Optimisation of radiation protection in practice: an ANSTO perspective

Sarah Turek, H. Lake, J. Saratsopoulos, A. Le Brun, A. Popp

Australian Nuclear Science and Technology Organisation (ANSTO)

ID#178

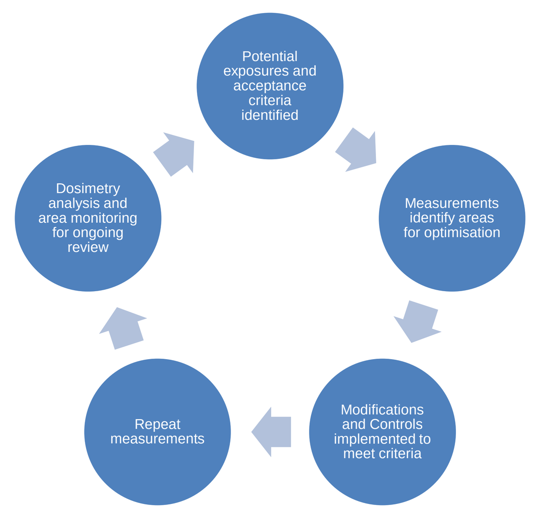
Australian Government | ANSTO Science. Ingenuity. Sustainability.

This poster presents experiences of optimisation of radiation protection for new instruments and practices at ANSTO. Two significantly different radiation sources were assessed with the same fundamental approach: applying the Hierarchy of Controls to decision making to achieve the best level of protection under the prevailing circumstances.

Introduction

Optimisation of protection is a process that is at the heart of a successful radiological protection program and is a frame of mind.

The variety of radiation sources at ANSTO encompasses the breadth of the health physics field, and with steady growth of practices in the nuclear research and nuclear medicine production capabilities there is continued scope for optimisation of both new and existing undertakings.



Decision making process

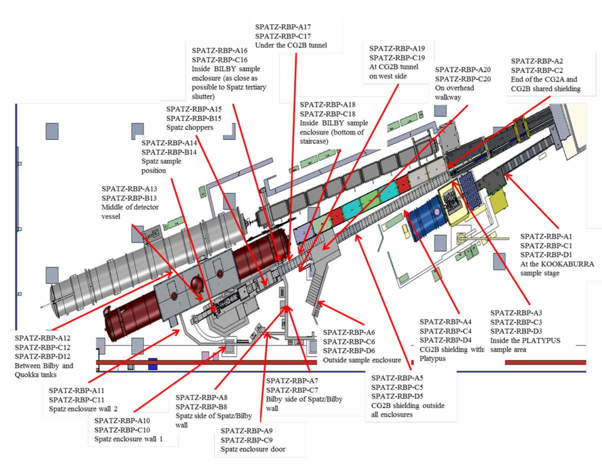
In order to achieve exposures that are ALARA the hierarchy of controls can be applied to decision making, with consideration for societal and economic factors.

In each case described here the optimisation approach, while following the hierarchy, is specific to the hazards identified and commensurate to the level of risk.

The acceptance criteria in each case was determined with respect to the expected occupancy for planned work and potential inherent (unmitigated) dose consequence.

Australian Centre for Neutron Scattering - SPATZ neutron beam instrument

The SPATZ time-of-flight reflectometer is a neutron beam instrument (NBI) located on the Cold Neutron Guide (CG2B) in the Neutron Guide Hall of the Australian Centre for Neutron Scattering (ACNS).



Hot commissioning of SPATZ used cold neutrons (λ ~ 2 – 20 Å, E ~ 0.2 – 20 meV) at various instrument operating configurations with low, intermediate, and high reactor powers. Gamma and neutron dose rate measurements were taken at pre-determined survey points.

Elimination of Fast Neutrons

- The beam monitor, able to sit in and out of the neutron beam, was identified as a major source of the neutron dose measured.
- Substitution of the fission-type beam monitor with a 3He-type monitor eliminated the source of fast neutrons.

Additional Shielding

- At the beam monitor a 50mm thick stainless steel U-shaped culvert, internally lined with 5mm thick neutron absorbing material, was installed over the existing lead culverts.
- Neutron-absorbing material was also applied to the CG2B guide extension and pre-sample guide tube.

Engineered Interlock

- Initial condition for the safety interlock system (SIS) to allow opening of SPATZ shutters - at least one chopper rotating above 10Hz.
- Engineered SIS control implemented requiring at least three choppers to be rotating above 10Hz for opening of the shutters.

