Australian Government

Australian Radiation Protection and Nuclear Safety Agency

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Code for Practice-Specific Requirements for Fixed and Portable Radiation Gauges

Radiation Protection Series C-X

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 authorisation. 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.

Standards provide a national reference point for radiation protection and safety. They mainly provide quantitative requirements, such as exposure limits and key procedural guidance regarded as essential for best practice in radiation protection. They may be referenced by regulators, authorities, industry and other stakeholders in State, Territory or Commonwealth jurisdictions.

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

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This publication was prepared jointly with the *Radiation Health Committee* and was approved by the Committee on <DD Month 202Y>. The *Radiation Health and Safety Advisory Council* advised the CEO to adopt the Code, subject to RHC approval, on <DD Month 202Y>.

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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 202<X>.

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 people 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

To be finalised prior to final publication

Gillian Hirth
CEO of ARPANSA

Contents

1. Introduction

1.1 Citation

This publication may be cited as the *Radiation Gauge Code (202<X>)*.

1.2 Background

Sealed radioactive sources and radiation generators housed in radiation gauges are used in a wide range of industries to improve the quality of products, optimise processes, and save energy and materials. The use of radiation gauges for measurement and process control is a well-established technology. The economic benefits of radiation gauges have been amply demonstrated, and there is clear evidence that the technology can be used safely and will continue to play an important role in a wide range of industries. [1]

In Australia, ionising radiation sources used for monitoring industrial processes are regulated under radiation control legislation enacted in each of the jurisdictions - States, Territories, and the Commonwealth.

There are three main categories of radiation gauges:

- Fixed shuttered – the gauge is permanently affixed and integrated into an industrial or commercial process. The gauge contains a shutter to minimise emissions from a radioactive source for safety reasons during maintenance or removal from service. The gauge shutter may require manual or electronic activation.
- Fixed shutterless – the gauge is permanently affixed and integrated into an industrial or commercial process. The gauge does not contain a shutter. To minimise radiation emissions from the gauge, the radiation source must be manually shielded (for radioactive sources) or electrically deactivated (for radiation generators).
- Portable moisture density – the gauge is manually deployed as required to conduct a measurement. The gauge typically contains a radioactive source that must be manually retracted from shielding by the user.

Radiation gauges exploit the interaction of radiation with material via one of the following processes:

- Transmission - radiation is attenuated as it travels through the material. To measure attenuation, the radiation source and detector are on opposite sides of the material. These gauges use radioactive sources (beta and gamma) or X ray generators, and are typically used to measure material density, thickness and fill-levels.
- Backscatter - radiation enters the material, interacts, and scatters. To measure backscatter, the source and detector are on the same side of the material, and the detector is shielded from the primary (direct) radiation. These gauges use radioactive sources (beta, gamma and neutron), and are typically used to measure material thickness.
- Reactive - radiation induces fluorescent X ray emissions in the material. These gauges use radioactive sources (low energy gamma ray and neutron) and X-ray generators, and are typically used for elemental analysis.

1.3 Purpose

The *Code for Radiation Protection in Planned Exposure Situations* (RPS C-1; ARPANSA 2020) sets out the requirements in Australia for the protection of occupationally exposed persons, the public and the environment in planned exposure situations. The responsibilities for radiation protection lie to a large degree with the Responsible Person. However, employees also have an important role to play in performing their duties safely.

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.

Annex A summarises the requirements of this Code, with reference to the related clauses of RPS C-1.

1.4 Scope

This document applies to the use of fixed and portable radiation gauges used for measurement in industry, agriculture and civil construction.

The use of radiation sources in well-logging devices is outside the scope of this Code and is addressed in: *Code for Practice-Specific Requirements for Well Logging with Sealed Radiation Sources* (RPS C-<X>; ARPANSA 202<X>).

The use of radiation sources for security purposes (e.g. X-ray inspection of luggage for dangerous items) is outside the scope of this Code and is addressed in:
Statement on Cabinet X-Ray Equipment for Examination of Letters, Packages, Baggage, Freight and Other Articles for Security, Quality Control and Other Purposes (RHS-21, NHMRC 1987).

