SOP RSC 2.2 Radiation Shielding & Facility Design

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Written by:	Radiation Safety Committee
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BACKGROUND

CSU utilises radiation for various scientific, medical, diagnostic and research purposes. This procedure describes the basic requirements for radiation shielding, facility design and storage of radioactive material. Such shielding must be in accordance with Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements.

This means that all areas where radiation is to be used need to be assessed to determine if shielding is required and to ensure that the shielding is adequate for the particular use. Shielding should be a central part of design from the earliest stages of facility and project planning.

This process also includes the need to reconsider the adequacy of shielding in existing radiation facilities when building modifications or increased building occupancy result in changes to previously unoccupied space adjacent to radiation facilities or sources.

DEFINITION

Facility is the building, room or space where the activity occurs and any adjacent spaces that could be affected by the activity or sources. Laboratory is defined as an area where scientific endeavour occurs.

RESPONSIBILITIES

Senior Technical Officer

The most senior technical officer that is responsible for a facility, or the equivalent person in another functional division of the university that is responsible for a facility, e.g. the Senior Manager of Capital Works will:

(a) ensure that the Radiation Safety Committee is consulted prior to development of any new facility;

(b) ensure that the Radiation Safety Committee is consulted prior to any modifications to existing buildings and facilities which incorporate radiation sources;

(c) ensure that records are kept of the consultation, including recommendations from the RSC or other professional consultants and the actions taken regarding the recommendations; and

(d) ensure that records of consultation are submitted to the RSC and WHS of the CSU within two weeks of any such meetings.

Radiation Safety Committee (RSC)

The RSC will have suitable qualifications and experience in shielding design for the particular type of facility involved, or else an expert with qualifications and experience in shielding design for the particular type of facility involved must be consulted.

The RSC will assess the advice from consultants for accuracy and verify (via a professional consultant if necessary) that the shielding is implemented correctly during and after construction.

Principal Investigator

The Principal Investigator will be responsible to ensure that the facility has adequate shielding and storage facilities for the activity being undertaken.

Works Project Officer

The Works Project Officer will be responsible for ensuring that the design of the works complies or exceeds the legislative requirements and:

- the RSC approves the design;
- that copies of the testing and certification results of the facility are provided to the RSC; and
- that the facility is not handed over until the RSC has approved the 'structural' elements of the facility.

PROCEDURE

Project Planning

(a) Arrange radiation activities within a facility to reduce the amount of shielding required.

(b) Consult with RSC from earliest planning stages.

(c) Consider the type of analysis being undertaken.

(d) On advice from the RSC, an independent Consulting Radiation Expert (CRE) specialising in shielding will be engaged as part of the design team.

(e) If a health physicist is responsible for the operation of a facility, then they should be part of the design team from the earliest stages.

(f) Shielding must comply with NSW EPA guideline Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements.

Design Considerations to Comply with Dose Constraints

Shielding design must ensure compliances with dose limits prescribed in Schedule 4 of the Protection from Harmful Radiation Regulation 2025. For the purpose of practical shielding design, the following design objectives will be used:

(a) should ensure that radiation levels in facilities do not give rise to an equivalent dose greater than 100 µSv per week for occupationally exposed persons from all sources of exposure; and

(b) must ensure that radiation levels in facilities do not give rise to an equivalent dose greater than 20 µSv per week for members of the general public.

These weekly values are design constraints used to ensure that annual dose limits required by Schedule 4 of the Protection from Harmful Radiation Regulation 2025 are comfortably met, and may be adjusted to more conservative values if recommended by the CRE.

Planning of Radiology Facilities

General considerations for the planning of radiology facilities (including X-ray analysis, diagnostic X-ray apparatus) include:

(a) intended patient workload

(b) the type of examinations to be undertaken.

Further assessments should be undertaken when:

(a) the intended use of a room changes; and/or

(b) X-ray equipment is upgraded;

NOTE: Further details of specific shielding requirements for medical applications can be found in NSW EPA Radiation Standard 6 – Registration requirements and Industry best practice for ionising Radiation apparatus used in diagnostic imaging.

