SESLHD PROCEDURE COVER SHEET

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SUMMARY	Shielding and facility design procedures to limit radiation risk to staff and members of public

1. POLICY STATEMENT

The South Eastern Sydney Local Health District (SESLHD or the LHD) is committed, through a risk management approach, to protecting employees, contractors, students, volunteers, patients, members of the public and the environment from unnecessary exposure to radiation arising from systems and processes which use radiation apparatus and radioactive substances, whilst maintaining optimum diagnostic and therapeutic quality, therapeutic efficacy and patient care.

This document provides the procedures necessary to ensure compliance in relation to radiation shielding, design of new facilities and storage of radioactive material.

2. BACKGROUND

2.1 Description of the procedure

Hospitals within SESLHD utilise ionising radiation for various therapeutic and diagnostic purposes. This radiation is produced either by radiation apparatus or by radioactive substances. All areas where this radiation is produced must be assessed to determine if radiation shielding is required and to ensure that the shielding is adequate. Shielding should be a central part of facility design from the earliest stages of project planning.

3. RESPONSIBILITIES

3.1 Hospital General Manager

The General Manager of any SESLHD hospital will:

- ensure that the site Radiation Safety Officer (RSO) and a suitably qualified Medical Physicist are consulted prior to any new developments or modifications to existing buildings and facilities which incorporate radiation sources; and
- ensure that, where required, one or more independent Consulting Radiation Expert (CRE), appropriately accredited for radiation shielding are engaged to:
    - assist architects with facility design; and
    - assist RSOs with verifying correct installation of required shielding.

3.2 Radiation Safety Officer (RSO)

The site Radiation Safety Officer, assisted by appropriately specialised Qualified Medical Physicists (QMPs) and appropriately accredited Consulting Radiation Experts (CREs), will:

- determine the category of risk (low, medium or high) for any facility using ionising radiation at the site;
- for low-risk facilities, ensure that a written self-assessment report is prepared to determine if a shielding plan is required;
- review all radiation shielding plans and ensure they are approved by one or more CREs as appropriate, prior to installation at the site;

- oversee installation of radiation shielding at the site to confirm conformance to the plan;
- assess the installed shielding to confirm that the required level of protection is achieved.

3.3 Qualified Medical Physicist (QMP)

A Qualified Medical Physicist employed by the Hospital or District to be responsible for the use of ionising radiation by the facility being developed, will:

- be qualified in the appropriate speciality for the facility, typically Nuclear Medicine, Radiology, or Radiotherapy;
- work with the site RSO and any Consulting Radiation Experts before, during and after construction to ensure that the required shielding is designed and implemented correctly.

3.4 Consulting Radiation Expert (CRE)

A Consulting Radiation Expert, engaged to assist with shielding design and implementation for a facility, will:

- have suitable qualifications and experience in shielding design for the particular type of facility and level of risk involved. They would typically be a QMP specialised in Nuclear Medicine, Radiology, or Radiotherapy;
- ensure that shielding plans are prepared in conformance with the requirements of NSW EPA *Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements*.
- work with the site RSO and QMPs before, during and after construction to verify that the required shielding is designed and implemented correctly.

4. PROCEDURE

4.1 Project Planning

The requirements of NSW EPA guideline *Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements* must be followed for all shielding design and assessment within the LHD.

When designing new buildings to house radiation sources of any kind the need for shielding should be considered at the earliest stages of the project. This also applies to modifications to existing buildings or construction in areas immediately adjacent to existing radiation sources. This is particularly important where building modifications result in higher occupation of previously unoccupied space adjacent to the radiation source.

For some facilities (e.g. linear accelerator bunkers, brachytherapy rooms) retrospective remediation of inadequate shielding is a very expensive exercise and may even be impossible. Careful planning and location of shielding at the commencement of the project can save substantial expense. Well considered placement of functional units within a facility at the design phase may reduce the amount of shielding required.

For these reasons the General Manager of the hospital where facilities using ionising radiation are to be constructed must seek advice from the site RSO at the earliest

possible phase of the project definition and planning. This also applies to any construction or change of use immediately adjacent to existing facilities where radiation is used.

Whenever fixed radiation shielding is to be installed an independent CRE specialising in shielding must be engaged as part of the design team. The Medical Physicist who will be responsible for the use of radiation by the facility should also be part of the design team from the earliest stages.

