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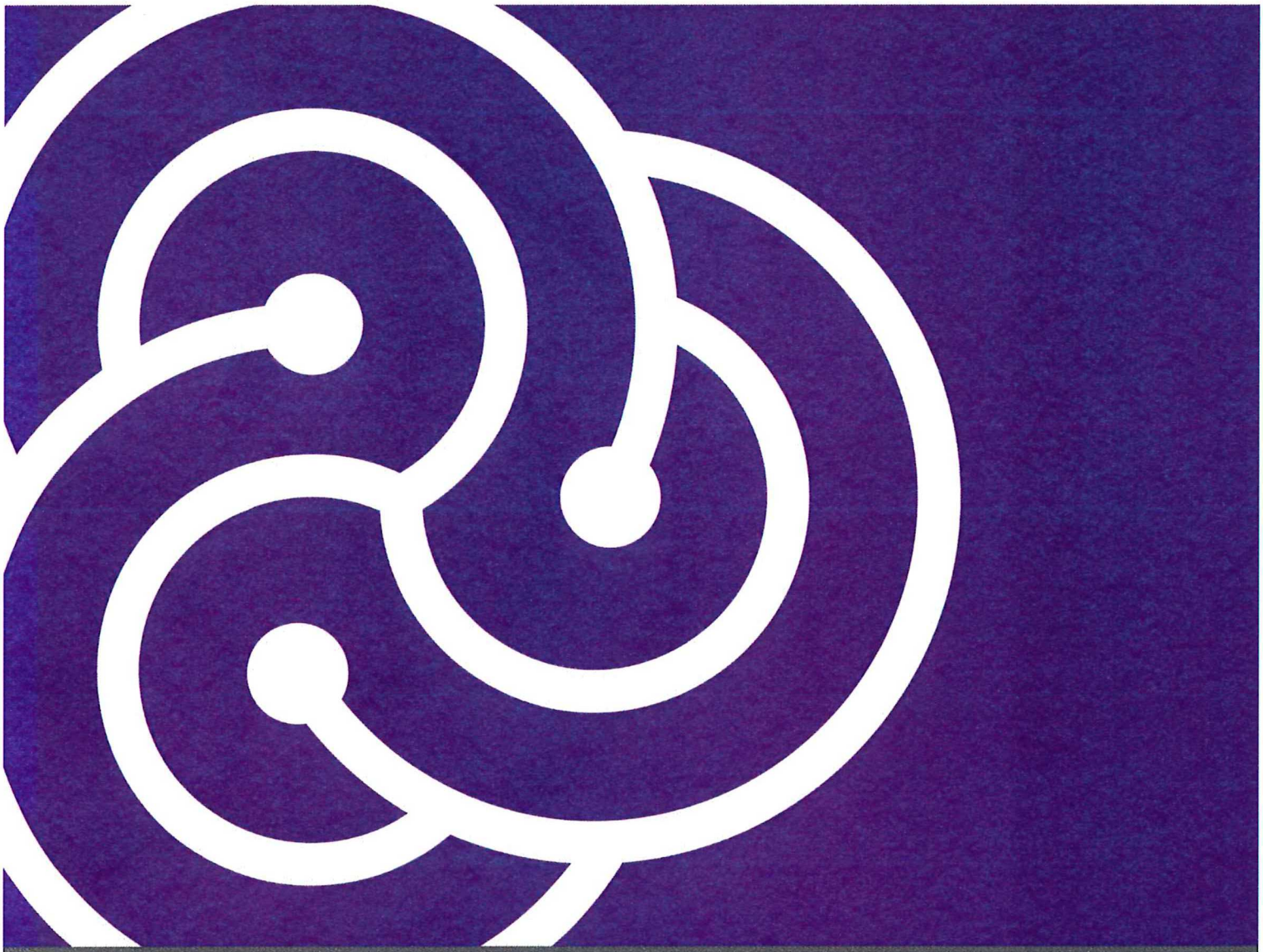
Code for Radiation Protection in Planned Exposure Situations

Radiation Protection Series C-1 (Rev. 1)



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January 2020

Radiation Protection Series

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) publishes Fundamentals, Codes and Guides in the Radiation Protection Series (RPS), which promote national policies and practices that protect human health and the environment from harmful effects of radiation. ARPANSA develops these publications jointly with state and territory regulators through the Radiation Health Committee (RHC), which oversees the preparation of draft policies and standards with the view of their uniform implementation in all Australian jurisdictions. Following agreement and, as relevant, approvals at the Ministerial level, the RHC recommends publication to the Radiation Health and Safety Advisory Council, which endorses documents and recommends their publication by the CEO of ARPANSA.

To the extent possible and relevant for Australian circumstances, the RPS publications give effect in Australia to international standards and guidance. The sources of such standards and guidance are varied and include the International Commission on Radiological Protection (ICRP); the International Commission on Non-Ionizing Radiation Protection (ICNIRP); the International Atomic Energy Agency (IAEA); and the World Health Organization (WHO).

Fundamentals set the fundamental principles for radiation protection and describe the fundamental radiation protection, safety and security objectives. They are written in an explanatory and non-regulatory style and describe the basic concepts and objectives of international best practice.

Codes are regulatory in style and may be referenced by regulations or conditions of licence. They contain either general safety or security requirements which may be applicable for all dealings with radiation, or practice-specific requirements. They provide overarching requirements and are expressed as 'must' statements which are to be satisfied to ensure an acceptable level of safety and/or security.

Guides provide recommendations and guidance on how to comply with the Codes or apply the principles of the Fundamentals. They are written in an explanatory and non-regulatory style and indicate the measures recommended to provide good practice. They are generally expressed as 'should' statements.

These three categories of publications are informed by public comment during drafting and are subject to a process of assessment of regulatory impact.

All ARPANSA publications (including earlier editions of codes and guides for which ARPANSA is now responsible) are available in electronic format, and can be downloaded free of charge by visiting ARPANSA's website at https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series.

Further information can be obtained by telephoning ARPANSA on 1800 022 333 (free call within Australia) or +61 (03) 9433 2211.

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This publication was prepared jointly with the *Radiation Health Committee*. The *Radiation Health and Safety Advisory Council* advised the CEO to adopt the Code.

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The mission of ARPANSA is to protect people and the environment from the harmful effects of radiation.

Published by the Chief Executive Officer of ARPANSA in January 2020.

Acknowledgement of Country

ARPANSA respectfully acknowledges Australia's Aboriginal and Torres Strait Islander communities and their rich culture and pays respect to their Elders past and present. We acknowledge Aboriginal and Torres Strait Islander peoples as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely.

We recognise and value the ongoing contribution of Aboriginal and Torres Strait Islander peoples and communities to Australian life and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

Foreword

The management of risks from ionising radiation requires actions that are based on fundamental principles of radiation protection, safety and security. The *Fundamentals for Protection Against Ionising Radiation (2014)* (RPS F-1) was published as part of ARPANSA's Radiation Protection Series (RPS) to provide an understanding of the effects of ionising radiation and associated risks for the health of humans and of the environment. RPS F-1 is the top tier document in the Australian national framework to manage risks from ionising radiation and explains how radiation protection, safety and security can work individually and collectively to manage such risks. Finally, it presents ten principles and their application in management of radiation risks.

RPS F-1 acknowledges that activities involving radiation are introduced for a purpose, and the regulatory framework should not unduly limit justified use of radiation. An exposure arising from the planned operation of a radiation source or facility that causes exposure to a radiation source is called a 'planned exposure' and in these planned exposure situations, some level of exposure can be expected to occur.

The *Code for Radiation Protection in Planned Exposure Situations,* RPS C-1, published in 2016, sets out the requirements in Australia for the protection of occupationally exposed persons, the public and the environment in planned exposure situations. The primary means of controlling exposure in planned exposure situations is by good design of facilities, equipment, operating procedures and through training – all of which contribute to optimisation of protection.