NOTE: The literature (NCRP 2004, BIR 2000) should be referred to for advice on structural shielding issues.

NOTE: As a general requirement, 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.

(a) Any viewing windows need to have at least the same lead equivalence as the minimum shielding specifications for the shielded barrier in which they are located.

(b) 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.

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

(d) Appendix C of NSW EPA Radiation Guideline 7 should be consulted for further technical details relating to shielding of diagnostic X-ray facilities.

(e) All shielded barriers must be labelled with the details of the shielding as per NSW 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.

(f) 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.

(g) A documented record of this assessment must be kept as part of the facility commissioning records. Radiation Guideline 7 should be consulted for the essential elements required in this record.

Planning of Unsealed Source Facilities

Consult with the RSC and follow the general guidelines found in AS2982 and AS2243.4.

The laboratory requires an assessment of grading before design requirements can be assessed.

For high level laboratories and facilities contact the University RSC for advice as security arrangements may be required to be incorporated into the design.

Low-Level laboratories

In low-level laboratories, fittings and finish shall be chosen so that they may be readily cleaned and shall incorporate features as follows:

(a) joints shall be sealed and made waterproof and be located away from sources of contamination (e.g. not near sinks or under edges of benches).

(b) seamless PVC flooring is recommended. Painted or carpeted surfaces are not acceptable.

(c) walls should be smooth, finished with a washable high gloss or semi-gloss paint and reasonably free of exposed electrical conduits, and water and gas pipes.

(d) benchtops must have a smooth, waterproof, chemically resistant covering that is easy to clean: Melamine, seamless vinyl, cast epoxy resin and stainless steel are recommended. Painted surfaces are not acceptable.

(e) drainage shall be arranged so that it is isolated and so that other building areas cannot become contaminated if the drainage system becomes blocked.

(f) secure storage facilities, which may include refrigerators and freezers, shall be provided for stocks of radionuclides. Shielding of the storage facility shall be provided if recommended by the RSO.

(g) the advice of the RSO shall be sought to determine if a fume cupboard is necessary for handling small quantities of non-volatile radionuclides that are of low radiotoxicity class (see AS 2243.4).

(h) stainless steel sinks are required.

(i) a hand washbasin with automated action, or knee- or foot-operated taps, should be available adjacent to the entrance doorway.

(j) a hand-held shower on a flexible hose and an eye wash facility.

Medium-Level Laboratories

A high degree of cleanliness is essential in medium-level laboratories, and finishes and fittings shall be chosen to assist its achievement. In addition to meeting the requirements of 4.5 above, the laboratory shall comply with the following:

(a) the floor is strong enough to support the weight of any shielding while maintaining its smooth decontaminable continuous surface.

(b) where welded PVC floor covering is used, a polyvinyl chloride content in excess of 76% by weight is to be used for ease of decontamination.

(c) the floor covering is coved up to and be sealed to walls and vertical surfaces to aid cleaning.

(d) benches are to be strong enough to support the weight of any shielding likely to be used. The front and side edges of the benchtop are to be slightly raised and the back covered up to the wall or reagent shelf, so that the benchtop acts as a shallow tray to help contain spills.

(e) joins between bench surfaces are to be designed and constructed so that they do not leak or trap contamination.

(f) a hand washbasin be provided and the taps shall be operated automatically, or be operated by knee or foot.

(g) drainage systems shall be self-contained and be appropriately labelled at accessible locations. Polyethylene and PVC pipes and fittings are recommended because they are resistant to most chemicals and are less likely than metal pipes to become internally contaminated.

(h) if glove-boxes are to be used, each shall have its own exhaust air filter. Discharge of the exhaust air shall comply with the requirements of AS/NZS 2243.8.

(i) laboratory ventilation requires careful design with outdoor fresh air quantities increasing as the quantity of radioactivity proposed for use increases. Table 9.1 provides a practical guide to the supply of outdoor air requirements for laboratories assuming a floor area of $10m^2$ per person and a ceiling height of 2m.

