SESLHD PROCEDURE COVER SHEET

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KEY TERMS	Radiation shielding; facility design; building construction
SUMMARY	Shielding and facility design procedures to limit radiation risk to staff and members of public

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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 procedure 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 radiation for various therapeutic and diagnostic purposes. This procedure describes the basic requirements for radiation shielding, facility design and storage of radioactive material. All areas where radiation is used need to be assessed to determine if 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 General Manager

- will ensure that the Radiation Safety Officer and a Medical Physicist are consulted prior to any new developments or modifications to existing buildings and facilities which incorporate radiation sources
- will ensure that independent radiation shielding experts are engaged to assist architects with facility design.

3.4 Qualified Expert (Consulting Radiation Expert (CRE))

- will have suitable qualifications and experience in shielding design for the particular type of facility involved. A medical physicist with specialist certification as a CRE in radiotherapy, nuclear medicine or diagnostic shielding would satisfy these requirements.
- For significant construction projects (e.g. new linear accelerator bunkers or nuclear medicine departments) external advice should be sought from an independent shielding CRE. The medical physicist will assess this advice for accuracy and verify that the shielding is implemented correctly during and after construction.

3.5 Radiation Safety Officer (RSO)

- will oversee and provide advice on radiation shielding within radiation using departments.
- may be assisted by specialist medical physicists and shielding experts.

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4. PROCEDURE

4.1 Project Planning

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 radiation using facilities are to be constructed must seek advice from the Radiation Safety Officer at the earliest possible phase of the project definition and planning. This also applies to any construction immediately adjacent to existing radiation using facilities.

In general, for radiation shielding design of any significant magnitude, an independent CRE specialising in shielding should be engaged as part of the design team. Where possible the medical physicist who will be responsible for the operation of the facility should also be part of the design team from the earliest stages.

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.

4.2 Design Dose Constraints

The design assessment and verification of shielding is to ensure that the ALARA principle is achieved.

Schedule 5 of the NSW Radiation Control Regulation 2013 sets out dose limits for the 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 equivalent dose greater than 100 µSv per week for occupationally exposed persons from all sources of exposure
- **must** ensure that radiation levels in affected areas do not give rise to an equivalent dose greater than 20 µSv per week for members of the general public.

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

The Qualified Expert (Medical or Shielding Physicist) needs to give careful consideration to the:

- siting of X-ray units; and

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- provision of structural shielding.

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

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

Shielding requirements need to be individually tailored to suit the practice requirements based on the intended patient workload and the type of examinations to be undertaken. Further assessments should be undertaken when:

- the intended use of a room changes
- X-ray equipment is upgraded
- surrounding room occupancy is altered.

Accordingly, the General Manager should seek the advice of a qualified expert or other individual experienced in performing such calculations. The literature (NCRP 2004, BIR 2000) should be referred to for advice on structural shielding issues.

As a general requirement, all shielded barriers should be designed according to the requirements of the relevant regulatory authority (for SESLHD this is the NSWEPA). The appropriate EPA guideline is *Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements*. Further details of specific diagnostic shielding requirements can be found in NSW EPA *Radiation Guideline 6 – Registration requirements and industry best practice for ionising radiation apparatus used in diagnostic imaging.*

Despite that, ARPANSA RPS 14 requires that barriers should:

- be at least two metres high; and
- have all penetrations and joints arranged so that they are equally as effective in shielding radiation.

Any viewing windows in walls or doors need to 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 below and above the X-ray installation respectively are occupied.

Where estimating shielding for CT installations, the Qualified Expert (Medical or Shielding Physicist) should insist that the equipment suppliers provide radiation scatter contour maps around the scanner as part of the documentation accompanying the equipment.

Appendix C of NSW EPA *Radiation Guideline 7* should be consulted for further technical details relating to shielding of diagnostic x-ray facilities.

All shielded barriers must be labelled with the details of the shielding as per EPA Radiation Guidelines 6 and 7. These labels should preferably be provided by the company constructing or providing the shielding and must specify the lead equivalent of the shield and the energy at which that lead equivalence is defined.

A shielding Consulting Radiation Expert (CRE) is not required to design a shielding plan for most diagnostic imaging facilities however a shielding CRE must assess the shielding for compliance. 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.

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When dictated by Radiation Guideline 7 an independent CRE should ensure that a radiation survey is undertaken to confirm the shielding meets the relevant requirements.

A documented record of this assessment should be keep as part of the facility commissioning records. Radiation Guideline 7 should be consulted for the essential elements required in this report.

4.3 Nuclear Medicine Facilities

Careful consideration should be given to both the location of nuclear medicine centres within a building and to the provision of structural shielding, particularly if PET studies are to be performed. As a general requirement, all barriers should be designed to a height of at least two metres. Viewing windows in walls or doors should have the same lead equivalence as the minimum shielding specifications for the barrier in which they are located. Due consideration should be given to the effectiveness of shielding at penetrations and joints and to the provision of floor and/or ceiling shielding when rooms immediately below and/or above the nuclear medicine installation are occupied.