ARPANSA, jointly with state and territory regulators in the Radiation Health Committee (RHC), has developed this Code based on the 'requirements' relating to planned exposure situations described in the Safety Requirements of the International Atomic Energy Agency (IAEA); *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards General Safety Requirements Part 3, GSR Part 3* (IAEA 2014), generally referred to as the Basic Safety Standards or BSS. During the publication of RPS C-1, the dose limits for persons more than 16 years of age but under 18 years was omitted from this Code.

At the request of the Commonwealth Government of Australia, an international team of senior nuclear and radiation safety experts met with representatives of ARPANSA, Queensland Health, the New South Wales Environment Protection Authority, Victoria's Department of Health and Human Services, South Australia's Environment Protection Authority, Tasmania's Department of Health, Western Australia's Radiological Council, the Northern Territory's Department of Health, and the Australian Capital Territory's Health Protection Service from 5 to 16 November 2018 to conduct an Integrated Regulatory Review Service (IRRS) mission. The IRRS Mission identified that the established statutory dose limits comply with IAEA's GSR Part 3, with the exception of apprentices and students of 16 to 18 years of age, who are not specifically considered and, therefore, recommended to include the dose limits for this age group in RPS C-1. In order to address this recommendation the RHC agreed to amend RPS C-1 to include the dose limits for age group of 16 years to under 18 years. The amended Code was approved by the RHC in July 2019 as RPS C-1, Revision 1 (Rev. 1).

This publication, together with RPS F-1, supersede *Code for Radiation Protection in Planned Exposure Situations* (2016), RPS C-1.

This Code is intended to complement the requirements of the relevant Work Health and Safety legislation in each jurisdiction. The relevant regulatory authority should be contacted should any conflict of interpretation arise. A listing of such authorities is provided at www.arpansa.gov.au/Regulation/Regulators.

Carl-Magnus Larsson
CEO of ARPANSA

Contents

1. Introduction

1.1 Citation

This publication may be cited as the *Planned Exposure Code (2020)*.

1.2 Background

Australia's 1995 *Recommendations for limiting exposure to ionizing radiation, and National Standard for Limiting Occupational Exposure to Ionizing Radiation (republished March 2002)*, were based on the 1990 recommendations of the International Commission on Radiological Protection (ICRP 1990). The ICRP published updated recommendations in its *2007 Recommendations of the International Commission on Radiological Protection,* ICRP *Publication 103* (ICRP 2007). The recommendations in *ICRP 103* take a consistent approach for all types of radiation **exposure** situations, with the central consideration being the **optimisation** of **radiation protection**.

The International Atomic Energy Agency (IAEA) *Fundamental Safety Principles, Safety Fundamentals No. SF-1,* published in 2006 (IAEA 2006), together with the ICRP *Publication 103* recommendations and the guidance on nuclear **security** developed by the IAEA in collaboration with its Member States, have informed the development of the ARPANSA Radiation Protection Series publication RPS F-1, *Fundamentals for Protection against Ionising Radiation* (ARPANSA 2014). This publication sets out the underlying principles that form the basis of the system of radiation protection used to manage risks from **ionising radiation** in Australia. It is referred to as the *Fundamentals* in this Code.

The *Fundamentals* describe the basic concepts and objectives of international best practice for Australia in relation to radiation protection. Section 2 of this Code outlines the relationship between the *Fundamentals* and the management of **radiation risk**s in **planned exposure situations.** The Code is based on the relevant requirements of the IAEA's *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards General Safety Requirements Part 3, GSR Part 3* (IAEA 2014), which in a regulatory style (as 'shall' statements), integrates ICRP's *Publication 103* with the IAEA safety standards.

The requirements in Section 3 of this Code are derived from those listed in GSR Part 3 for planned exposure situations. Appendix 1 lists the requirements cross-referenced to GSR Part 3. GSR Part 3 is published on the IAEA website.

For national uniformity purposes, the numbered paragraphs within Section 3 of this Code may be applied across all jurisdictions, either singly or *in toto*, as licence conditions on authorised **practices** for users of **radiation sources**, should the **relevant regulatory authority** so require.

1.3 Purpose

The purpose of this document is to set out the requirements in Australia for the protection of **occupationally exposed persons**, the public and the **environment** from the harmful effects of ionising radiation in planned exposure situations.

This Code is directed principally to the **Responsible Person** who carries out an operation that results in planned exposures, and sets out the measures that must be put in place for radiation protection in such situations.

It is intended that relevant regulatory authorities around Australia will use this document in the regulation of radiation practices in planned exposure situations.

1.4 Scope

This Code applies to planned exposure situations and the control of **occupational exposure**, **public exposure** and **environmental exposure**. The requirements for planned exposure situations apply to the following practices:

(a) the production, supply and transport of **radioactive material** and of devices that contain radioactive material, including **sealed** and unsealed sources

(b) the production, testing and supply of devices that generate radiation, including linear accelerators, cyclotrons, and fixed and mobile radiography equipment

(c) any activities within the nuclear fuel cycle that involve or could involve exposure to radiation or exposure due to radioactive material

(d) the use of radiation or radioactive material for medical, industrial, veterinary, agricultural, legal or security purposes

(e) the use of radiation or radioactive material for education, training or research, including any activities relating to such use that involve or could involve exposure to radiation or exposure due to radioactive material

(f) the mining and processing of raw materials that involve exposure due to radioactive material

(g) any other practice as specified by the relevant regulatory authority.

The requirements of this Code should be applied using a **graded approach**. A Responsible Person also needs to comply with any requirements specified by the relevant regulatory authority, including the need for a Safety Assessment (clauses 3.1.17 to 3.1.19). Not all requirements specified in this Code are relevant for every practice or radiation source, or for all the actions specified in 3.1.10.

This Code does not apply to:

(a) **existing exposure situations**

(b) **emergency exposure situation**s, except for emergency situations arising from the planned operation of a radiation source or **facility**

(c) **medical exposure**

(d) participants in research involving exposure of human volunteers to radiation

(e) non-occupational exposure received as a consequence of assisting an exposed patient

(f) dealings with material below the **exemption level** prescribed by the relevant regulatory authority

(g) **dealing**s with bulk amounts[1] of material below the **clearance level** prescribed by the relevant regulatory authority.

1.5 Interpretation

The presence of the term ‘must’ when it appears in this Code indicates that the requirement to which it refers is mandatory.

[1] A bulk amount is considered to be more than the order of a tonne.

Each of the terms in bold type on first use has the meaning given in the Glossary together with any amplification given in this Code. In particular, the term ‘radiation’ means ‘ionising radiation’, as defined in the Glossary.

2. Objectives of radiation Protection for Planned Exposure Situations

The *Fundamentals* outlines the system of radiation protection in Australia. Section 4 of the *Fundamentals* describes the ten principles that guide actions to manage radiation risks to protect human health and the environment from the possible harmful effects of ionising radiation, namely:

1. Clear division of responsibilities
2. Legislative and regulatory framework
3. Leadership and management for safety
4. **Justification**
5. Optimisation of protection
6. Limitation of risks
7. Protection of present and future generations
8. Prevention of **accident**s and malicious acts
9. Emergency preparedness and response
10. Protective actions to reduce existing or unregulated radiation risks.

The wording of each of these principles can be found in Appendix 2.

The approach to radiation protection taken in the *Fundamentals* is based on three types of radiation exposure situations: planned, emergency, and existing exposure, consistent with the *Recommendations of the International Commission on Radiological Protection, ICRP Publication 103* (ICRP 2007).

A planned exposure situation arises from the deliberate introduction or operation of a radiation source or facility that results in an exposure from a radiation source. In such situations, radiation protection can be planned in advance before exposures occur and the magnitude and extent of exposures can be reasonably predicted.

The approach to managing radiation risks in planned exposure situations is guided by principles 1 - 8. Principles 9 and 10, concerning protective actions to reduce emergency and existing or unregulated radiation risks, are covered in corresponding RPS publications on radiation protection in emergency and existing exposure situations.