2. Radiation protection and safety principles

2.1 Justification

The use of ionising radiation in various radiation gauges to monitor and improve process efficiency and quality is generally considered to be justified. This particular use of radiation has yielded an increase in productivity and efficiency of goods and service provision, whilst reducing energy use and cost. Mitigation of the risks associated with the use of radiation gauges has been routinely demonstrated to be sufficiently effective, confirming that applicable dose limits and constraints can be complied with, and more broadly ensuring that resulting doses remain as low as reasonably achievable. A combination of engineering and administrative controls together with appropriately trained personnel must be optimised in such practices to ensure appropriate radiation protection.

Whilst the use of radiation gauges is generally justified, the use of ionising radiation sources must always be assessed against the possible substitution or elimination of those sources. In some cases, radioactive sources may be replaced by electrically generated X-rays, such as in blood irradiators or production line inspection systems. Only measurement applications that cannot be achieved by means other than ionising radiation should employ this technology, and when deemed necessary, the lowest risk suitable radiation source should be used.

2.2 Radiation Protection Program

A justified radiation practice is subject to a radiation protection program informed by a Safety Assessment. The radiation protection program needs to address the planned exposure situations and, as appropriate, emergency exposure situations for the radiation practice.

The radiation protection program must cover the operating organisation's management structure, policies, responsibilities, procedures, and organisational arrangements. All these elements must be put in place by the Responsible Person to control radiation hazards and to optimise protection and safety.

The radiation protection program may be incorporated into the organisation's integrated management system for protection and safety. It may also be acceptable to manage elements of the radiation protection program separately, provided management of the program is carried out in a coordinated manner.

Detailed recommendations on establishing and maintaining a radiation protection program for the protection of workers according to international best practice are provided in:

- IAEA Safety Standards Series No. GSG-7, *Occupational Radiation Protection* (GSG-7; IAEA 2018); and
- IAEA Specific Safety Guide No. 58, *Radiation Safety in the Use of Nuclear Gauges* (SSG-58; IAEA 2020).

This international best practice guidance should be consulted to ensure the scope of the program is appropriate to the scale and complexity of the radiation practice.

2.3 Optimisation of Protection and Safety

To optimise protection and safety the Responsible Person must ensure that a Safety Assessment is carried out that identifies appropriate control measures and proportionate responses to the various planned exposure situations.

An important step in optimisation is the choice of appropriate dose constraints for the various activities involving the use of radiation gauges. Dose constraints are established based on the possible or likely exposure resulting from various exposure scenarios. Dose constraints provide a desired upper bound for the optimisation process. The level below the dose constraint at which the optimisation process may be ceased is determined by applying a graded approach.

2.4 The Safety Assessment

The primary objective of the Safety Assessment is to evaluate the adequacy of planned or existing measures for protection and safety, and to identify additional measures that need to be established. The Safety Assessment should consider both the exposure from routine activities, and the probability and magnitude of potential exposures arising from accidents or incidents.

An initial Safety Assessment is the primary tool for determining which control measures need to be enacted, and for confirming that all factors that have a bearing on protection and safety are considered. Following this initial assessment, a step-wise process is undertaken to reduce the detriment from a radiation practice by implementation of various control measures including engineering and administration, and those to deal with emergency situations.

The Safety Assessment should be progressed until detriment reduction can only be achieved by deploying resources disproportionate to the potential consequences. This step-wise process leads to the optimisation of protection and safety, provided that individuals are adequately protected.

Where the Safety Assessment indicates a realistic possibility of an accident or incident affecting people or the environment, the Responsible Person must first and foremost consider further mitigative controls. If the likelihood of an emergency situation remains possible following iterative implementation of further controls, a Hazard Assessment must be undertaken and suitable emergency plan must be prepared as part of the Radiation Management Plan. The primary goal of the emergency plan is to preserve life, and reduce the likelihood and severity of potential harm to people and the environment. To be effective, the emergency plan needs to be realistic for the situation and adequately resourced.