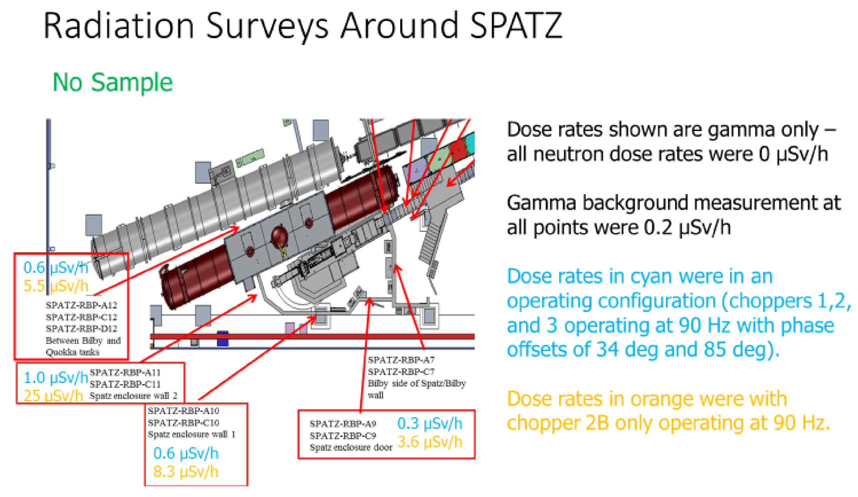
Administrative Controls

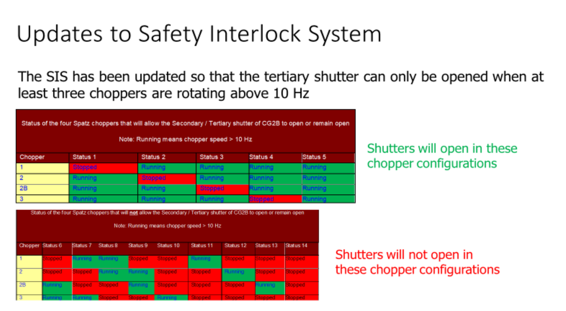
- Access controls used to limit personnel exposure include procedures and a No Loiter zone indicated by a painted floor area and signage.
- Use of this area for equipment storage additionally limits access.

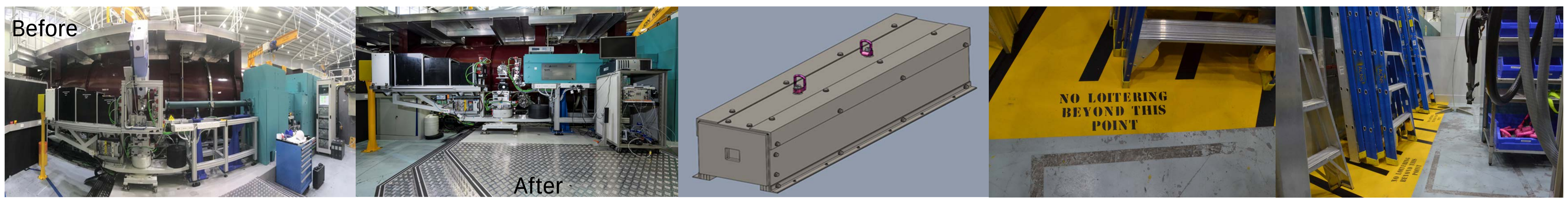
Results

Following the application of controls and modifications most of the identified survey points meet the design criteria

The two points exceeding the criteria do not indicate personnel exposure under normal conditions, and as a result radiation protection measures were considered to be optimised.







Nuclear Medicine - OncoBeta production

Rhenium-SCT is a therapeutic product using the radioisotope Rhenium-188, a high-energy beta emitter with a short physical half-life.

The same characteristics making this an effective treatment for non-melanoma skin cancer also present significant occupational radiation hazards. Risk assessment of the process identified Very High inherent (unmitigated) risk of Equivalent dose to the lens of the eyes, and High inherent risk of Equivalent dose to the extremities and skin. Hot cell containment is a required isolation and engineering control.

In addition to hot commissioning of the production process, homogeneity testing for product validation was identified as a regulatory requirement. This work with unsealed source material was proposed to be undertaken in a fume cupboard, rather than the enclosed hot cell. A questionnaire was developed by the Radiation Protection Advisor to initiate optimisation of the radiation protection aspects of this activity, using the hierarchy of controls as a guide.

Re-188
Half-life 17.005h
Parents W-188 (β- 100%), Re-188m (IT 100%)
Decay radiation β- 100%
Max Beta Decay Energy 2120.42keV
Decay product Os-188 (stable)

Results

Response to the questionnaire identified Substitution and Engineering controls along with Administrative controls and PPE, and from this potential exposures were determined to be optimised.

Exposure type	Estimated annual individual dose (mSv)					
	Inherent before controls			Residual after controls		
	Dose (mSv)	Impact	Risk rating	Dose (mSv)	Impact	Risk rating
Effective dose	0.12	Minor	Low	0.01	Negligible	Low
Equivalent dose to the Lens of the Eye	6.17	Minor	Low	3.10	Minor	Low
Equivalent dose to the Extremities	94.57	Moderate	Medium	9.46	Minor	Low

Optimisation Questionnaire

HIGHEST LEVEL OF PROTECTION — MOST RELIABLE

Elimination

- Product homogeneity testing has external radiation exposure and contamination skin dose risks. Does the Homogeneity test need to be performed?
- Can homogeneity testing be achieved without the radioactive component of the compound?

Substitution

- Regardless of the expected activity produced in each carpoule via the elution process, what is the minimum Re-188 activity required for homogeneity testing?
- The production process may give higher than expected yield and carpoules containing more activity than needed for testing. Is it possible to decay the carpoule and reduce the Re-188 activity prior to preparation of the testing samples?
- Is it possible to dilute the product to reduce the concentration of radioactivity in the carpoule and testing samples? If so, how much dilution is possible?

Isolation

- Can this testing be performed inside a closed hot cell?

Engineering

- Can the purpose designed applicator used in clinical settings be used during the testing process to provide a physical guard and shielding to the hand?
- Have any other Engineering Controls been considered?

Administration

- Is the test activity described in an instruction or procedure, and has training against the procedure taken place with non-radioactive materials in preparation to undertaking the testing?

PPE

- Is there any task-specific PPE that may be worn?

LOWEST LEVEL OF PROTECTION — LEAST RELIABLE