Controlling exposure in planned exposure situations is achieved through good design of facilities, equipment, adherence to established operating procedures, and effective implementation of the radiation management plan. In that manner, protection of those exposed (e.g. workers and the public, and organisms in the environment) can be **optimised** (see 2.2). In the case of workers and the public, **dose limits** are set and must be complied with in order to ensure there is an adequate level of radiation protection.

It should be noted that rather than classify workers, *ICRP 103* recommends the classification of work areas as **controlled areas** and **supervised areas**.

2.1 Justification

Regulation of planned exposure situations in Australia is well established. Each state and territory has its own radiation regulator, the relevant regulatory authority, to oversee dealings with ionising radiation by the private sector and internal government departments within their respective jurisdictions. ARPANSA regulates Commonwealth entities around Australia and in some overseas locations. In consultation with the other jurisdictions, each relevant regulatory authority ensures that:

- provision is made for:
    - the justification of any type of practice
    - review of the justification, as necessary
- only **justified** practices are authorised.

However, the following practices are deemed to be not justified:

- practices, except for justified practices involving medical exposure, which result in an increase in radionuclide concentration, by the deliberate addition of a **radioactive substance** or by **activation**, in food, feed, beverages, cosmetics or any other commodity or product intended for ingestion, inhalation or percutaneous intake by, or application to, a person
- practices involving the use of radiation or radioactive substances in commodities or in consumer products such as toys and personal jewellery or adornments, which result in an increase in radionuclide concentration, by the deliberate addition of a radioactive substance or by activation
- human imaging using radiation that is performed as a form of art or for publicity purposes
- human imaging using radiation for theft detection purposes.

Human imaging using radiation that is performed for occupational, legal or health insurance purposes, and is undertaken without reference to clinical indication, is usually considered to be not justified. If, in exceptional circumstances, the relevant regulatory authority decides that such human imaging for specific practices is justified, the requirements of this Code will apply.

Human imaging using radiation for the detection of concealed objects for anti-smuggling purposes is normally deemed to be not justified. If, in exceptional circumstances, the relevant regulatory authority decides that the justification of such human imaging is to be considered, the requirements of this Code will apply.

Only the relevant regulatory authority will determine if human imaging using radiation for the detection of concealed objects that can be used for criminal acts, and that pose a national security threat, is justified. Where the relevant regulatory authority deems such human imaging to be justified, the requirements of this Code will apply.

Procedures with inspection imaging devices in which radiation is used to expose persons for the purpose of detection of concealed weapons, contraband or other objects on or within the body are considered to give rise to public exposure.

2.2 Optimisation and limitation

The principle of optimisation of protection requires that the likelihood of incurring exposures, the number of people exposed and the magnitude of the exposures should be all kept as low as reasonably achievable, taking into account economic and societal factors. The level of protection should be the best under prevailing circumstances and should provide for adequate margin of benefit over harm. The optimisation principle offers a means to take a graded approach to management of radiation risks and focuses on achieving an ethically acceptable outcome, within the boundaries of the legal system, based on balancing risks and benefits.

Furthermore, optimisation can be applied to effective management of environmental exposures. For activities that may give rise to environmental concern, it is important that assessments consider both human health and environmental endpoints, so that the best decision can be taken on the basis of a holistic understanding of radiation risks.

2.2.1 Constraints and limits

In planned exposure situations, a **dose constraint** provides a prospective source–related value of individual dose, which is set below the dose limit[2]. It is an operational tool to be established and used in the **optimisation of protection and safety** by the Responsible Person. Dose constraints are not dose limits but will support actions to prevent dose limits from being exceeded and assist in optimising protection. Exceeding a dose constraint does not represent non-compliance with regulatory requirements but should prompt a review of the cause of the dose constraint being exceeded and, if appropriate, follow-up action.

For occupational exposure the dose constraint is a value of individual dose used to narrow the range of options for managing the exposure such that only options resulting in a dose below the constraint are considered in the planning process. Actual doses are, thus, expected to be below the dose constraint in normal operation.

For public exposure in planned exposure situations, the relevant regulatory authority ensures the establishment or approval of dose constraints, taking into account the characteristics of the site and of the radiation source or facility, the scenarios for exposure and the views of interested parties. Measures should then be undertaken to optimise protection at or below the dose constraint and, as for occupational exposure, actual exposures are expected to be below the constraint in normal operation.

After exposures have occurred, the dose constraint may be used as a benchmark for assessing the suitability of the optimised strategy for **protection and safety** (referred to as the protection strategy) that has been implemented and for making adjustments as necessary. The setting of the dose constraint needs to be considered in conjunction with other health and safety provisions and the technology available.

Exposures may be either certain or almost certain to occur, or potential which means that they are not expected to occur but may do so under certain circumstances. Such **potential exposures** may be more appropriately approached by constraining the risk, or setting a risk criterion that, for example, outlines the requirements for protective capability of a disposal facility for radioactive waste in the distant future. The risk constraint can be formulated as the product of probability of the exposure, and resulting consequence. Optimisation can also be applied to reduce the risk. Dose constraints and risk constraints can be used in

[2] Dose limits for occupationally exposed persons and for members of the public are given in Schedules A and B, respectively, of this Code.

combination. The ambition is to reduce all doses to levels that are as low as reasonably achievable, economic and societal factors being taken into account.

2.3 Aligning safety and security objectives

Safety measures and security measures have in common the aim of protecting human life and health and the environment. These measures need to be applied, as necessary and appropriate, to all radiation sources, facilities and activities, and to radioactive material in any form.

The **safety** objective is the same as the objective of radiation protection, i.e. to protect people and the environment from the harmful effects of radiation. The *Fundamentals* state, consistent with the IAEA *Fundamental Safety Principles* (IAEA 2006), that measures should be taken to:

(a) restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, or any other radiation source

(b) control the radiation exposure of people and the release of radioactive material to the environment

(c) mitigate the consequences of such events if they were to occur.

The security objective can be described in similar terms, placing emphasis on the protection of people, property, society and the environment, from harmful effects of radiation following a security event. It links in with the protective elements of the *Code of Practice for the Security of Radioactive Sources (2007)* (RPS11), the objectives of which are to:

(a) achieve and maintain a high level of safety and security of radioactive sources

(b) prevent unauthorised access or damage to, and loss, theft or unauthorised transfer of, radioactive sources, so as to reduce the likelihood of accidental harmful exposure to such sources or the malicious use of such sources to cause harm to individuals, society or the environment

(c) mitigate or minimise the radiological consequences of any accident or malicious act involving a radiation source.

It is important that safety and security measures are designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

Security infrastructure and safety infrastructure need to be developed, as far as possible, in a well-coordinated manner. All organisations involved need to be made aware of the commonalities and the differences between safety and security so as to be able to factor both into development plans.

This Code (relating to safety) and RPS11 (relating to security) have been developed so that safety and security complement and enhance one another, recognising the synergies between them.

2.4 A graded approach to implementation

The requirements of this Code are intended to be applied in accordance with a graded approach, where the protective measures to be implemented are commensurate with the radiation hazard associated with the planned exposure situation. Not all the requirements of this Code are relevant for every practice or radiation source, or for all the actions specified in clause 3.1.10.

The concept of a graded approach relating to the implementation of the requirements in this Code refers to Requirement 6 of GSR Part 3, which states that:

> *The application of the requirements of these Standards in planned exposure situations shall be commensurate with the characteristics of the practice or the source within a practice, and with the likelihood and magnitude of exposures*.

2.5 The role of the Responsible Person

As defined in the Glossary of this Code, the Responsible Person will be, generally, the person who holds the **authorisation** to deal with a radiation source and will therefore have management responsibility over the radiation source along with control over who may use it.

The Responsible Person has the responsibility for setting up and implementing the technical and organisational measures necessary for protection and safety for the practices and radiation sources for which the relevant regulatory authority provides authorisation. The Responsible Person may designate a suitably qualified person to carry out tasks relating to these responsibilities but the Responsible Person retains the prime responsibility for protection and safety.

The Responsible Person is responsible for maintaining control over the sources of exposure for the protection of:

- workers who are occupationally exposed
- the public
- the environment.