IAEA General Safety Requirements No. GSR Pt 4, Safety Assessment for Facilities and Activities (GSR Pt 4; IAEA 2016) discusses both the basis for requiring a Safety Assessment (Section 2 of GSR Pt 4) and the application of a graded approach for the optimisation of protection. GSR Pt 4 indicates that a Safety Assessment needs to include an assessment of:

- Provisions in place for radiation protection;
- Control of radiation risks within specified limits and constraints; and
- Reduction of radiation risk to a level that is as low as reasonably achievable.

GSR Pt 4 (Section 4 and Figure 1) provides further guidance on Safety Assessments.

The requirements of the Responsible Person for development of a Safety Assessment are presented in Section 2.4 of this Code, and further details of the Safety Assessment are presented in Annex B of this Code.

3. Safety requirements for use of radiation gauges

The Responsible Person must comply with the general requirements of the *Code for Radiation Protection in Planned Exposure Situations* (RPS C-1; ARPANSA 2020) presented in the following sections. Further practice-specific requirements for fixed and portable radiation gauges that follow from the general requirements of RPS C-1 are specified in each section.

3.1 Radiation Management Plan

Practice-specific requirements relate to the following general requirements of RPS C-1: Clauses 3.1.4 – 3.1.5, 3.1.7 – 3.1.8

Radiation management plan

3.1.4 The Responsible Person must ensure that:

(a) a radiation management plan appropriate for the exposure situation is developed, 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.

(c) the societal and economic factors

(d) the impact on beneficial uses of radiation.

3.1.5 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.

3.1.7 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.

The Radiation Management Plan (RMP) is the Responsible Person's documented radiation protection program. It is informed by a Safety Assessment (including Hazard Assessment) carried out for the radiation practice and contains or references content such as working rules, radiation monitoring requirements, dose constraints for various activities, emergency procedures, safe and secure storage and transport requirements for the radiation sources in the practice.

The Responsible Person must:

3.1.1 develop a RMP that makes use of the outputs from the Safety Assessment to ensure that working rules and work practices, storage and transport of radiation sources and exposure to the environment, members of the public and occupationally exposed persons are within limits and monitored against the dose constraints used in the Safety Assessment. The minimum mandatory requirements for a RMP are provided in Annex C.

3.1.2 review the RMP regularly according to expectations of the regulatory authority, and following changes to the practice or the occurrence of an incident or other unexpected event. The frequency of RMP review might be stipulated by legislation, or specified by the regulator, or linked to licence renewal cycle.

3.1.3 have a statement of the organisation's commitment to resourcing all the requirements specified in the RMP.

3.1.4 appoint a Radiation Safety Officer who is technically competent in radiation protection matters relevant to dealings with sealed sources and sealed source equipment and can assist the Responsible Person to oversee the application of regulatory requirements (see Annex F).

3.1.5 specify the roles and responsibilities of the Radiation Safety Officer in the Radiation Management Plan (see Annex C).

3.2 Safety Assessment

Practice-specific requirements relate to the following general requirements of RPS C-1: Clauses 3.1.12 – 3.1.14, 3.1.17 – 3.1.19

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.

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.

The primary objective of the Safety Assessment is to evaluate the adequacy of planned or existing measures for radiation protection and safety, and to identify any additional measures that need to be established. Both the exposure from routine activities and the probability and severity of potential exposures arising from accidents or incidents need to be considered.

The Safety Assessment is further discussed in Section 2.4 of this Code, and further details are presented in Annex B of this Code.

The Responsible Person must:

3.2.1 Develop and document a Safety Assessment which makes use of dose constraints for key activities within the practice such as work in controlled and supervised areas. The Safety Assessment will apply dose constraints based on typical exposure levels for workers in this type of radiation practice.

3.2.2 Submit the Safety Assessment to the relevant regulatory authority for review and assessment.

3.2.3 Demonstrate that the Safety Assessment has been and continues to be used to specify:

a) the program for maintenance, surveillance and inspection

b) the procedures to be put in place for all operational activities significant to safety, and for responding to anticipated operational occurrences and accidents

c) the necessary competences for the staff involved in the facility or activity; and to make decisions in an integrated, risk informed approach.

