-audit in the follow year.

[20] BNMS referred 20-30% of SLNs should contain metastatic disease.

SAMPLE PORTFOLIO

In May of 2016, the staff at [redacted] raised on-going issues with imaging of BSLN so a further review of imaging was performed and it was decided that staff should scan for longer without the cobalt flood. However, in August regarding a patient with no uptake and poor counts a review of injection technique for SLN was performed. The results showed that some staff were not using all the volume in syringe due to back-pressure. As a result size of injection needle was changed from orange (25G, 0.5 mm) to a diabetic needle and syringe (29G, 0.33mm) and staff were encouraged to use the entire volume in syringe.

In 2017, 38 patients' images (all patients were females and the scans date from May 2016 to May 2017) and CRIS reports were reviewed at [redacted] to investigate if there was any improvement in the results. As can be observed in the graph, [redacted] had a huge improvement in the results with the changes referred before.

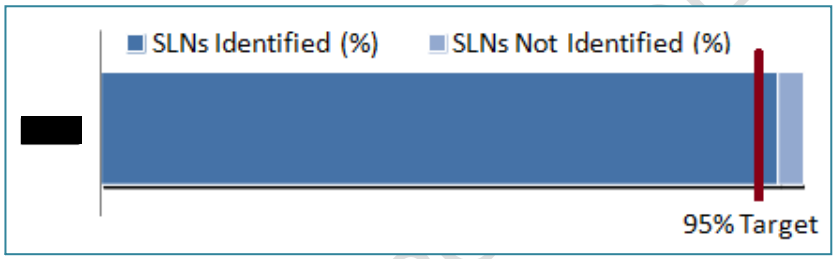

Figure 31 - Results of SLN identified and not identified at [redacted]

Being the only member of the clinical technologist/nurse staff working at both departments and performing different protocols, I strongly believe the problem was focused on the injection technique of the staff at [redacted] and not on the image acquisition procedure. Also, I think it is important to continue to re-audit this procedure to ensure both departments are maintaining the improvement on the results.

SAMPLE PORTFOLIO

12.6. Safe Working Practice

12.6.1. Induction Form

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

SAMPLE PORTFOLIO

Figure 32 - Induction checklist record – Part 1

[redacted]

[redacted]

SAMPLE PORTFOLIO

Figure 33 - Induction checklist record – Part 2

SAMPLE PORTFOLIO

Figure 34 - Induction checklist record – Part 3

SAMPLE PORTFOLIO

Figure 35 - Induction checklist record – Part 4

SAMPLE PORTFOLIO

Figure 36 - Induction checklist record – Part 5

SAMPLE PORTFOLIO

Figure 37 - Induction checklist record – Part 6

Induction Portal		Item	Details	Date Achieved	Tick box when completed
Step 3 **Statutory and Mandatory Training Information**	**Week 1-Month 3**	**Professional Development and Training**	Learning and Education There are a number of Learning and Education opportunities for staff which can be found on HR Connect A complete list of Statutory/ Mandatory training can be found by clicking here.	9/4/17	☑

Induction Portal		Item	Details	Date Achieved	Tick box when completed
Step 4 ***Healthcare Support Workers***		***Healthcare Support Workers***	• If your new member of staff has been identified as a Health Care Support Worker, then they must additionally meet a set of 14 induction standards and also agree to a Code of conduct. HCSW's must also complete a workbook providing evidence on how they are meeting the above standards. If your member of staff is not a HCSW, you do not need to complete this section and please to go to Step 5. The Standards are below: 1. Protecting the public from harm and abuse. 2. Being fit (healthy) to work. 3. Maintaining health and safety at work. 4. Assessing risks at work. 5. Reporting incidents at work. 6. Working within confidentiality guidelines. 7. Developing your knowledge and practice. 8. Reviewing your working practice to improve your knowledge. 9. Contributing to team work. 10. Building "customer" relationships".	N/A	☐

