17 April 2024

Dr Gillian Hirth
CEO
Australian Radiation Protection and Nuclear Safety Agency
619 Lower Plenty Road
Yallambie VIC 3085

National guidance for shielding design, installation and verification

Dear Dr Hirth,

Following the presentation to Council on 'National uniformity in radiation safety, challenges for health and medicine' on the 10 August 2023, and various case studies, the Council was asked to consider issues of national uniformity in shielding design in relation to occupational and public radiation dose exposures in diagnostic radiology and radiotherapy.

The Council discussed the practical challenges of differing occupational exposure standards across jurisdictions and shielding design assessments, verification and regulation against those standards. The Council also discussed prescriptive regulatory requirements versus an industry code of practice for shielding design and construction. It was noted that the Radiation Health Committee (**RHC**) is developing national compliance testing standards, however there is not yet a national shielding design and construction standard.

Three actions arose from the Council meeting, namely:

1. ARPANSA to provide a summary of what standard/s are currently in place for shielding design and construction.
2. Council to consider recommending a review of shielding design and construction standards, to identify national uniformity issues.
3. Council to consider establishing a working group on shielding to look at gaps, possible solutions, approaching industry who are recognised as having significant expertise in this area.

Based on Action 3, a Shielding Working Group (SWG) was established.

It is noted that ARPANSA does not have standards for shielding design and construction and that these remain the responsibilities of the State and Territory jurisdictions. It is preferable that

ARPANSA promotes national uniformity in shielding design and construction and a consistent approach by all jurisdictions by developing guidance, codes or standards.

The standards for shielding dose constraints in each jurisdiction are listed in Table 1. These standards demonstrate considerable variability in application and definition between jurisdictions.

Shielding Design Assessment Methods

Current shielding design methodology is informed by several reference documents including:

- National Council for Radiation Protection (NCRP) Report No. 147, *Structural Shielding Design for Medical X-Ray Imaging Facilities,* 2004 (NCRP 147).
- British Institute of Radiology (BIR), *Radiation Shielding for Diagnostic Radiology*, 2012 (BIR 2012).
- Design and Shielding of Radiotherapy Treatment Facilities, IPEM Report 75, 2nd Ed, (IPEM, 2017)

This methodology and approach is used by other countries such as the United States and the United Kingdom, as well as here in Australia, and has not changed since 2012. These methods apply occupancy factors based on area usage, in the absence of actual occupancy data (which could be conservative), and limits for the public and occupational exposure. The methodology also assumes common shielding material densities, distance vs exposures per week, and transmission factors for scattered radiation.

Code of Practice and Safety Guides

The shielding design is supported by an ARPANSA Code of Practice and Safety Guides published in 2008, as follows:

- ARPANSA RHS 14, *Radiation Protection in the Medical Applications of Ionizing Radiation,* May 2008.
- ARPANSA RHS 14.1, *Radiation Protection in Diagnostic and Interventional Radiology*, 8 August 2008.
- ARPANSA RHS 14.2, *Radiation Protection in Nuclear Medicine*, 8 August 2008.
- ARPANSA RHS 14.3, *Radiation Protection in Radiotherapy*, 19 December 2008.

It is noted that RPS 14 has been superseded by RPS C-5, *Code for Radiation Protection in Medical Exposure*, July 2019, but lacks technical detail.

Observations in Verification

The following observations were made by assessors who undertake shielding design verification:

- Retrospective shielding material changes can lead to significant costs, delays and equipment down time. This includes design changes resulting from standards being applied retrospectively, or regulatory decisions resulting in non-compliance of a previously approved

installation. This was acknowledged as an important issue but was noted as out of scope for Council review.
- Information gaps can occur, such as incomplete designs or unavailable installation records.
- Dose constraints and regulatory assessments may be based on extreme or unrealistic occupancy levels, resulting in conservatism on conservatism, leading to excessive shielding requirements.

Recommendations to ARPANSA CEO

The Council recommends:

- That ARPANSA promote national uniformity and encourage all jurisdictions to engage with the RHC regarding a national uniform or common regulatory approach to shielding design, installation, verification, and approval.
- That there should be 'common' guidance on shielding design, including optimisation of material requirements against consistent dose constraints or dose rate targets.
- That the documents upon which the current shielding design methodology is based (NCRP 147 and BIR 2012) should be reviewed to assess whether the method of assessment remains fit for purpose in the Australian context, noting that computer-assisted design is used in other industries for radiation and nuclear safety, but will require new expertise and validation.
- That a guidance document for shielding design, installation and verification should be developed in consultation and in cooperation with assessors and design manufacturers. The guidance document should encompass a discussion about shielding philosophy which describes why certain approaches are being taken.
- In the longer term, the feedback and response to the guidance document would inform a Standard or Code of Practice which could be developed by ARPANSA for adoption by each jurisdiction, following the example of the Transport Code.

Kind regards

Jane Canestra

Jane Canestra
Chair
Radiation Health and Safety Advisory Council

Table 1 – Dose Constraints for Shielding Applied in each Jurisdiction.