3.2.4 Conduct an annual review of the Safety Assessment and whenever any of the following factors apply:

a) When safety might be compromised or affected as a result of modifications to facilities or activities

b) When the acquisition of a new radiation source or a source with different characteristics is planned

c) When operating experience or the investigation of incidents, failures or errors indicates that current safety measures are invalid or are not fully effective

d) When significant changes to relevant standards, regulations or guidance have been made.

3.2.5 Ensure that any revisions or modifications of the Safety Assessment are reviewed and assessed in a timely manner as specified by the regulatory authority.

3.2.6 Ensure that the suitability of the Radiation Management Plan is assessed following any revision or modification of the Safety Assessment. Any resulting modifications to the RMP must be reviewed and assessed in a timely manner as specified by the regulatory authority, as these changes may impact safety as well as licence conditions.

3.3 Prevention and mitigation of accidents (incidents)

Practice-specific requirements relate to the following general requirements of RPS C-1: Clause 3.1.15

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.

Although the radiation sources and associated radiation gauge equipment incorporate engineered safety features, there remains a need for safe working procedures to ensure protection and safety. The Radiation Management Plan contains or refers to safe working procedures informed by the Safety Assessment. More broadly -a robust safety culture must be continually promoted and maintained within the organisation

The Responsible Person must:

3.3.1 promote individual and collective commitment to protection and safety at all levels of the organisation, including staff responsible for administration, security, storage facilities, operation, transport, assembly and maintenance of fixed and portable radiation gauges and sources, as appropriate

3.3.2 ensure a common understanding of the key aspects of safety culture within the organisation

3.3.3 support individuals and teams to perform radiation gauging activities safely and successfully, with account taken of the interactions between individuals, the radiation gauges and equipment, the company or organisation and the client

3.3.4 encourage open communication and participation of operating staff, radiation protection officer(s) and other workers in the organisation in the development and implementation of policies, rules and procedures dealing with protection and safety when using radiation

3.3.5 ensure accountability of the organisation and of individuals at all levels for protection and safety in the procurement, storage, installation, operation, maintenance, handling and safe management of radiation gauges until the safe disposal after the end of their useful life

3.3.6 encourage a questioning and learning attitude, discouraging complacency with regard to protection and safety, and providing means by which the organisation continually seeks to develop and strengthen its safety culture

3.3.7 ensure that personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment or discrimination

3.3.8 have a clearly documented process enabling the reporting of incidents both within the organisation and to the appropriate regulator

3.3.9 have clearly documented and well understood plans for dealing with the cause of an incident or accident

3.3.10 have clearly documented and well understood plans for analysis of an incident or accidents and incorporating the results of the analysis into processes and plans withing the organisation to reduce the likelihood of recurrence of similar incidents or accidents.

3.4 Record Keeping

Practice-specific requirements relate to the following general requirements of RPS C-1: Clauses 3.1.20 – 3.1.24

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:

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

(i) occupationally exposed persons in their employ

(ii) members of the public

(b) 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.

Record keeping is an important tool to aid in optimisation and to lessen the potential for incidents and accidents to occur. The organisation's record keeping arrangements should be specified in the RMP.

The Responsible Person must:

3.4.1 maintain records of radiation doses received by gauge users and persons who regularly enter controlled and supervised areas, and maintain dose records for the period specified in RPS C-1

3.4.2 maintain records that clearly identify any doses received because of incidents or while following emergency procedures, as distinct from doses received during routine work

3.4.3 ensure the records reflecting an individual's occupational dose is based on that recorded by the worker's primary individual dosimeter(s), issued by the dosimetry service, rather than the doses measured by additional devices such as electronic personal dosimeters or area dosimetry

3.4.4 maintain records of authorisations (licences), and radiation source inventories, current locations, and access

3.4.5 maintain records of radiation source acquisitions, disposals and transport

3.4.6 maintain records and documentation of radiation gauges including drawings, approvals, servicing, repairs, and modifications

3.4.7 maintain records and documentation of work practices, roles and responsibilities

3.4.8 maintain training records of persons who work in controlled and supervised areas

3.4.9 maintain records of accidents, incidents and near misses involving radiation sources and the analysis of these events and the corrective actions identified from the analysis

3.4.10 ensure records are readily available for inspection by the regulatory authority

3.4.11 specify record keeping requirements in the Radiation Management Plan.