Figure 38 - Induction checklist record – Part 7

			11. Managing yourself as a resource. 12. Working within your own limits. 13. Working in line with the equality, diversity, rights and responsibilities of people. 14. "Whistle-blowing" in cases of harm and abuse. **Reviewer Handbook** This document is a guide for reviewers who are overseeing the process of HCSW induction completion **HCSW Workbook** This document is for HCSW's. It explains what they need to do in order to meet the induction standards. Your new start should be given a copy of this document so that they understand the background and process of what is required. **Completing the Workbook** The HCSW will require to submit evidence to you via the workbook. This can be done in two ways 1. They can download a paper version of the workbook and print this off. They can write their evidence in the space provided or 2. They can download an electronic version of the workbook. This file is in PDF (Adobe) format and it enables your HCSW to type and save information and if required amend and delete their evidence.	N/A	

Figure 39 - Induction checklist record – Part 8

Induction Portal		Item	Details	Date Achieved	Tick box when completed
Step 5		***Induction Governance***	This section of the list is the final part of the induction checklist. As a manager, here is quick reminder of what your new start should have achieved • If the new start is a HCSW, the workbook needs to be completed, reviewed and signed off. • The induction checklist (this document) and Induction Checklist Record (first page) has been completed. Keep this in the Personnel File. • The statutory/ mandatory training on LearnPro has been completed. • A copy of the completed Induction checklist has been given to the employee and the original is in the personnel file of the new start. • **IMPORTANT**- Please now complete the <u>induction completion online form.</u> • This is important as it allows us to update the employee record on EMPOWER (HR database). If you do not complete and return this form, your member of staff will be listed as non compliant and will be highlighted to HR.	29/3/17	☑

END OF CHECKLIST

Induction Portal		Item	Details	Date Achieved	Tick box when completed
Step 6		***Profession and Role Specific Training***	• Complete Step 6: Role Specific Induction has been identified and agreed following completion of statutory/ mandatory training.	29/3/17	☑

Figure 40 - Induction checklist record – Part 9

12.6.2. Learn-Pro Statutory Courses

[redacted]

CERTIFICATE
OF ACHIEVEMENT
10/01/2018

Name:
Health Service:
Registration Date:
Job Family:
Role:

[redacted]

Division / Trust:
Hospital:
Ward:
Sub Family:
Date Generated:

[redacted]

ELEARNING COURSES

Assessments Completed 1 courses

Dementia Informed Level DVD Assessment
Completed on 06/12/17.

MODULE LIST	
Dementia Informed Level DVD Assessment	Passed assessment on 06/12/17.

CPD Completed 3 courses

[redacted] **Food Hygiene**
Completed on 24/03/17. Valid until 24/06/25.

MODULE LIST	
Legal Requirements, Food Poisoning and Bacteria	Passed assessment on 24/03/17.
Food Contamination	Passed assessment on 24/03/17.
Preventing Food Poisoning	Passed assessment on 24/03/17.

[redacted] **IV3000 Venepuncture & Peripheral Cannulation**
Completed on 06/12/17.

MODULE LIST	
Introduction	Accessed module on 06/04/17.
1. Professional and Legal Issues	Completed module on 06/04/17.
2. Related Anatomy and Physiology	Completed module on 24/05/17.
3. Site Selection and Vein Assessment	Completed module on 02/08/17.
4. Equipment Choice	Completed module on 02/08/17.
5. Principles and Practice	Completed module on 05/12/17.
6. Potential Complications	Completed module on 05/12/17.
7. Post Insertion Care (Cannulation)	Completed module on 06/12/17.
8. Infection Prevention	Completed module on 06/12/17.

Figure 41 - Learn-pro courses – Part 1

[redacted]Management of Needlestick & Similar Injuries
Completed on 28/12/17. Valid until 28/12/19.

MODULE LIST	
[redacted]Management of Needlestick & Similar Injuries	Passed assessment on 28/12/17.

Infection Prevention and Control Completed 1 courses

NES: Prevention and Management of Occ. Exposure
Completed on 28/12/17.
This module is part of the Scottish Infection Prevention and Control Education Pathway. The anticipated learning time for module plus assessment is 40 minutes. Learning outcomes: - Recognise risks of occupational exposure to blood and body fluids. - Take actions to prevent and minimise the risks by avoiding and managing potential hazards including the safe management of sharps. - Take appropriate action in the event of an occupational exposure incident.

MODULE LIST	
[redacted]Prevention and Management of Occ. Exposure	Completed module on 28/12/17.
[redacted]Prev. and Mgmt. of Occ. Exposure (Assessment)	Completed module on 28/12/17.