While the responsibility for protection and safety remains consistent across the range of use of radiation sources, the magnitude of the task to maintain protection and safety will vary considerably. Clearly in accordance with a graded approach as outlined in clause 2.4 above, the technical and organisational measures needed for protection and safety of a low activity calibration source and those for a dental X-ray unit are far less than they would be for a high energy linear accelerator.

3. Safety Requirements for Planned Exposure Situations

This section of the Code outlines the general requirements on the Responsible Person (section 3.1) and more specific requirements that relate to occupational exposure (section 3.2) and exposure of the public and the environment (section 3.3).

The numbered paragraphs have varying degrees of applicability depending on the type of radiation source or facility, and the specifics of the relevant legal framework. They should be applied in a manner that is commensurate with the hazard and with the nature of the radiation source or facility. They can be used as licence conditions, either singly or *in toto,* by the relevant regulatory authority or authorities as deemed appropriate.

3.1 General requirements

Application of the principles of radiation protection

3.1.1 The Responsible Person must ensure protection and safety in planned exposure situations.

3.1.2 The Responsible Person must, commensurate with the radiation hazard associated with the planned exposure situation, ensure that the principles of radiation protection are applied so that:

(a) no practice is undertaken unless it is justified

(b) protection and safety are optimised

(c) no occupationally exposed person in their employ receives a dose in excess of the dose limits specified in Schedule A

(d) no member of the public receives a dose in excess of the dose limits specified in Schedule B.

3.1.3 The Responsible Person must ensure protection from exposure to radiation by the application of a hierarchy of radiation control measures that may include:

(a) elimination of the radiation exposure hazard

(b) substitution of the radiation hazard with something less hazardous

(c) incorporation of engineered controls to restrict radiation levels and intakes of radioactive materials in the workplace

(d) application of administrative controls through work procedures, training and installation of warning signs and labels, and restricting access to radiation by designation of controlled and supervised areas

(e) the use of appropriate personal protective equipment.

Radiation management plan

3.1.4 The Responsible Person must ensure that:

(a) a radiation management plan appropriate for the exposure situation[3] is developed, documented, resourced, implemented and regularly reviewed

(b) the radiation management plan implemented in accordance with sub-clause (a):

(i) adopts objectives for protection and safety in accordance with the requirements of this Code

(ii) applies measures for protection and safety that are commensurate with the radiation risks associated with the exposure situation both in normal operation and in the event of an **incident** or accident

(iii) is adequate to ensure compliance with the requirements of this Code.

3.1.5 The Responsible Person must ensure the radiation management plan addresses protection commensurate with the level of radiation risk that it seeks to mitigate of:

(a) occupationally exposed persons

(b) members of the public

(c) the environment.

3.1.6 The Responsible Person must:

(a) permit access by authorised representatives of the relevant regulatory authority to carry out inspections of the:

(i) radiation sources

(ii) facilities

(iii) protection and safety records

(b) cooperate in the conduct of inspections specified in sub-clause (a).

3.1.7 The Responsible Person must ensure that all necessary resources for implementing the radiation management plan are provided, including:

(a) personal protective equipment

(b) safety devices

(c) radiation monitoring equipment.

3.1.8 The Responsible Person must ensure that a **qualified expert**, who could be an employee of the Responsible Person, is identified and is consulted as necessary on the proper observance of this Code.

[3] The protection and safety elements of the radiation management plan are to be commensurate with the complexity of and the radiation risks associated with the activity in a graded manner.

Management for protection and safety

3.1.9 The Responsible Person must ensure that protection and safety are effectively integrated into the overall management system of the organisation for which they are responsible.

3.1.10 Unless specifically exempted or authorised by the relevant regulatory authority, a person must not, other than in accordance with the requirements of this Code and relevant legislation:

(a) adopt, introduce, conduct, discontinue or cease a practice, or

(b) as applicable, mine, extract, process, design, manufacture, construct, assemble, install, acquire, import, export, supply, provide, distribute, loan, hire, receive, site, locate, commission, possess, use, operate, maintain, repair, transfer, decommission, disassemble, transport, store or dispose of a radiation source.

3.1.11 Any person intending to carry out any of the actions specified in clause 3.1.10 must:

(a) submit a notification to the relevant regulatory authority of such an intention

(b) unless notification alone is sufficient, apply to the relevant regulatory authority for authorisation

(c) not carry out any of the actions specified in clause 3.1.10 until the relevant regulatory authority issues the relevant authorisation.

Optimisation of protection and safety

3.1.12 The Responsible Person must ensure protection of people and the environment from exposure to radiation by the application of radiation control measures that are designed to optimise protection, taking into account:

(a) the exposures controlled

(b) the societal and economic factors

(c) the impact on beneficial uses of radiation.

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

(b) an appropriate review is undertaken if the constraint has been exceeded.

Prevention and mitigation of accidents

3.1.15 The Responsible Person must:

(a) ensure that when any person reports a matter that may compromise radiation protection, appropriate action is taken to investigate and, if necessary, rectify the matter

(b) take appropriate action in the event of an incident or accident as set out in the radiation management plan

(c) report without delay to the relevant regulatory authority each incident or accident that exceeds criteria specified in the radiation management plan.

3.1.16 In the event of an incident or accident, the Responsible Person must advise the relevant regulatory authority as soon as practicable of:

(a) the cause of the incident or accident

(b) the consequences of the incident or accident

(c) the steps taken to remedy the situation

(d) the steps taken to prevent a recurrence.

Safety assessment

3.1.17 The Responsible Person must ensure that a safety assessment is conducted that is either generic or specific to the radiation source or facility for which the Responsible Person is responsible.

3.1.18 The Responsible Person must ensure that the safety assessment is documented and, where appropriate, is independently reviewed under the relevant management system.

3.1.19 Before the granting of an authorisation, the Responsible Person must ensure that the safety assessment is submitted to the relevant regulatory authority for review and assessment.

Record keeping

3.1.20 The Responsible Person must ensure that a record keeping system is implemented that includes the following:

(a) authorisations granted by the relevant regulatory authority

(b) the radiation management plan

(c) details of training courses and of participation by occupationally exposed persons

(d) details of radiation monitoring and dose assessment

(e) inventories of radiation sources and radioactive waste

(f) details of incidents and accidents involving exposure to radiation and of corrective measures taken.

3.1.21 The Responsible Person must ensure that records kept under this Code are available for inspection by the relevant regulatory authority.

3.1.22 The Responsible Person must ensure that records of doses assessed to have been received by an occupationally exposed person, including details of monitoring results and dose calculation methods, are kept:

(a) during the working life of the occupationally exposed person

(b) afterwards for not less than 30 years after the last dose assessment

(c) at least until the occupationally exposed person reaches, or would have reached, the age of 75 years.

3.1.23 When a practice terminates, the Responsible Person must pass to the relevant regulatory authority:

(b) the records of radiation doses assessed to have been received by:

(i) occupationally exposed persons in their employ

(ii) members of the public

(c) any other records specified by the relevant regulatory authority.

3.1.24 The Responsible Person must:

(a) keep records relating to exposure of the workforce

(b) provide a copy of the dose record of an occupationally exposed person to that person periodically, on request and on termination of employment

(c) provide details of the doses estimated to have been received by an occupationally exposed person to the relevant regulatory authority or its approved central record keeping agency.

Radiation generators and radioactive sources

3.1.25 The Responsible Person must ensure that:

(a) when a radiation source is not in use, it is stored in an appropriate manner for protection and safety

(b) arrangements are made promptly for the safe management of and control over **radiation generators** and radioactive sources once it has been decided to take them out of use.