In the case of a high-risk facility, and for radiotherapy in the medium-risk category, an independent assessment of the shielding plan must be carried out by a second, appropriately accredited CRE to verify that the shielding plan is correct. The independent assessment by the second CRE must also be documented on the shielding plan.

Even when engagement of a shielding CRE is not mandatory under Guideline 7 for the purpose of designing a shielding plan consideration should be given to engaging a CRE for projects of any magnitude. Hospital Managers must seek advice from the RSO in this regard.

4.2 Design Dose Constraints

The purpose of the design, assessment and verification of shielding is to ensure that the ALARA principle (as low as reasonably achievable) for radiation protection is achieved.

Schedule 5 of the *Protection from Harmful Radiation Regulation 2013* (NSW) sets out dose limits for members of the public and occupationally exposed persons, which **must not** be exceeded.

To achieve this requirement, the shielding design:

- should ensure that radiation levels in affected areas do not give rise to an effective dose greater than 100 µSv per week for occupationally exposed persons (from all sources of exposure); and
- **must** ensure that radiation levels in affected areas do not give rise to an effective dose greater than 20 µSv per week for members of the general public.

4.3 General Design Considerations

All radiation barriers must be designed according to the requirements of NSW EPA guideline *Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements*.

Shielding requirements need to be individually tailored to suit the practice requirements based on the intended patient workload and the type of procedures to be undertaken and must be re-assessed whenever:

- the intended use or workload of a room changes; or
- radiation apparatus is upgraded; or
- the occupancy of neighbouring areas, including those above and below the facility, changes.

4.3.1 Low and Medium Risk Facilities

According to the Guideline, ionising radiation barriers for low and medium risk facilities should:

- extend from finished floor level (FFL) to a height of at least 2.1 m above the FFL, or to the slab above for CT scanners;
- be continuous, with overlaps ensuring that there are no direct lines of sight through a gap from the patient or X-ray tube; and
- have all penetrations and joints arranged so that they are equally as effective in shielding radiation as the wall shielding.

Any viewing windows in walls or doors must have at least the same lead equivalence as the minimum shielding specifications for the shielded barrier in which they are located. Due consideration should be given to the provision of floor and/or ceiling shielding when rooms immediately above or below the radiation source are occupied.

All shielded barriers must be clearly and durably marked with the details of the shielding as per EPA Radiation Guidelines 6 and 7. These labels should be provided by the company constructing or providing the shielding and must specify the lead equivalent thickness of the shield and the energy (x-ray kVp or keV) at which that equivalence is defined.

4.3.2 High Risk Facilities

Premises are classified as high-risk where the potential for radiation exposure is high and substantial shielding is required to operate within dose limits.

A shielding plan must be prepared for all high-risk premises as detailed in Section 6 of EPA Radiation Guideline 7. Complex shielding plans for high risk premises may require significantly more detail than the minimum requirements listed in Section 6.

Due to the complex nature of high-risk premises each shielding plan is to be assessed by an appropriately accredited CRE on a case by case basis, then verified by a second, independent accredited CRE.

4.4 Shielding Verification

Prior to initial use of radiation equipment and sources, the RSO should ensure that a radiation survey is undertaken to confirm the shielding meets the design requirements. This should be done in conjunction with the CRE engaged to develop the shielding plan. A documented record of this assessment should be kept as part of the facility commissioning records. Radiation Guideline 7 should be consulted for the essential elements required in this report.

Preferably the independent CRE and/or the local, appropriately specialised QMP should inspect the shielding periodically during construction. After construction it can be very difficult to ascertain what shielding is in walls and ceilings except by indirect measurements.

4.5 Diagnostic Radiology Facilities (including diagnostic x-ray apparatus in theatres and other areas outside the Medical Imaging Department)

Most diagnostic radiology facilities are classified as medium risk under NSW EPA *Radiation Guideline 7*, with dental and mammographic applications generally considered low risk. Some low-risk premises may be self-assessed and may not require a shielding plan. A shielding plan must be prepared for all medium risk facilities but there is no

requirement that this plan be prepared by a CRE. However, a shielding CRE must assess the plan for compliance.