Statutory / Mandatory Completed 6 courses

[redacted]Adult Support & Protection - Basic
Completed on 27/03/17. Valid until 27/03/20.

MODULE LIST	
Adult Support and Protection Act	Passed assessment on 27/03/17.

[redacted]Child Protection - Level One
Completed on 06/12/17. Valid until 06/12/20.

MODULE LIST	
[redacted]Child Protection - Level one	Passed assessment on 06/12/17.

[redacted] Child Protection Webinar
Completed on 27/03/17.

MODULE LIST	
[redacted]Child Protection Webinar	Accessed module on 27/03/17.

[redacted] Equality and Diversity
Completed on 24/03/17. Valid until 24/06/25.

MODULE LIST	
Introduction to Equality and Diversity	Passed assessment on 24/03/17.

[redacted] Fire Safety
Completed on 24/03/17. Valid until 22/03/19.

MODULE LIST	
Introduction and General Fire Safety	Passed assessment on 22/03/17.
Fire Prevention	Passed assessment on 24/03/17.
Fire Fighting Equipment	Passed assessment on 24/03/17.
Specialist Roles	Passed assessment on 24/03/17.
Fire Emergency within the Ward	Passed assessment on 24/03/17.

[redacted]Health and Safety
Completed on 06/04/17. Valid until 27/03/18.

MODULE LIST	
Health and Safety Awareness	Passed assessment on 27/03/17.

Figure 42 - Learn-pro courses – Part 2

Risk Assessment	Passed assessment on 27/03/17.
Incident Reporting	Passed assessment on 27/03/17.
Violence and Aggression	Passed assessment on 27/03/17.
Manual Handling (Patient) - Legislation	Passed assessment on 27/03/17.
Manual Handling (Patient) - Ergonomics	Passed assessment on 27/03/17.
Manual Handling (Patient) – Anatomy	Passed assessment on 27/03/17.
Manual Handling (Patient) – Causes of Injury	Passed assessment on 28/03/17.
Manual Handling (Patient) - Efficient Movement	Passed assessment on 28/03/17.
Manual Handling (Non Patient) - Legislation	Passed assessment on 28/03/17.
Manual Handling (Non Patient) - Ergonomics	Passed assessment on 28/03/17.
Manual Handling (Non Patient) – Anatomy	Passed assessment on 28/03/17.
Manual Handling (Non Patient) – Causes of Injury	Passed assessment on 28/03/17.
Manual Handling (Non Patient) - Efficient Movement	Passed assessment on 28/03/17.
COSHH	Passed assessment on 04/04/17.
Display Screen Equipment	Passed assessment on 04/04/17.
Lone Working	Passed assessment on 06/04/17.

Figure 43 - Learn-pro courses – Part 3

12.6.3. Sharp and Needlestick Injury Risk Assessment

Ionising Radiation Regulations 1999: Risk Assessment

Subject of Assessment	Use of sharps and associated disposal (including radioactive sharps).
Date of Commencement	26/10/2017
Hazards	Sharps injury including potential exposure to blood borne viruses and/or contamination with radiopharmaceutical.
Description of risk	Risk staff of sharp and needle stick injury. Safe sharps products are used in the majority of activities. Activities identified as a potential risk and/or not compatible/conducive with the use of safe sharps practices are outlined below: 1. Drawing up radiopharmaceuticals from vials into syringes for patient and non-patient use. 2. Drawing up pharmaceuticals from vials into syringes for patient use. 3. Administering pharmaceuticals and radiopharmaceuticals to patients (several times per day). 4. Re-sheathing needles for measurement of syringe radioactivity without contaminating the measuring device or work area (these sharps are not used on patients). 5. Transfer of blood products between syringe and vacuette container. 6. Preparation of blood samples for assay/reinjection. 7. Disposal of sharps
Staff involved	Clinical technologists, nursing staff, healthcare imaging assistants, scientific and medical staff all undertake some work within the department which carries the potential risk of needle stick injury.
Other Persons Involved	None.