3.5 Radiation Generators and Radioactive Sources

Practice-specific requirements relate to the following general requirements of RPS C-1: Clause 3.1.25

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

The regulatory authority may decline to licence or approve for transfer those gauges that do not comply with the *Equipment Standard for Radiation Gauges* (<XXXX>; ARPANSA, 202<X>), or gauges that are not currently approved under an applicable regulatory approval regime. The Responsible Person should ensure that the make, model and technical specification of gauges intended for licensing, as far as can be determined, conforms with the technical requirements of the Equipment Standard for Radiation Gauges and type approved equipment models. The Responsible Person should communicate with the regulatory authority to establish the suitability and conformity of gauges as early as possible in the device acquisition process.

The Responsible Person should ensure that sources are kept under proper control. This applies from the time the sources are first acquired until they are legally transferred to another owner, finally returned to their original supplier, or otherwise disposed of at the end of their useful/working life. The proper control of sources needs to address both the safety and security of the sources.

For instance, whenever radiation sources are stored at a primary storage location or at field sites, or under transport, the storage arrangements should provide radiation protection for persons and the environment in line with dose limits and the dose constraints set in the Safety Assessment. A security plan and procedures for transport, field use and storage of portable or mobile radiation sources should be developed using a security assessment. The security assessment should form part of the Safety Assessment, and the security plan should meet the minimum security requirements of this Code and be integral to the Radiation Management Plan.

The security arrangements for radiation sources and generators, whether they are stored at their primary storage location or in the field, should be designed to deter, detect, delay and respond to unauthorized access to the radioactive sources.

When radiation sources are no longer used, and there are no plans to use them again in the foreseeable future, they should be disposed of in a manner determined in consultation with, and approved by, the regulatory authority.

The Responsible Person must:

3.5.1 ensure that a radiation gauge model (including generic source), prior to possession and licensing, complies with the Equipment Standard for Radiation Gauges. Compliance of a radiation gauge with these standards may only be assessed by the manufacturer, or suitably qualified and licenced person as stipulated by the regulatory authority.

3.5.2 ensure that a radiation gauge continues to comply with the Equipment Standard for Radiation Gauges. This requirement applies to gauges for their entire life, from initial procurement until final transfer of ownership. Compliance of a radiation gauge with these standards may only be assessed by the manufacturer, or suitably qualified and licenced person as stipulated by the regulatory authority.

3.5.3 ensure that a radiation gauge identified as non-compliant with the Equipment Standard for Radiation Gauges (e.g. when damaged or malfunctioning) is clearly labelled and recorded as being non-compliant, and appropriate measures immediately undertaken to ensure ongoing safety. The Responsible Person must inform regulatory authority as soon as possible upon designation of a gauge as non-compliant, and undertake further actions as deemed necessary by the regulatory authority. The Radiation Management Plan should contain instructions for the management of potentially non-compliant gauges.

3.5.4 ensure that radiation gauges that are not being used are stored safely and securely in an approved store that meets the requirements of Annex E of this Code. For stored portable radiation gauges, the source assembly must be fully retracted and key locked into a shielded position, or otherwise shielded and protected from access in a manner acceptable to the regulatory authority. During shutdowns and maintenance periods, fixed gauges that are stored in situ must have their shutters locked in the off position, and X-ray apparatus must be de-energised and isolated, and the activation key removed and securely stored. In all cases the keys for accessing stores, sources and shutters should be securely stored, recorded and controlled.