In preparing a shielding plan, the CRE and/or Radiology Physicist must give careful consideration to the:

- siting of X-ray units; and
- provision of structural shielding.

These considerations are particularly important when an X-ray unit is:

- operated in close proximity to occupied areas; or
- used in a confined space.

When designing shielding for high dose diagnostic or interventional radiology equipment, such as CT scanners, the CRE and Radiology Physicist must be provided with contour maps of the scattered x-ray distribution around the scanner as part of the documentation accompanying the equipment.

NSW EPA *Radiation Guideline 7* and *Radiation Guideline 6 – Registration requirements and industry best practice for ionising radiation apparatus used in diagnostic imaging* should be consulted for further technical details relating to shielding of diagnostic x-ray facilities.

4.6 Nuclear Medicine Facilities

Diagnostic nuclear medicine facilities are classified as “medium risk” under NSW EPA *Radiation Guideline 7.* A Consulting Radiation Expert (CRE) is not required to design a shielding plan for most diagnostic nuclear medicine facilities however a shielding CRE must assess the plan for compliance.

PET scanning facilities and radionuclide therapy facilities are designated as “high risk” applications in NSW EPA *Radiation Guideline 7* and therefore require a shielding CRE to design a shielding plan and a second independent shielding CRE to assess and certify the compliance of the shielding plan.

Careful consideration should be given to both the location of nuclear medicine facilities within a building and to the provision of structural shielding, particularly if PET studies are to be performed.

In the instance of designing shielding for PET/CT or SPECT/CT installations, the CRE and Nuclear Medicine Physicist must be provided with contour maps of the scattered x-ray distribution around the scanner as part of the documentation accompanying the equipment.

Where possible, radiation sources should be shielded locally to minimise the need for whole room shielding. Fixed shielding must be provided for SPECT/CT systems and is recommended but not mandatory for other gamma cameras. Where fixed shielding is not provided, mobile shielding may be used to protect the operator.

4.6.1 Facilities for dispensing radiopharmaceuticals

The facility needs to be designed to give proper radiation and contamination protection to personnel and the environment and to maintain the quality of the product. The standard principles for the layout of radioisotope laboratories, designed to protect the staff and the

external environment in the event of radioactive contamination in the laboratory, should be followed (AS/NZS 2982.1).

Radiopharmaceutical and waste storage facilities should be shielded as necessary. Storage areas should also be secure to prevent access by unauthorised staff or visitors during operational hours as well as after hours.

Dose drawing facilities should be equipped with heavy shielding and lead glass to protect the operator. Consideration should be given to shielding dose calibrators, syringes and multi-dose vials.

All fume hoods and exhausted pharmaceutical handling cabinets must be designed to prevent uncontrolled discharge of radioisotopes. Associated plumbing and ducting must be marked with signs indicating the possible radiation hazard.

The facility must also meet the criteria identified in SESLHDPR/541 – Radiation Safety - Minimising Radiation Exposure in Laboratories.

4.7 Radiotherapy Facilities

Radiotherapy simulators, and superficial therapy up to 150 kVp, are considered medium risk. A Consulting Radiation Expert (CRE) is not required to design a shielding plan for these applications however a shielding CRE must assess the plan for compliance.

Radiotherapy applications using a sealed source or irradiating apparatus greater than 150 kVp, including remote after-loading devices, are considered high risk and therefore require a shielding CRE to design a shielding plan and a second independent shielding CRE to assess and certify the compliance of the plan.

Specification of shielding material and shielding design should be chosen so that dose constraints can be met with due consideration to the occupancy of the areas adjacent to the treatment room. Careful consideration should be given to the provision of floor and/or ceiling shielding when rooms immediately above or below the radiotherapy treatment area are occupied.

All protective barriers in the rooms housing radiotherapy equipment, including the mobile shielding requirements for IORT or LDR brachytherapy, should also be specified. Full details of the parameters on which the shielding calculations are based should also be documented in the report provided by the CRE. The Radiotherapy Physicist responsible for radiation use in the facility should continue to be involved throughout the planning and construction stages to ensure that the design satisfies radiation safety standards and practice.

If there is any change to radiotherapy equipment and/or any other modifications which impact on the shielding or change in the use of the adjacent areas (including above or below), the adequacy of the shielding must be reassessed.