SAMPLE PORTFOLIO

Assessment

Existing Precautions

Activities 1, 2 & 3	• Disposable protective gloves to be worn during preparation and administration of radiopharmaceutical/pharmaceutical. • Only trained staff are permitted to prepare radiopharmaceuticals and/or manipulate volumes of unsealed radionuclide's with sharps. • A blunt filter needle is required for pharmaceuticals drawn up from glass vials (e.g. furosemide, heparin). These must be resheathed using a Safe-T-Cap device in conjunction with a 'single hand' technique. • A needle is required for vials with a bung i.e patient radiopharmaceuticals or pharmaceuticals. These must be resheathed using a Safe-T-Cap device in conjunction with a 'single hand' technique. • Safety butterflies, venflons and cannulas are used for all IV administrations. • Only trained staff are permitted to administer radiopharmaceuticals and and/or pharmaceuticals intravenously. Training is via successful completion of an [redacted] course, observation of a number of injections. And finally, competence will only be achieved once a number of successful injections have been undertaken under supervision. • To avoid/minimise patient distress and subsequent movement staff explain the injection procedure to the patient warning immediately prior to injection. • Sharps that have been in contact with a patient during IV administration are not re-sheathed and disposed of immediately. *Radiation protection measures require the use of syringe shields, these shields are not compatible with safety syringes. However these have not been in contact with any patient and the risk is low. Re-sheathed*

SAMPLE PORTFOLIO

	needles are removed, disposed of directly to sharps container and replaced by a sterile syringe end cap prior to use, this practice minimised further use of non-sharp products.
Activity 3	• **<u>Sentinel Node Studies (Breast):</u>** Only trained staff are permitted to administer radiopharmaceuticals intra-dermally. Training is via successful completion of an [redacted] course, observation of a number of injections. And finally, competence will only be achieved once a number of successful injections have been undertaken under supervision. • The intra-dermal injections required for the procedure are undertaken using a diabetic insulin needle. • Sharps that have been in contact with a patient during IV administration are not re-sheathed. *Safety diabetic insulin needle are being trialled within the department, it should be noted that some operators have found difficulty using these i.e. significant back pressure from plunger during administration, resulting in compromise of technique. Compromise of the technique can result in the operator administering the radiopharmaceutical too deeply or depressing the plunger with force could result contamination of the area of interest. As this procedure is used to guide surgeons to radioactive lymph nodes in theatre, any compromise in the technique, as described, could result in this part of the surgical procedure being abandoned.*
Activity 4	• Re-sheathing of syringes containing radiopharmaceuticals drawn up from glass vials is only permitted when a Safe-T-Cap device is used in conjunction with a 'single hand' technique. *This practice is required to minimise the risk of radioactive contamination of the work area and radionuclide calibrator and therefore ensure accuracy of the measured activity administered to the*

SAMPLE PORTFOLIO

	patient. There have been no reported instances in the NE sector of needlestick injury using the re-sheathing Safe-T-Cap device so it is felt that the risk remains minimal.
Activity 5	• **Blood volume studies**: Two 9ml vacuette containers of blood are required at three discreet time intervals. Sampling is achieved via the use of an IV safety cannula with 20ml syringe attached. 20ml of blood is removed from the patient and the blood decanted into the two separate 9ml vacuette containers by removing their tops and discharging the syringe without the use of a needle. *This deviation of safe sharp practice is required to minimise inaccuracies in blood sampling, direct use of two vacuette's is problematic in part due to the nature of the patient's blood disorder i.e. Polycythaemia, and can result in delays between sampling for a single time point. This in turn could affect the clinical result of the test.*
Activity 6	• **Blood volume studies**: Blood products are manipulated using blunt mixing needles rather than safety sharps to eliminate the risk of a needlestick injury resulting in a blood borne virus risk. Safety sharps are not conducive to the transfer of blood products between the various containers required during the procedure. • **Blood labelling and blood volume studies:** Blood products for reinjection are drawn up using a needle and syringe. The needles are then re-sheathed using a Safe-T-Cap device in conjunction with a 'single hand' technique. Once the activity within the syringe has been measured the sheathed needle is removed and replaced by a safety cap. *Limited distance between the retracted safety sheath and needle end within the receptacle containing the blood product restricts adequate insertion of a safety needle and causes difficulty when drawing up. Full*

SAMPLE PORTFOLIO

	insertion of the safety needle into the blood would result in contamination of the operators hand and/or working environment. In addition, patients attending for blood volume procedures often have very viscous blood, the use of mixer needles is prohibited due to the potential for clots being drawn into the syringe for re-administration to the patient. A needle is required to avoid clots being drawn into the syringe.
Activity 7	• Staff member should ensure sharps containers are available prior to undertaking work involving the use of sharps, safety or otherwise. • Needles used for patients should be disposed of in a sharps container for disposal without disconnecting the needle from the syringe – dispose of the whole assembly. • Never leave sharps for someone else to tidy up – it is the responsibility of the staff member using the needle to dispose of it properly. • Needles are disposed of in an approved puncture resistant sharps container. • Do not overfill sharps containers. • Full (3/4 full) sharps containers should be sealed for incineration and placed into the waste store.