In the particular instance of estimating shielding for PET/CT or SPECT/CT installations, the calculation may be expedited by requiring that the equipment suppliers provide radiation scatter contour maps around the scanner as part of the documentation. The effectiveness of shielding at penetrations and joints should be ensured. Viewing windows in walls or doors will need at least the same lead equivalence as the minimum shielding specifications for the CT requirements for the barrier in which they are located. NSW EPA *Radiation Guideline 7* should be consulted for specific requirements.

Where possible 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 lead panels may be used to shield the operator.

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

When dictated by Radiation Guideline 7 an independent CRE should ensure that a radiation survey is undertaken to confirm the shielding meets the relevant requirements.

A documented record of this assessment should be keep as part of the facility commissioning records. Radiation Guideline 7 should be consulted for the essential elements required in this report.

4.3.1 Facilities for dispensing radiopharmaceuticals

The radiopharmacy facility and equipment should be located, designed, constructed and maintained to suit the operations to be carried out. The layout and design should be such as to minimise the risk of errors and to permit effective cleaning and maintenance, the avoidance of cross contamination, the build-up of dust or dirt and any other influences that may adversely affect the quality of 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 customary principles for the

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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 2982.1:1997).

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. Activities greater than 10 GBq of iodine-131 in liquid form are to be handled in a hot cell. All radio-iodination reactions where less than 10 GBq of iodine–131 in liquid form is used should be performed in an adequately shielded fume cupboard or fully enclosed pharmaceutical isolator. The fume cupboard performance should meet AS/NZS 2243.8:2006.

Laboratories and pharmaceutical dispensing areas should be equipped with eye washes and shower facilities to facilitate decontamination of staff in case of accidental exposures. Care should be taken in placement of these decontamination facilities so that when operated the drainage of waste water does not contribute to increased spread of contamination or electrical hazards.

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

4.4 Radiotherapy Facilities

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. Due consideration should be given to the provision of floor and/or ceiling shielding when rooms immediately below or above the radiotherapy treatment area, are occupied.

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 should be reassessed (NCRP 2005).

A Shielding CRE should be employed (suitably experienced in radiotherapy shielding requirements and approved by the NSW EPA) at the architect’s or builder’s early planning stage for buildings which will house radiotherapy equipment. The shielding CRE provides advice on optimum shielding design, and determines and documents the radiation shielding specifications. These documents constitute the Shielding Plan defined in NSW EPA Radiation Guideline 7.

All protective barriers in the rooms housing radiotherapy equipment, including the mobile shielding requirements for IORT or LDR brachytherapy, should 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 hospital medical physicist should continue to be involved throughout the planning and construction stages to ensure that the building design and facilities satisfy radiation safety standards and practice.

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4.4.1 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.

4.4.2 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 2982.1:1997 (Standards Australia 1997) and AS 2243.4 1998 (Standards Australia 1998) 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.

4.4.3 Radiation survey for new radiotherapy equipment

Prior to initial use of radiotherapy equipment and sources, the independent CRE should ensure that a radiation survey is undertaken to confirm the shielding meets the relevant requirements. Preferably the independent CRE and/or the local radiation oncology medical physicist 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. A documented record of this assessment should be keep as part of the facility commissioning records. Radiation Guideline 7 should be consulted for the essential elements required in this report.

5. DOCUMENTATION

- 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).

6. AUDIT

The following records should be available for audit:

- Shielding Plans as per requirements of NSW EPA Guideline 7
- Shielding CRE reports showing all details of assumptions made regarding workloads, energies, dimensions and occupancies etc
- Shielding assessment reports by independent CRE or local physicist as per requirements of NSW EPA Guideline 7

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7. REFERENCES

[1] ARPANSA RPS 14 "Code of Practice for Radiation Protection in the Medical Applications of Ionizing Radiation", ARPANSA, Yallambie (2008)

[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 (2009).

[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 2000. 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.

[9] AS 2243.4 1998. Australian Standard 2243.4-1998: *Safety in laboratories – Ionizing radiations*, Standards Australia.

[10] AS/NZS 2243.8:2006. Australian and New Zealand Standard 2243.8:2006: *Safety in laboratories – Fume cupboards*, Standards Australia.

[11] AS/NZS 2982.1:1997. Australian and New Zealand Standard 2982.1:1997: *Laboratory design and construction - General requirements*, Standards Australia.

[12] NSW Government (2013) “Radiation Control Regulation”

8. REVISION AND APPROVAL HISTORY

Date	Revision No.	Author and Approval
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
March 2020	2	Updates endorsed by Executive Sponsor

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