Human imaging using radiation for purposes other than medical diagnosis, medical treatment or biomedical research

3.1.26 Where the relevant regulatory authority approves the use of radiation to expose persons for the purpose of detection of concealed weapons, contraband or other objects on or within the body, the Responsible Person must ensure that:

(a) the requirements for public exposure in planned exposure situations are applied

(b) optimisation of protection and safety is subject to any dose constraints for public exposure set by the relevant regulatory authority

(c) all persons who are to undergo procedures with inspection imaging devices in which ionising radiation is used are informed of the possibility of requesting the use of an alternate inspection technique that does not use ionising radiation, where available

(d) any inspection imaging device used for the detection of concealed objects on or within the body, whether it is manufactured in or imported into the jurisdiction in which it is used, conforms to applicable standards of the:

(i) International Electrotechnical Commission
(ii) International Organization for Standardization
or
(iii) equivalent national standards.

3.2 Requirements for Occupational Exposure

The requirements relating to occupational exposure in planned exposure situations apply to occupational exposure:

- due to a practice or a radiation source within a practice
- as required in emergency exposure situations
- as required for existing exposure situations.

For exposure due to **natural sources**, these requirements for occupational exposure in planned exposure situations apply, as appropriate, only to the exposure situations as follows:

- Exposure due to material in any practice specified in the Scope of this Code where the activity concentration in the material of any radionuclide in the uranium decay chain or the thorium decay chain is greater than 1 Bq/g or the activity concentration of ^{40}K is greater than 10 Bq/g.
- Exposure due to ^{222}Rn and to ^{222}Rn progeny and due to ^{220}Rn and to ^{220}Rn progeny in workplaces in which occupational exposure due to other radionuclides in the uranium decay chain or the thorium decay chain is controlled as a planned exposure situation.
- Exposure due to ^{222}Rn and to ^{222}Rn progeny where the annual average activity concentration of ^{222}Rn in air in workplaces remains above the reference level for existing exposure situations as established by the relevant regulatory authority.

Responsibilities of the Responsible Person for the protection of workers

3.2.1 The Responsible Person must ensure that a radiation monitoring program for occupational exposures is established and maintained, which addresses:

(a) identification of sources of radiation exposure and pathways

(b) radiation dose assessment allowing for all exposure pathways

(c) detection of changes in the circumstances of exposure

(d) acquisition of sufficient information to enable optimisation measures to be adopted and reviewed

(e) appropriate monitoring methods.

3.2.2 The Responsible Person must ensure that each person exposed to radiation from a radiation source that is not required by or directly related to that person's work has the same level of protection against such exposure as a member of the public.

Compliance by workers

3.2.3 The Responsible Person must ensure that each occupationally exposed person in their employ complies, to the extent that the occupationally exposed person is capable, with all reasonable measures to control and assess exposure to radiation in the workplace, including:

(a) the radiation protection requirements specified in the radiation management plan

(b) the legitimate instructions of the Responsible Person in relation to radiation protection

(c) participation in training related to radiation protection, as required

(d) proper use of the training received to ensure their own health and safety and that of other persons

(e) proper use of protective and monitoring equipment provided

(f) on employment, provide to the Responsible Person, or assist the Responsible Person to obtain, details of their prior occupational radiation exposure, as necessary

(g) reporting to the Responsible Person any matter of which they are aware that may compromise radiation protection.

Cooperation between Responsible Persons

3.2.4 Where applicable, the Responsible Person must engage with other Responsible Persons at the same site[4] to ensure coordination of radiation protection efforts at the site.

Assessment of occupational exposure and workers' health

3.2.5 The Responsible Person must arrange for appropriate radiation monitoring to the extent necessary to:

[4] For example, as a member of a site radiation management committee.

(a) demonstrate the effectiveness of the measures for protection and safety

(b) assess external radiation doses

(c) assess intakes of radionuclides and the committed **effective dose**s.

3.2.6 The Responsible Person must ensure that sufficient evidence is kept to be able to demonstrate at any time that:

(a) all doses estimated to have been received by occupationally exposed persons in their employ are below the relevant limit in Schedule A

(b) all doses to members of the public are below the relevant limit in Schedule B

(c) optimisation of radiation protection has been carried out.

Information, instruction and training

3.2.7 The Responsible Person must provide induction training, refresher training and other relevant information to occupationally exposed persons.

3.2.8 The Responsible Person must ensure that the type and level of training required and its method of presentation is:

(a) consistent with the training needs of the occupationally exposed persons

(b) commensurate with the radiation risks associated with the workplace.

3.2.9 The Responsible Person must ensure that all personnel who may be exposed to radiation in their work have appropriate education, training and qualification so that they:

(a) understand their responsibilities

(b) can perform their duties competently, with appropriate judgement and in accordance with the Responsible Person's radiation management plan.

3.2.10 The Responsible Person must document the induction and training programs conducted in accordance with the radiation management plan and record participation.

Conditions of service

3.2.11 The Responsible Person must make all reasonable efforts to provide a worker with suitable alternate employment if it has been determined that the worker, for health reasons, may no longer continue in employment under conditions where they may be exposed to radiation exceeding the effective dose limit for a member of the public specified in Schedule B. The determination may be made either by:

(a) the relevant regulatory authority
or

(b) based on the framework of the program for workers' **health surveillance** in accordance with the requirements of this Code.

Requirements for protection and safety for female workers and for persons under 16 years of age and persons under 18 years of age but more than 16 years of age

3.2.12 The Responsible Person must ensure that when an occupationally exposed female has declared to the Responsible Person that she is pregnant or is breast-feeding, additional controls are considered to protect the embryo/foetus or breast-fed infant to a level similar to that provided for members of the public.

3.2.13 The Responsible Person must ensure that no person under the age of 16 years is or could be subject to occupational exposure.

3.2.14 The Responsible Person must ensure that persons under the age of 18 but more than 16 years are not subject to occupational exposure unless they are under supervision and only for the purpose of training for employment or for the purpose of studies in which sources are used.

3.3 Requirements for Public and Environmental Exposure

The requirements relating to public exposure in planned exposure situations apply to public exposure due to a practice or a radiation source within a practice. For exposure due to natural sources, such requirements apply only to the following types of public exposure:

- exposure due to material in any practice specified in the Scope of this Code where the activity concentration in the material of any radionuclide in the uranium decay chain or the thorium decay chain is greater than 1 Bq/g or the activity concentration of ^{40}K is greater than 10 Bq/g
- exposure due to discharges or due to the management of radioactive waste arising from a practice involving this type of material.

Radioactive waste and discharges

3.3.1 The Responsible Person must ensure that disposal of radioactive material is only carried out in accordance with an authorisation issued by the relevant regulatory authority that takes protection of the public and the environment into account.

3.3.2 Where a practice generates radioactive waste, the Responsible Person must ensure that the radiation management plan specified in clause 3.1.4 includes a section on radioactive waste management.

Monitoring and reporting

3.3.3 The Responsible Person must ensure that:

(a) a monitoring program, sufficient to verify and demonstrate compliance with the authorisation, is implemented to confirm that public exposure due to any radiation source within the practice is adequately assessed

(b) the monitoring program specified in sub-clause (a) includes monitoring of, as appropriate:

(i) external exposure due to such sources
(ii) discharges
(iii) radioactivity in the environment
(iv) other parameters important for the assessment of public exposure

(c) appropriate records are maintained of:

(i) the results of the monitoring program
(ii) estimated doses to members of the public

(d) the results of the monitoring program are reported or made available to the relevant regulatory authority at approved intervals, including, as applicable:

(i) the levels and composition of discharges
(ii) dose rates at the site boundary and in premises open to members of the public
(iii) results of environmental monitoring
(iv) retrospective assessments of doses to the **representative person**

(e) any levels exceeding the **operational limits and conditions** relating to public and occupational exposure are reported promptly to the relevant regulatory authority in accordance with reporting criteria established by the relevant regulatory authority

(f) any significant increase in dose rate or concentrations of radionuclides in the environment that could be attributed to the authorised practice is reported promptly to the relevant regulatory authority in accordance with reporting criteria established by the relevant regulatory authority

(g) a capability is maintained to conduct monitoring:

(i) in an emergency
(ii) in the event of an unexpected increase in radiation levels
or
(iii) of concentrations of radionuclides in the environment due to an accident or other unusual event attributed to the authorised radiation source or facility

(h) the adequacy of the assumptions made for the assessment of public exposure and the assessment for radiological environmental impacts is verified by a qualified expert

(i) results from radiation source monitoring and environmental monitoring programs and assessments of doses from public exposure are made available on request, as appropriate.