SAMPLE PORTFOLIO

In the event of a needlestick injury, the following facilities are in place:

• Appropriate hand washing facilities with elbow operated taps are provided in all areas where radioactive material is handled and injections carried out.

The poster ***'Management of Needlestick Injuries and Exposures to Blood and High-Risk Body Fluids'*** is displayed in each section and details [redacted] procedures to be followed if an incident occurs, which include:

• Encourage bleeding as much as possible and wash the injury under running water.

• Do not suck the injured area.

- Wipe the area with a small alcohol wipe (mediswab).
- Contact Occupational Health for advice.
- Report the incident
- Attend A&E if the injury occurs out of hours and Occupational Health staff are not available.

A formal record of the incident must be reported via DATIX and there is a follow-up procedure in place. Finally, further associated documentation can be accessed on staffnet and Hepatitis B Virus vaccination is provided for all staff members via Occupational Health.

Level of Risk - Is the control of this risk adequate?

Give more than one risk level if the assessment covers a range of circumstances. You can use the 'matrix' to show how 'likelihood' and 'consequences' combine to give a conclusion. Also, be critical of existing measures: if you can think how they might fail, or how they could be improved, these are indications of a red or orange risk.

Table 13 - Risk Matrix

Likelihood	Impact/Consequences				
	Negligible	Minor	Moderate	Major	Extreme
Almost Certain	Medium	High	High	V High	V High
Likely	Medium	Medium	High	High	V High
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Very High High Medium Low

Current risk level: Medium (likelihood Unlikely, the consequences/impact from a radiation exposure is Low. HOWEVER the consequence is considered Major from BBV).

Action Plan (if risk level is **High (Orange) or Very High (Red)**

Use this part of the form for risks that require action. Use it to communicate, with your Line Manager or Risk Coordinator or others if required. If using a copy of this form to notify others, they should reply on the form and return to you. Check that you do receive replies.

Describe the measures required to make the work safe. Include hardware – engineering controls, and procedures. Say what you intend to change. If proposed actions are out with your remit, identify them on the plan below but do not say who or by when; leave this to the manager with the authority to decide this and allocate the resources required.

Proposed actions to control the problem List the actions required. If action by others is required, you must send them a copy	**By Whom**	**Start Date**	**Action due date**

Action by Others Required - Complete as appropriate: (please tick or enter YES, name and date where appropriate)

Report up management chain for action	
Report to Estates for action	
Contact advisers/specialists	
Alert your staff to problem, new working practice, interim solutions, etc	

Assessor	**Designation**	**Date**	**Review**
Manager			

SAMPLE PORTFOLIO

12.6.4. COSHH Risk Assessments

Department: [redacted] Nuclear Medicine **Ref no: Actichlor Tablets**

Substance / Activity: Effervescent chlorine releasing tablet for cleaning blood spillages. Surface disinfectant
Is there a safe system of work for the activity? Yes

Product / Trade Name / Mixture etc	**Hazard Classification** (Corrosive, Harmful, Irritant, Toxic, Very Toxic)	**Chemical Nature** (aerosol, dust, fume, gas, liquid, powder, etc)	**Route of Entry / Exposure** (Absorption, Ingestion, Inhalation, Injection)
Actichlor Plus Tablets	Harmful; Dangerous to the environment	Solid	Inhalation; intoxication; skin respiratory and eye irritation
Troclosene sodium; organic acids; arylsulfonates; Sodium fatty acid sarcosides	R22; R36/37; R31; R50/53 Xn; N	Soluable	Contact with acid liberates to toxic gas; very toxic to aquatic organisms and may cause long term adverse affects in the aquatic environment.