3.5.5 only dispose of a radioactive source or neutron generator in accordance with an authority granted by the regulatory authority. Ideally the source or generator would be returned to the original supplier. Decommissioning and disposal of radioactive sources in cases where the manufacturer or original supplier is no longer in business can also be arranged according to the requirements specified by the regulatory authority. If the Responsible Person decides to take any other action regarding source disposal, then this action must be subject to approval by the regulatory authority.

3.5.6 ensure that records are maintained of all authorisations for the receipt, storage, transfer, or disposal of radioactive sources (including any certificates provided by recipients or by disposal facilities for radioactive waste).

3.5.7 ensure that periodic accountancy checks of radiation sources are conducted to confirm that they are in their assigned locations and are secure, that warning signs are visible, and that source details are clearly displayed.

3.5.8 in cases where all radiation sources are to be removed from a facility, remove all radiation symbols (trefoils) and other relevant notices from the facility and conduct a workplace monitoring survey to provide additional confirmation that the sources have been removed from the site. A final decommissioning plan must be prepared, which includes the final radiation survey and details of the storage, transfer, or disposal of sources of radiation.

3.5.9 inform the relevant authority when all sources of radiation have been removed from the site and submit to the regulatory authority the documents relating to disposal of the sources and the monitoring survey carried out at the facility.

3.5.10 ensure that a suspected loss of control over a radiation source should be promptly investigated by the operating organization. The regulatory authority (and any other relevant authority) should be notified, as specified by the regulatory authority and the relevant emergency plans and procedures.

3.5.11 assess and manage the security requirements for the sources in line with the Radiation Protection Series No. 11, *Code of Practice for the Security of Radioactive Sources* (RPS11; ARPANSA, 2019).

3.6 Protection of Workers

Practice-specific requirements relate to the following general requirements of RPS C-1: Clauses 3.2.1, 3.2.5 – 3.2.6, 3.3.3

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.

Assessment of occupational exposure and workers' health

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

(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 doses

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.

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

(RPS C-1 Clause 3.3.3 continued)

(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
  (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.

A workplace radiation monitoring program must be designed and implemented to assess the adequacy of the arrangements for protection and safety when radiation gauges are used, transported and stored. The program must include measurements of dose rate at critical work locations, and must identify appropriate monitoring methods for accurate monitoring to be carried out.

The Responsible Person must:

3.6.1 implement a radiation monitoring program (see Annex C) using suitable radiation monitoring equipment (see Annex G).

3.6.2 maintain records of occupational exposure and public exposure according to Section 3.4.

3.7 Compliance by Workers

Practice-specific requirements relate to the following general requirements of RPS C-1: Clause 3.2.3

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

While responsibility for safety rests with the Responsible Person, workers are required to fulfil their obligations and perform their duties for protection and safety. To facilitate this the responsible person will provide training and induction to company policies, procedures, radiation safety and any required technical skills needed by workers, that will enable workers to understand and meet their obligations and roles in the safety culture of the organisation.

The Responsible Person must:

3.7.1 have a clear statement of duties for occupationally exposed workers

3.7.2 induct and train workers in the rules and procedures for protection and safety within the organisation

3.7.3 provide training in the proper use of monitoring equipment, personal protective equipment and safety devices that the workers have been provided with (see Annex G)

3.7.4 request information on workers past and present work that is relevant for ensuring effective and comprehensive protection and safety for themselves and others.

3.8 Cooperation Between Responsible Persons

Practice-specific requirements relate to the following general requirements of RPS C-1: Clause 3.2.4

Cooperation between Responsible Persons

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

Portable radiation gauges may need to be used on sites where other sources of radiation exposure may be present. Similarly portable or mobile radiation sources may need to be used at places where fixed radiation gauges are used and stored. These sources of exposure may be under the control of different Responsible Persons. It may also be the case that non-radiation hazards exist and the impact of these on radiation safety and security may need to be considered during the Safety Assessment for site specific gauging activities.

The safe management of these situations requires cooperation between all responsible parties at a site.

The Responsible Person for the portable radiation gauging operations must:

3.8.1 ensure sufficient time is devoted to planning the radiation gauging work and communicate that plan to other responsible parties.

3.8.2 identify any conditions or limitations on radiation gauging work that would hinder it from being performed in a safe manner and working with other responsible parties to address such matters.