Schedule A Dose limits for occupationally exposed persons

The occupational dose limits for ionising radiation are as follows:

Type of limit	**Limit** (18 years and over)[1]	**Limit** (more than 16 years but under 18 years)[1,5]
Effective dose	20 mSv per year, averaged over a period of five consecutive years[2]	6 mSv per year
Annual **equivalent dose** to the lens of the eye	20 mSv per year, averaged over a period of five consecutive years[3]	20 mSv per year
Annual **equivalent dose** to the skin[4]	500 mSv per year	150 mSv per year
Annual **equivalent dose** to the hands and feet	500 mSv per year	150 mSv per year

1 The limits apply to the sum of the relevant doses from external exposure in the specified period and the 50-year committed dose from intakes in the same period.

2 With the further provision that the effective dose must not exceed 50 mSv in any single year. When a pregnancy is declared by an occupationally exposed female, the working conditions of that person should be such as to ensure that the additional dose to the embryo/foetus would not exceed about 1 mSv during the remainder of the pregnancy.

3 With the further provision that the equivalent dose must not exceed 50 mSv in any single year.

4 The equivalent dose limit for the skin applies to the dose averaged over 1 cm^2 of the most highly irradiated area of the skin. The dose to the skin also contributes to the effective dose, this contribution being the average dose to the entire skin multiplied by the tissue weighting factor for the skin.

5 Persons under the age of 16 years must not be subject to occupational exposure. Persons under the age of 18 but more than 16 years must not be subject to occupational exposure unless they are under supervision and only for the purpose of training for employment or for the purpose of studies in which sources are used.

Schedule B Dose limits for members of the public

The public dose limits for ionising radiation are as follows:

Type of limit	Dose Limit[1]
Effective dose	1 mSv per year[2]
Annual **equivalent dose** in the lens of the eye	15 mSv per year
Annual **equivalent dose** in the skin[3]	50 mSv per year

[1] The limits apply to the sum of the relevant doses from external exposure in the specified period and the 50-year committed dose (to age 70 years for children) from intakes in the same period.

[2] In special circumstances, a higher value of effective dose could be allowed in a single year, provided that the average over five years does not exceed 1 mSv per year.

[3] The equivalent dose limit for the skin applies to the dose averaged over any 1 cm^2 area of skin, regardless of the total area exposed. The dose to the skin also contributes to the effective dose, this contribution being the average dose to the entire skin multiplied by the tissue weighting factor for the skin.

Appendix 1: Derivation of existing planned exposure Code clauses from GSR Part 3 requirements

The following table cross-references each clause in Section 3 of this Guide to the relevant requirement in the Trusted International Standard, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards - General Safety Requirements, IAEA Safety Standards Series GSR Part 3 (IAEA 2014). GSR Part 3 is published on the IAEA website.

RPS C-1 (rev. 1)		IAEA GSR Part 3
Requirement	**Clause(s)**	**Requirement**
Application of the principles of radiation protection	3.1.2	Requirement 1
Application of the principles of radiation protection, Radiation Management Plan, Information, instruction and training	3.1.1, 3.1.4, 3.1.6, 3.1.8, 3.1.14, 3.2.9	Requirement 4
Radiation Management Plan, Management for protection and safety	3.1.5, 3.1.9-3.1.10	Requirement 5
Management for protection and safety	3.1.11	Requirement 7
Optimisation of protection and safety, Record keeping, Information, instruction and training	3.1.12, 3.1.20-3.1.21, 3.2.10	Requirement 9
Optimisation of protection and safety	3.1.13-3.1.14	Requirement 11
Dose limits	3.1.2(c) and (d)	Requirement 12
Safety assessment	3.1.17-3.1.19	Requirement 13
Record keeping	3.1.22-3.1.23	Requirement 14
Prevention and mitigation of accidents	3.1.15	Requirement 15
Investigations and feedback of information on operating experience	3.1.16	Requirement 16
Radiation generators and radioactive sources	3.1.25	Requirement 17
Human imaging using radiation for purposes other than medical diagnosis, medical treatment or biomedical research	3.1.26	Requirement 18

RPS C-1 (rev. 1)		IAEA GSR Part 3
Requirement	**Clause(s)**	**Requirement**
Responsibilities of the Responsible Person for the protection of workers	3.2.1-3.2.2	Requirement 21
Compliance by workers	3.2.3	Requirement 22
Cooperation between Responsible Persons	3.2.4	Requirement 23
Application of the principles of radiation protection, Radiation Management Plan	3.1.3, 3.1.7	Requirement 24
Assessment of occupational exposure and workers' health, Record keeping	3.1.24, 3.2.5-3.2.6	Requirement 25
Information, instruction and training	3.2.7-3.2.8, 3.2.10	Requirement 26
Conditions of service	3.2.11	Requirement 27
Requirements for protection and safety for female workers and for persons under 16 years of age and persons under 18 years of age but more than 16 years of age.	3.2.12-3.2.14	Requirement 28
Radioactive waste and discharges	3.3.1-3.3.2	Requirement 31
Monitoring and reporting	3.3.3	Requirement 32

Requirements up to and including Requirement 33 in GSR Part 3 that are not cross-referenced in the above table are obligations on the government, the regulatory body, or both and are therefore not included in this Code. The provisions in those Requirements are incorporated into the *National Directory for Radiation Protection* (RPS 6), or the legislation of the relevant regulatory authority for each Australian jurisdiction.

Requirements 34-42 in GSR Part 3 apply to **medical exposure** situations, Requirements 43-46 in GSR Part 3 apply to emergency exposure situations and Requirements 47–52 in GSR Part 3 apply to existing exposure situations. The provisions in those Requirements will be incorporated into separate documents in the Radiation Protection Series.

Appendix 2: The Ten Principles of Radiation Risk management from the Fundamentals for Protection against Ionising Radiation (2014)

The following ten principles of radiation risk management are explained in detail in Section 4 of the *Fundamentals for Protection Against Ionising Radiation (2014)* (RPS F-1):

1. **Clear division of responsibilities**

   The prime responsibility for management of radiation risks must rest with the person or organisation responsible for facilities and activities that give rise to radiation risks.

2. **Legislative and regulatory framework**

   An effective framework including legislation, regulation and guidance to promote management of radiation risks, including an independent regulatory body, must be established and sustained.

3. **Leadership and management for safety**

   Effective leadership and management of radiation risks must be established and sustained in organisations concerned with, and facilities and activities that give rise to, radiation risks.

4. **Justification**

   Facilities and activities that give rise to radiation risks must yield an overall benefit.

5. **Optimisation of protection**

   Protection must be optimised so that radiation risks are as low as reasonably achievable.

6. **Limitation of risks**

   Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm, and that the environment is protected.

7. **Protection of present and future generations**

   People and the environment, present and future, must be protected against radiation risks.

8. **Prevention of accidents and malicious acts**

   All practical efforts must be made to prevent and mitigate accidents, and acts with malicious intent, that may give rise to radiation risks.

9. **Emergency preparedness and response**

   Arrangements must be made for emergency preparedness and response for incidents, accidents and malicious acts that may give rise to radiation risks.

10. **Protective actions to reduce existing or unregulated radiation risks.**

    Protective actions to reduce existing or unregulated radiation risks must be justified and optimised.

Glossary

Absorbed dose, D

The fundamental dosimetric quantity D, defined as:

$$D = \frac{d\bar{\varepsilon}}{dm}$$

where $d\bar{\varepsilon}$ is the mean energy imparted by ionising radiation to matter in a volume element, and

dm is the mass of matter in the volume element.

The SI unit for absorbed dose is joule per kilogram (J/kg), termed the gray (Gy).