4.7.1 Treatment room design

Treatment rooms should have emergency switches controlling the mains power to the radiotherapy equipment to allow for emergency termination of a radiation exposure. They should be both visible and easily accessible to staff from any point in the treatment room.

Treatment rooms should incorporate engineering controls which prevent persons from inadvertently entering the room whilst a treatment is in progress, or whilst the therapy machine may be operated for other purposes.

4.7.2 Brachytherapy

For clinical or laboratory areas where remote afterloading brachytherapy radioactive sources are prepared, sterilised and cleaned, the facilities and design should conform to the relevant requirements for radiation laboratories using sealed sources detailed in the Australian Standards AS/NZS 2982 and AS 2243.4 or provide an equivalent level of safety as these.

The RSO should be consulted if the brachytherapy treatment room is used for any purpose other than brachytherapy treatment whilst the brachytherapy source(s) contained in the treatment unit remain stored in that room.

Occasionally it may be required to move a brachytherapy device from one area to another. The RSO should be consulted if this is proposed, to ensure that the dose limits for individuals and the shielding and design aspects comply with the requirements of the relevant regulatory authority.

5. DOCUMENTATION

- Written self-assessment reports as detailed in section 5 of Radiation Guideline 7 for all low-risk premises;
- Shielding plans, as detailed in section 6 of Radiation Guideline 7, approved by appropriately accredited CREs for all premises that require them;
- Engineering drawings of facilities “as constructed” detailing any shielding including lead equivalence or HVL of each barrier as well as any pipes or ducting that may carry radioactive materials (waste or otherwise).
- Shielding verification reports, completed by a CRE, for all premises for which additional radiation shielding has been installed.
- Internal reviews of shielding designs performed by the site RSO prior to installation or changes of use.

6. AUDIT

The following records must be available for audit:

- Shielding self-assessment reports;
- Shielding plans, reviews and verification reports.

7. REFERENCES

[1] ARPANSA RPS C-1 "Code for Radiation Protection in Planned Exposure Situations", ARPANSA, Yallambie (2020)

[2] ARPANSA RPS 14.1 “Safety guide for Radiation Protection in Diagnostic and Interventional Radiology” ARPANSA, Yallambie (2008)

[3] ARPANSA RPS 14.2 “Safety guide for Radiation Protection in Nuclear Medicine” ARPANSA, Yallambie (2008)

[4] ARPANSA RPS 14.3 “Safety guide for Radiation Protection in Radiotherapy” ARPANSA, Yallambie (2008)

[5] NSW EPA Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements, EPA Sydney (2015).

[6] NSW EPA Radiation Guideline 6 – Registration requirements and Industry best practice for ionising Radiation apparatus used in diagnostic imaging, Part 1, Part 2, Part 3, and Part 5, EPA Sydney

[7] NCRP Report No. 147, National Council on Radiation Protection and Measurements, Structural shielding design for medical x-ray imaging facilities, Bethseda 2004.

[8] BIR 2012. British Institute of Radiology and Institute of Physics and Engineering in Medicine, *Radiation shielding for diagnostic x-rays*, Edited by Sutton DG and Williams JR. Charlesworth Group, Huddersfield (2012).

[9] AS/NZS 2243.4:2018. Australian Standard 2243.4:2018 *Safety in laboratories – Ionizing radiations*, Standards Australia.

[10] AS/NZS 2982.1:2010. Australian and New Zealand Standard 2982.1:2010: *Laboratory design and construction - General requirements*, Standards Australia.

[11] Protection from Harmful Radiation Regulation 2013. (NSW)

8. VERSION AND APPROVAL HISTORY

Date	Version	Version and approval notes
9/9/2010	Draft	Martin Carolan, SHN RSO
Nov 2010	Draft	Richard Smart, RSO
February 2011	0	Approved by Combined Clinical Council
December 2015	1	Periodic Review
October 2016	1	Updates endorsed by Executive Sponsor
December 2019	2	Updates endorsed by Executive Sponsor
26 April 2024	3.0	Major review: Updated references to ARPANSA C1 and C5; adjusted Section 4.3 to reflect differing requirements for low and high risk facilities; adjusted Section 4.6 to reflect differing requirements for low and high risk facilities. Approved by SESLHD Clinical and Quality Council.