3.8.3 work to ensure that radiation gauging work is coordinated with other work on the site, to minimize the risks to workers arising from site specific hazards and to minimize radiation exposure of other workers on the site.

3.8.4 where portable gauges are to be used on the premises of a client rather than on the premises of the operating organisation, the client needs to be consulted on the preparation and planning of the work. This likely includes agreeing the location and time for the work with the portable gauge to be performed. Any specific measures for protection and safety of persons on the site should be discussed between the parties, to avoid possible confusion on the site.

3.8.5 ensure that the requirements of Radiation Protection Series No. 11, *Code of Practice for the Security of Radioactive Sources* (RPS 11; ARPANSA, 2019) are complied with. Note that the storage of a radiation gauge at a site may result in a change of the security category for the aggregation of radioactive sources at the site, and potentially additional compliance requirements.

3.9 Information, Instruction and Training

Practice-specific requirements relate to the following general requirements of RPS C-1: Clauses 3.2.7 – 3.2.9

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.

Training of workers is a critical aspect for ensuring safety and protection. Dealing with radiation sources of high activity and high dose rates (and in some cases chemical toxicity) requires an understanding of the biological risks presented by these sources. Training in the use of appropriate dose control measures identified in the Safety Assessment needs to be covered from a theoretical perspective and re-enforced through practical exercises.

All operators or users of radiation gauges need to understand the use of radiation monitoring equipment for area surveys, pre-transport checks and for personal radiation dose monitoring.

Certain specialised activities relating to the use of radiation gauges (e.g. installation, removal, maintenance and repair) potentially affect components related to safety of the gauge (e.g. source, source holder, source drive mechanism, shutter, shutter control and shielding). To be performed safely such activities require specialised training and equipment, supported by current and thorough information.

These safety-related specialised activities should be governed by a management system that encompass all aspects of the work to be performed, including but not restricted to radiation safety. Whilst these activities are often performed by an equipment or service provider, certain aspects of this work may be performed by appropriately trained and authorised staff within the radiation practice. A task-based safety assessment to undertake such activities is mandatory, and should include consideration of low-probability high-impact events based on a thorough assessment of all technical aspects of the radiation gauge, with anticipated conditions (e.g. operation, storage, transport) accounted for.

For the purpose of determining appropriate level of general (non-specialised) training, occupationally exposed staff are categorised as:

- Level 1 - personnel working in supervised areas, or
- Level 2 - personnel working in controlled areas with the radiation sources, including personnel involved in the transport and calibration.

Training also needs to cover emergency response and the actions required by staff to render situations safe. Refresher training for staff is important to ensure that their knowledge and skills are kept up to date. Such training needs to include a review of:

- fundamentals of protection and safety
- changes to safety standards, equipment, policies and procedures
- changes in regulatory requirements.

Refresher training could be combined with other refresher training programs relevant to the same workers. Whilst a typical frequency for refresher training is every three to five years, significant changes in regulations or the occurrence of safety issues should be disseminated as written instructions as soon as practicable, and subsequently included in refresher training.

The Responsible Person must:

3.9.1 ensure that workers receive training that is relevant to working safely within controlled and supervised areas, at a level commensurate to the work being undertaken (see Annex F).

3.9.2 ensure that a radiation protection supervisor, radiation safety officer or similarly named person fulfilling this role is appointed. This person must have received the training in the use of radiation sources relevant to the radiation practice, and have an appropriate level of experience as deemed sufficient by the regulatory authority (see Annex F). The person fulfilling this role must be competent in performing wipes tests, understanding when a radiation source is securely positioned in sealed source device or container, performing radiation surveys to ensure a radiation source is safely 'isolated', and understand the security and transport requirements for the sources under the control of the Responsible Person.

3.9.3 ensure that training records are maintained on the workers personnel records, or as part of any integrated management system that records such information.