Jurisdiction	Document	Publication Date	Dose constraints applied:	Comment
NSW	https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/radiation/150136-radiation-guideline-7.ashx	2015	**Occupationally exposed persons**: 100 µSv/wk = 5 mSv/yr **Members of the public:** 20 µSv/wk = 1 mSv/yr	Extremely detailed. Divides premises into low, medium and high risk and states the dose constraints and shielding requirements for each.
NT	https://digitallibrary.health.nt.gov.au/prodjspui/bitstream/10137/1021/1/Radation%20Protection%20Guideline%20on%20shielding%20design%20for%20new%20or%20old%20medical%20facilities.pdf	2011	**Controlled areas**: 0.1 mSv/wk = 5 mSv/yr **Uncontrolled areas**: 0.02 mSv/wk = 1 mSv/yr	Does not define controlled and uncontrolled areas in the document.
QLD	https://www.health.qld.gov.au/__data/assets/pdf_file/0019/1104661/premises-ionising-radiation-sources.pdf	2021	**Type 1 area**: 10 µSv/wk = 0.5 mSv/yr **Type 2 area**: 40 µSv/wk = 2 mSv/yr **Type 3 area**: 40 µSv/wk = 2 mSv/yr	Defines dose constraints by area type, with location of the radiation source being the reference.
SA	https://www.epa.sa.gov.au/files/15405_code_of_compliance_2.pdf	2022	**Occupationally exposed worker**: 5 mSv/yr **Any other person:** 1 mSv/yr	Defines radiation premises into 3 categories, however dose constraints do not differ between them.
TAS	https://www.health.tas.gov.au/sites/default/files/2022-04/Radiation%20Protection_Guideline_Design%20and%20Validation%20of%20Shielding%20of%20Diagnostic%20X-ray%20Facility_20220401.pdf	2022	**BIR methodology**: Occupational exposed persons: 6 mGy/yr Members of the public: 1 mGy/yr **NCRP 147 methodology**: Occupational exposed persons: 5 mGy/yr Members of the public: 0.25 mGy/yr	Gives the option of using the BIR 2012 methodology or NCRP 147 methodology when calculating shielding.

VIC	https://content.health.vic.gov.au/sites/default/files/migrated/files/collections/policies-and-guidelines/d/documents-required-with-management-licence-applications-and-notifications---pdf.pdf	2018	Victoria does not currently apply dose constraints. Shielding design is expected to achieve a reduction in transmitted radiation such that the relevant limits prescribed in the Radiation Regulation 2017 are not exceeded	The document link referenced in this table provides details on the requirements for shielding assessment reports.
WA	https://www.radiologicalcouncil.wa.gov.au/~/media/RadiologicalCouncil/Documents/PDFs/Radiation-Shielding-Requirements-for-Diagnostic-X-ray-Facilities.pdf	2022	**10% of the occupational** and **50% of the public** annual effective dose limits respectively. Equates to 2 mSv/yr and 0.5 mSv/yr respectively	Regarding these dose constraints, the document states: *"These conservative guidelines acknowledge that the dose limits have been consistently reduced over time and apply the ALARA principle recommended by the International Commission on Radiological Protection."*
ACT	https://www.health.act.gov.au/businesses/radiation-safety/register-radiation-source	Unknown when last updated.	**Controlled areas**: 2 mSv/yr **Other areas**: 0.5 mSv/yr **Or blanket design constraint** of 0.5 mSv/yr for entire department	Details shielding height limits across different modalities.
Commonwealth	ARPANSA Regulatory Guide Plans & Arrangements for Managing Safety https://www.arpansa.gov.au/regulation-and-licensing/licensing/information-for-licence-holders/regulatory-guides/regulatory-guide-plans-and-arrangements	2023	3.4 The optimisation of the protection and safety measures associated with any particular conduct or dealing must be subject to dose constraints, the value of which is agreed by ARPANSA. Selection of dose constraints should be based on international best practice. 3.24 The workplace has been planned and designed to ensure that:	As a guide, the dose constraint is arrived at on a case-by-case basis and usually articulated at the time of licence application/assessment or during an application for approval to make a change with significant implications for safety.

			• Doses, including effective dose and equivalent dose, are in compliance with prescribed dose limits and are as low as reasonably achievable (ALARA), economic and social factors being taken into account, and that appropriate dose constraints have been used. • For each radiation source, the level of radiation protection provided is optimised so that both individual and collective (normal and potential) exposures are kept ALARA. • Exposure to ionising radiation is in compliance with a source related dose constraint of 10% of the effective dose limits specified in the Regulations (or another percentage agreed with the CEO). • Exposure to non-ionising radiation is kept below relevant exposure limits to the lowest level that can be achieved.	
	RPS C-1 (Rev.1) https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/codes-and-standards/rpsc-1	2020	3.1.13 The Responsible Person must ensure that radiation protection is optimised by the adoption of appropriate dose constraints into the radiation management plan during: (a) all stages of development and operation of the practice (b) the design, construction and operation of the workplace (c) design and implementation of work procedures. 3.1.14 The Responsible Person must for each dose constraint that has been adopted, demonstrate that: (a) the level of protection achieved is compatible with that constraint	Overarching general requirement imposed on all Commonwealth licence holders.

			(b) an appropriate review is undertaken if the constraint has been exceeded.	
	AS/NZS 2243.4:2018 https://www.standards.org.au/search-for-a-standard	2018	4.2.2 Supervised Areas If exposure conditions in a supervised area could lead to an effective dose of greater than 1mSv/y or an equivalent dose greater than 10% of any relevant dose limit, the area shall be designated a controlled area.	Applicable where AS/NZS 2243.4 is applied as a condition of licence.