NOTE: The RSC shall advise on recirculation of laboratory air within radioisotope laboratories. Fume cupboard exhaust air shall not be recirculated. Radioisotope laboratories shall be maintained at a negative pressure with respect to adjacent spaces. An alarm system that is automatically activated in the event of failure of the ventilation system shall be installed.

NOTE: The RSC shall determine whether overshoes and barriers are required.

NOTE: Laboratories of a medical or biological nature, where sterility of products also has to be maintained, will present special design difficulties. In such cases the RSC will need to resolve the different requirements of the radioisotope codes and standards, the sterility standards for cleanrooms and the Australian Code of Good Manufacturing Practice for Therapeutic Goods. In addition, for product and operator protection, laminar flow biological safety cabinets complying with AS 2252.2 may be required.

- Ceilings are to be smooth and decontaminable as for walls. Flush light fittings shall be used in preference to suspended fittings which trap dust.
- Laboratories, in the upper part of the medium-level classification or above, shall have ceilings coved to the walls to aid cleaning.
- For medium-level laboratories in which higher levels of radioactivity are used, consideration shall be given to the provision of delay tanks for collection of the effluent before discharge to the sewer. The advice of the RSO, regulatory authority and waste water authority shall be sought when considering the need for, and design of, such a system.
- At least one fume cupboard in accordance with AS/NZS 2243.8 shall be provided. Appropriate exhaust air filters are desirable and provision shall be made to fit them at a later date even if they are not required in the first instance. Provision shall be made for exhaust air sampling. The base of the fume cupboard shall be capable of carrying 0.5 kg/cm2 (0.5 MPa) averaged over the whole area of the base.

DOCUMENTATION

In accordance with NSW EPA Guideline 7, the following will be kept at the facility and a copy sent to the WHS unit:

(a) shielding plans as per requirements of NSW EPA Guideline 7;

(b) shielding CRE reports showing all details of assumptions made regarding workloads, energies, dimensions and occupancies, etc.;

(c) shielding assessment reports by independent CRE or local physicist as per requirements of NSW EPA Guideline 7;

(d) 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).

AUDIT

Every 2 years

REFERENCES

ARPANSA (2008) Code of Practice for Radiation Protection in the Medical Applications of Ionizing Radiation, ARPANSA, Yallambie

ARPANSA (2008) Safety guide for Radiation Protection in Diagnostic and Interventional Radiology (RPS 14.1) ARPANSA, Yallambie

ARPANSA (2008) Safety guide for Radiation Protection in Nuclear Medicine (RPS 14.2) ARPANSA, Yallambie

ARPANSA (2008) Safety guide for Radiation Protection in Radiotherapy (RPS 14.3) ARPANSA, Yallambie

NSW EPA (2009) Radiation Guideline 7 – Radiation Shielding Design Assessment and Verification Requirements, EPA Sydney.

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

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

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.

AS 2243.4 2018. Australian Standard 2243.4-1998: Safety in laboratories – Ionizing radiations, Standards Australia.

AS/NZS 2243.8:2014. Australian and New Zealand Standard 2243.8:2006: Safety in laboratories – Fume cupboards, Standards Australia.

AS/NZS 2982:2010. Australian and New Zealand Standard 2982:2010 Laboratory design and construction - General requirements, Standards Australia.

IAEA-TECDOC-1528 Organization of a Radioisotope Based Molecular Biology Laboratory December 2006. Vienna

IAEA-TECDOC-1367 Practice specific model regulations: Radiation safety of non-medical irradiation facilities August 2003. Vienna

NSW Government (2025) Protection from Harmful Radiation Regulation

REVISION & APPROVAL HISTORY

Date	Revision No.	Author and Approval
Dec 2014	Version 1	William Bartolo, Bartolo Safety Management Service
May 2016	Version 2	William Bartolo, Bartolo Safety Management Service
Dec 2016	Version 3	Radiation Safety Committee, Charles Sturt University
Jan 2017	Version 4	William Bartolo, Bartolo Safety Management Service and Radiation Safety Committee, Charles Sturt University
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Oct 2025	Version 6	Mr Chris Cummins; Radiation Safety Committee, Charles Sturt University