The energy can be averaged over any defined volume, the average dose being equal to the total energy imparted in the volume divided by the mass in the volume.

Absorbed dose is defined at a point; the mean absorbed dose in a specified tissue or organ of the human body is termed the organ dose.

Accident

Any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection and safety.

Activation

The process of inducing radioactivity in matter by irradiation of that matter.

Activity

The quantity, A, for an amount of radionuclide in a given energy state at a given time, defined as:

$$A(t) = \frac{dN}{dt}$$

where dN is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval dt.

The SI unit for activity is reciprocal second (s–1), termed the becquerel (Bq).

Authorisation

The granting by a relevant regulatory body of written permission for a Responsible Person to conduct specified activities.

Clearance level

A value, established by the relevant regulatory authority and expressed in terms of activity concentration, at or below which regulatory control may be removed from a source of radiation within a notified or authorised practice.

Controlled area

A defined area in which specific protection measures and safety provisions are or could be required for controlling exposures or preventing the spread of contamination in normal working conditions, and preventing or limiting the extent of potential exposures.

Discharges

Planned and controlled releases into the environment, as a legitimate practice, within limits authorised by the relevant regulatory authority, of liquid or gaseous radioactive materials.

Dose

1. A measure of the energy deposited by radiation in a target.
2. Absorbed dose, committed dose (i.e. committed equivalent dose or committed effective dose), effective dose, equivalent dose or organ dose, as indicated by the context.

Dose constraint

A prospective and source related value of individual dose (dose constraint) or of individual risk (risk constraint) that is used in planned exposure situations as a parameter for the optimisation of protection and safety for the source, and that serves as a boundary in defining the range of options in optimisation. For occupational exposures, a constraint on individual dose to workers used by Responsible Persons to set the range of options in optimising protection and safety for the source. For public exposure, the dose constraint is a source related value established or approved by the relevant regulatory authority, with account taken of the doses from planned operations of all sources under control.

Dose limit

The value of a quantity used in certain specified activities or circumstances that must not be exceeded.

Effective dose, *E*

The quantity *E*, defined as a summation of the tissue or organ equivalent doses, each multiplied by the appropriate tissue weighting factor:

$$E = \sum_{\mathrm{T}} w_{\mathrm{T}} \,.\, H_{\mathrm{T}}$$

where H_{T} is the equivalent dose in tissue or organ T, and
w_{T} is the tissue weighting factor for a tissue or organ T.

From the definition of equivalent dose, it follows that:

$$E = \sum_{\mathrm{T}} w_{\mathrm{T}} \,.\, \sum_{\mathrm{R}} w_{\mathrm{R}} \,.\, D_{\mathrm{T,R}}$$

where w_{R} is the radiation weighting factor for radiation type R, and
$D_{\mathrm{T,R}}$ is the average absorbed dose in the tissue or organ T delivered by radiation type R.

The SI unit for effective dose is joule per kilogram (J kg^{-1}), termed the sievert (Sv). An explanation of the quantity is given in Annex B of the ICRP Publication 103 (ICRP 2007).

Effective dose is a measure of dose designed to reflect the amount of radiation detriment likely to result from the dose.

Effective dose cannot be used to quantify higher doses or to make decisions on the need for any medical treatment relating to tissue reactions effects.

Values of effective dose from exposure for any type(s) of radiation and any mode(s) of exposure can be compared directly.

Emergency exposure situation

A situation of exposure that arises as a result of an accident, a malicious act, or any other unexpected event, and requires prompt action in order to avoid or reduce adverse consequences.

Environment

The conditions under which people, animals and plants live or develop and which sustain all life and development; especially such conditions as affected by human activities. Protection of the environment includes the protection and conservation of:

- non-human species, both animal and plant, and their biodiversity
- environmental goods and services such as the production of food and feed
- resources used in agriculture, forestry, fisheries and tourism
- amenities used in spiritual, cultural and recreational activities
- media such as soil, water and air
- natural processes such as carbon, nitrogen and water cycles.

Environmental exposure

The exposure of animals, plants and other organisms in the natural environment.

Equivalent dose

The quantity $H_{T,R}$, defined as:

$$H_{T,R} = w_R \cdot D_{T,R}$$

where $D_{T,R}$ is the absorbed dose delivered by radiation type R averaged over a tissue or organ T, and w_R is the radiation weighting factor for radiation type R.

When the radiation field is composed of different radiation types with different values of w_R, the equivalent dose is:

$$H_T = \sum_R w_R \,.\, D_{T,R}$$

The SI unit for equivalent dose is joule per kilogram (J kg^{-1}), termed the sievert (Sv). An explanation of the quantity is given in Annex B of the ICRP Publication 103 (ICRP 2007).

Equivalent dose is a measure of the dose to a tissue or organ designed to reflect the amount of harm caused.

Equivalent dose cannot be used to quantify higher doses or to make decisions on the need for any medical treatment relating to tissue reactions effects.

Values of equivalent dose to a specified tissue or organ from any type(s) of radiation can be compared directly.

Exemption

The determination by the relevant regulatory authority that a source or practice need not be subject to some or all aspects of regulatory control on the basis that the exposure and the potential exposure due to the source or practice are too small to warrant the application of those aspects or that this is the optimum option for protection irrespective of the actual level of the doses or risks.

Existing exposure situation

A situation of exposure that already exists when a decision on the need for control needs to be taken. Existing exposure situations include exposure to natural background radiation that is amenable to control; exposure due to residual radioactive material that derives from past practices that were never subject to regulatory control; and exposure due to residual radioactive material deriving from a nuclear or radiological emergency after an emergency has been declared to be ended.

Exposure

The state or condition of being subjected to radiation. External exposure is exposure to radiation from a source outside the body. Internal exposure is exposure to radiation from a source within the body.

Facility

A general term that includes nuclear facilities, irradiation installations, some mining and raw material processing facilities such as uranium mines, radioactive waste management facilities, and any other places where radioactive material is produced, processed, used, handled, stored or disposed of, or where radiation generators are installed on such a scale that consideration of protection and safety is required.

A facility includes one for which little or no regulatory control may be necessary or achievable. The more specific term ‘authorised facility’ should be used to distinguish those facilities for which the relevant regulatory authority has given any form of authorisation.

Graded approach

For a system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control.

Health surveillance

Medical supervision intended to ensure the initial and continuing fitness of workers for their intended tasks.

Incident

Any unintended event, including operating errors, equipment failures, initiating events, accident precursors, near misses or other mishaps, or unauthorised act, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of protection and safety.

Ionising radiation

For the purposes of radiation protection, radiation capable of producing ion pairs in biological material(s).

Justified

See ‘Justification’

Justification

For a planned exposure situation, the process of determining whether a practice is beneficial overall, i.e. whether the expected benefits to individuals and to society from introducing or continuing the practice outweigh the harm (including radiation detriment) resulting from the practice.

Medical exposure

Exposure incurred by patients as part of their own medical or dental diagnosis (diagnostic exposure) or treatment (therapeutic exposure) by persons, other than those occupationally exposed, knowingly, while voluntarily helping in the support and comfort of patients, and by volunteers in a program of biomedical research involving their exposure.

Natural source

A naturally occurring source of radiation, such as the sun and stars (sources of cosmic radiation) and rocks and soil (terrestrial sources of radiation), or any other material whose radioactivity is for all intents and purposes due only to radionuclides of natural origin, such as products or residues from the processing of minerals; but excluding radioactive material for use in a nuclear installation and radioactive waste generated in a nuclear installation.

Occupational exposure

Exposure of workers incurred in the course of their work.

Occupationally exposed person

A worker who is exposed to ionising radiation arising from work undertaken within a practice.

Operational limits and conditions

A set of rules setting forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by the relevant regulatory authority for safe operation of an authorised facility.

Optimisation of protection and safety

The process of determining what level of protection and safety would result in the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure being ‘as low as reasonably achievable, economic and societal factors being taken into account’ (ALARA).

Optimised

See ‘Optimisation’.