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Individuals or groups exposed	Staff
Duration of exposure	Intermittent
Does the substance have a W.E.L.?	No * If Yes, contact Occupational Hygienist / Health & Safety Practitioner
Is a Safety Data Sheet Available?	Yes

<u>Existing Precautions</u>

Summarise current controls in place Include any procedures for Storage, Transport, Handling, Disposal and Maintenance as well as the general use of the substance.	**Describe how they might fail to prevent adverse outcomes.**
Store 0ºC-25ºC in a well ventilated, cool, dry cupboard and away from food and drink. Separate from acids and in original container. Use only in adequate ventilation and wear appropriate PPE. No smoking, eating or drinking when handling and wash hands after use. If clothes and/or PPE contaminated remove.	

Emergency Procedures	
<u>First Aid</u> Eye Contact: Flush eyes immediately with water for about 15mins making sure no contacts lens and lifting lids. Inhalation: Remove the victim to an area with fresh air and if required provide oxygen. Skin Contact: Wash with plenty of water. If clothes or shoes contaminated remove. Ingestion: Wash mouth with water and do not induce vomiting. Get medical help.	**<u>Spillages</u>**

Level of Risk - Is the control of this risk adequate?

Give more than one risk level if the assessment covers a range of circumstances. You can use the 'matrix' to show how 'likelihood' and 'consequences' combine to give a conclusion.

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Also, be critical of existing measures: if you can think how they might fail, or how they could be improved, these are indications of a red or orange risk.

Table 14 - Risk Matrix

Likelihood	Impact/Consequences				
	Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
Almost Certain	**Medium**	**High**	**High**	**V High**	**V High**
Likely	**Medium**	**Medium**	**High**	**High**	**V High**
Possible	**Low**	**Medium**	**Medium**	**High**	**High**
Unlikely	**Low**	**Medium**	**Medium**	**Medium**	**High**
Rare	**Low**	**Low**	**Low**	**Medium**	**Medium**

Low

Health Surveillance/ Atmospheric Monitoring	
Is Health Surveillance or Atmospheric Monitoring of staff required? (If yes, contact the Occupational Health Service/ Occupational Hygienist)	Yes

New & Expectant Mothers	
Are additional control measures required for new & expectant mothers?	No
If yes, please specify:	

Action Plan (if risk level is **High (Orange) or Very High (Red)**

Use this part of the form for risks that require action. Use it to communicate, with your Line Manager or Risk Coordinator or others if required. If using a copy of this form to notify others, they should reply on the form and return to you. Check that you do receive replies. Describe the measures required to make the work safe. Include hardware – engineering controls, and procedures. Say what you intend to change. If proposed actions are out with your remit, identify them on the plan below but do not say who or by when; leave this to the manager with the authority to decide this and allocate the resources required.

Proposed actions to control the problem List the actions required. If action by others is required, you must send them a	**By Whom**	**Start Date**	**Action due date**

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copy			

Action by Others Required - Complete as appropriate: (please tick or enter YES, name and date where appropriate)

Report up management chain for action	
Report to Estates for action	
Contact advisers/specialists	
Alert your staff to problem, new working practice, interim solutions, etc	

Assessor	**Designation**	**Date**	**Review**
Manager			

All COSHH risk assessments should be correctly completed and a record kept. Initially, the substance must be described, including the name of the product, the respective hazard classifications including the associated R-Phrase (this appears on each label and is mandatory), the chemical nature (Liquid, gas, etc) and the route of entry and/or exposure (Inhalation; intoxication, etc).

In the COSHH risk assessment mentioned previously, Actichlor Tablets are classified as harmful and dangerous to the environment and is a R22 (Harmful if swallowed), R31 (Contact with acids liberates toxic gas), R36/37 (Irritating to eyes and respiratory system) and R50/53 (Very toxic to aquatic organism, may cause long-term adverse effects in aquatic environment).

General information about the groups exposed, duration of exposure, if the substances have a Workplace Exposure Limit (W.E.L), a safety data sheet available and the level of risk is completed on the form. To control and reduce the risks derived from Actichlor tablets the department must follow the precautions and the emergency procedures present in the risk assessment.

At these departments, the COSHH revision only occurs if the manufacture and/or a substance changes in the product, otherwise this document need be reviewed annually.

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