Planned exposure situation

The situation of exposure that arises from the planned operation of a source or from a planned activity that results in an exposure due to a source. Since provision for protection and safety can be made before embarking on the activity concerned, associated exposures and their probabilities of occurrence can be restricted from the outset. The primary means of controlling exposure in planned exposure situations is by good design of installations, equipment and operating procedures. In planned exposure situations, a certain level of exposure is expected to occur.

Potential exposure

Prospectively considered exposure that is not expected to be delivered with certainty but that may result from an anticipated operational occurrence or accident at a source or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors.

Practice

Any human activity that introduces additional sources of radiation or additional exposure pathways, or that modifies the network of exposure pathways from existing sources, so as to increase the exposure or the likelihood of exposure of people or the number of people exposed.

Protection and safety

The protection of people against exposure to ionising radiation or exposure due to radioactive material and the safety of sources, including the means for achieving this, and the means for preventing accidents and for mitigating the consequences of accidents if they do occur.

For the purposes of this Guide, 'protection and safety' includes the protection of people against ionising radiation and safety. It does not include non-radiation-related aspects of safety. 'Protection and safety' is concerned with both radiation risks under normal circumstances and radiation risks as a consequence of **incidents**, as well as with other possible direct consequences of a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation. Safety measures include actions to prevent incidents and arrangements put in place to mitigate their consequences if they were to occur.

Public exposure

Exposure incurred by members of the public due to sources in planned exposure situations, emergency exposure situations and existing exposure situations, excluding any occupational exposure or medical exposure.

Qualified expert

An individual who, by virtue of certification by appropriate boards or societies, professional licence or academic qualifications and experience, is duly recognised as having expertise in a relevant field of specialisation, e.g. medical physics, radiation protection, occupational health, fire safety, quality management or any relevant engineering or safety specialty.

Radiation

In this Code, the term ‘radiation’ refers only to ionising radiation unless otherwise stated.

For the purposes of radiation protection, ionising radiation is capable of producing ion pairs in biological material(s).

For most practical purposes, it may be assumed that strongly penetrating radiation includes photons of energy above about 12 keV, electrons of energy more than about 2 MeV, and neutrons.

For most practical purposes, it may be assumed that weakly penetrating radiation includes photons of energy below about 12 keV, electrons of energy less than about 2 MeV, and massive charged particles such as protons and alpha particles.

Radiation generator

A device capable of generating ionising radiation, such as X rays, neutrons, electrons or other charged particles, that may be used for scientific, industrial or medical purposes.

Radiation protection

The protection of people and the environment from harmful effects of exposure to ionising radiation, and the means for achieving this.

Radiation risk

Detrimental health effects of exposure to ionising radiation including the likelihood of such effects occurring, and other risks including environmental risks, that might arise from exposure to ionising radiation; the presence of radioactive material (including radioactive waste) or its release to the environment; or a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation; alone or in combination.

Radiation source

Anything that may cause radiation exposure — such as by emitting ionising radiation or by releasing radioactive substances or radioactive material — and can be treated as a single entity for purposes of protection and safety.

Radiation weighting factor

A number by which the absorbed dose in a tissue or organ is multiplied to reflect the relative biological effectiveness of the radiation in inducing stochastic effects at low doses, the result being the equivalent dose.

Values are selected to be representative of the relevant relative biological effectiveness and are broadly compatible with the values previously recommended for quality factors in the definition of dose equivalent. The radiation weighting factor values are:

Type of radiation	W_R
Photons	1
Electrons and muons	1
Protons and charges pions	2
Alpha particles, fission fragments, heavy ions	20
Neutrons	A continued function of neutron energy $w_{\mathrm{R}} = \begin{cases} 2.5 + 18.2\, e^{-[\ln(E_{\mathrm{n}})]^2/6}, E_n < 1\ MeV \\ 5.0 + 17.0\, e^{-[\ln(2E_{\mathrm{n}})]^2/6}, 1\ MeV \le E_n \le 50\ MeV \\ 2.5 + 3.25\, e^{-[\ln(0.04E_{\mathrm{n}})]^2/6}, E_n > 50\ MeV \end{cases}$

Note: All values relate to radiation incident on the body or, for internal radiation sources, radiation emitted from the incorporated radionuclide(s).

Radioactive material

Scientific meaning: Material exhibiting radioactivity; emitting or relating to the emission of ionising radiation or particles.

Regulatory meaning: Material designated by the relevant regulatory authority as being subject to regulatory control because of its radioactivity.

Radioactive substance

Scientific meaning: refers only to the presence of radioactivity, and gives no indication of the magnitude of the hazard involved.

Regulatory meaning: Designated by the relevant regulatory authority as being subject to regulatory control because of its radioactivity.'

Relevant regulatory authority

The radiation protection authority or authorities designated, or otherwise recognised, for regulatory purposes in connection with protection and safety relating to applications of ionising radiation. A list of relevant regulatory authorities in Australia can be found on ARPANSA's website at www.arpansa.gov.au/regulation-and-licensing/regulation/state-territory-regulators.

Representative person

An individual receiving a dose that is representative of the doses to the more highly exposed individuals in the population.

Responsible person[5]

In relation to any radiation source, prescribed radiation facility or premises on which radiation sources are stored or used means the legal person:

(a) having overall management responsibility including responsibility for the security and maintenance of the radiation source, facility or premises

(b) having overall control over who may use the radiation source, facility or premises

(c) in whose name the radiation source, facility or premises would be registered if this is required.

Safety

For the purposes of this Guide, 'safety' means the protection of people and the environment against radiation risks, and the safety of facilities and activities that give rise to radiation risks. 'Safety' as used here includes the safety of nuclear installations, radiation safety, the safety of radioactive waste management and safety in the transport of radioactive material. It does not include non-radiation related aspects of safety.

Safety is concerned with both radiation risks under normal circumstances and radiation risks as a consequence of incidents, as well as with other possible direct consequences of a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation. Safety measures include actions to prevent incidents and arrangements put in place to mitigate their consequences if they were to occur.

Sealed (radioactive) source

A radioactive source in which the radioactive material is:

(a) permanently sealed in a capsule
or

(b) closely bonded and in a solid form.

Security

The prevention of, detection of, and response to, criminal or intentional unauthorised acts involving or directed at nuclear material, other radioactive material, associated facilities, or associated activities.

Supervised area

A defined area not designated as a controlled area but for which occupational exposure conditions are kept under review, even though specific protection measures or safety provisions are not normally needed.

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[5] Note: A Responsible Person has the same meaning as a Person Conducting a Business or Undertaking (PCBU), as defined in the Commonwealth *Work Health and Safety Act 2011*, who is conducting a business or undertaking that uses radiation and requires an authorisation under appropriate legislation.

Tissue weighting factor, w_T

A number by which the absorbed dose in a tissue or organ is multiplied to reflect the relative biological effectiveness of the radiation in inducing stochastic effects at low doses, the result being the equivalent dose.

Values are selected to be representative of the relevant relative biological effectiveness and are broadly compatible with the values previously recommended for quality factors in the definition of dose equivalent. The radiation weighting factor values are:

Tissue or organ	W_T	$\sum w_T$
Bone marrow (red), colon, lung, stomach, breast, remainder tissues*	0.12	0.72
Gonads	0.08	0.08
Bladder, oesophagus, liver, thyroid	0.04	0.16
Bone surface, brain, salivary glands, skin	0.01	0.04
Total		**1.00**

* The w_T for remainder tissues (0.12) applies to the arithmetic mean dose to these 13 tissues and organs for each sex: adrenals, extrathoracic region, gall bladder, heart, kidneys, lymphatic nodes, muscle, oral mucosa, pancreas, prostate (male), small intestine, spleen, thymus, uterus/cervix (female).

Unsealed (radioactive) source

A radioactive source in which the radioactive material is neither:

(a) permanently sealed in a capsule, nor

(b) closely bonded and in a solid form.

References

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) 2019. Code of Practice for the Security of Radioactive Sources. Radiation Protection Series No.11. [https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/codes-and-standards/rps11]

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