Annex A Indicative Summary of Practice-Specific Responsibilities of the Responsible Person

Section	RPS C-<X> Requirement Indicative Summary	RPS C-1 Basis
RADIATION MANAGEMENT PLAN (RMP)		**3.1.4 – 3.1.5, 3.1.7 – 3.1.8**
3.1.1	Develop a Radiation Management Plan (RMP) from the SA outputs.	
3.1.2	Review the RMP annually or after operational changes or events	
3.1.3	Commit to resourcing the requirements of the RMP.	
3.1.4	Appoint an appropriate Radiation Safety Officer (RSO).	
3.1.5	Specify the functions of the RSO in the RMP	
SAFETY ASSESSMENT (SA)		**3.1.12 – 3.1.14, 3.1.17 – 3.1.19**
3.2.1	Develop and document a Safety Assessment (SA).	
3.2.2	Submit the SA to regulator for assessment.	
3.2.3	Demonstrate the SA used to continuously specify: (a) programs (maintenance, surveillance, inspection) (b) procedures (operational, incidental), (c) staff competencies and risk-informed approach.	
3.2.4	Conduct annual review of the SA, or if: (a) modifications may compromise safety (b) a new or different source is acquired (c) experience or investigation indicates safety measure modification is required (d) standards, regulations or guidance is changed.	
3.2.5	Assess modifications of the SA according to regulatory requirements.	
3.2.6	Assess resulting modifications of the RMP according to regulatory requirements.	
PREVENTION AND MITIGATION OF ACCIDENTS		**3.1.15**
3.3.1	Promote commitment to safety throughout the organisation.	
3.3.2	Ensure common understanding of organisation safety culture.	
3.3.3	Support safe and successful use of radiation gauges.	
3.3.4	Encourage participation in radiation safety policy / procedure development.	
3.3.5	Ensure accountability in management and use of radiation gauges.	
3.3.6	Encourage learning, development and strengthening of the organisation safety culture.	
3.3.7	Ensure safety concerns can be freely raised.	
3.3.8	Document incident reporting processes, organisational and regulatory.	
3.3.9	Document incident plans.	
3.3.10	Document plans for incident analysis and incorporating results into processes.	
RECORD KEEPING		**3.1.20 – 3.1.24**
3.4.1	Maintain dose records from personnel radiation monitoring.	
3.4.2	Maintain dose records for incidents or emergency procedures.	
3.4.3	Ensure dose records reflect the primary individual dosimeter.	
3.4.4	Maintain records of authorisations / licences and source inventory.	

Section	RPS C-<X> Requirement Indicative Summary	RPS C-1 Basis
3.4.5	Maintain records of source acquisitions, disposals and transport.	
3.4.6	Maintain gauge documentation and records	
3.4.7	Maintain documentation and records of work practices, roles and responsibilities.	
3.4.8	Maintain training records of controlled & supervised area personnel.	
3.4.9	Maintain records of incident analysis & corrective actions.	
3.4.10	Ensure records are available for inspection by the regulator.	
3.4.11	Specify record keeping requirements in the RMP.	
RADIATION SOURCES		**3.1.25**
3.5.1	Ensure the gauge initially complies with the Equipment Standard for Radiation Gauges.	
3.5.2	Ensure the gauge continues to comply with the Equipment Standard for Radiation Gauges.	
3.5.3	Ensure a non-compliant gauge is labelled, recorded and reported to the regulator.	
3.5.4	Ensure gauges are stored according to Annex E of this Code.	
3.5.5	Ensure gauges are disposed of in accordance with regulatory authority.	
3.5.6	Ensure records of regulatory authorisations are maintained.	
3.5.7	Ensure periodic accountancy checks of source locations.	
3.5.8	Ensure workplace monitoring and removal of signage upon radiation source removal.	
3.5.9	Inform regulator of source removal including monitoring survey & disposal documentation.	
3.5.10	Ensure prompt investigation of suspected loss of source control.	
3.5.11	Assess security requirements for sources in line with RPS 11.	
RESPONSIBILITIES FOR THE PROTECTION OF WORKERS		**3.2.1, 3.2.5 – 3.2.6, 3.3.3**
3.6.1	Implement a Radiation Monitoring Program as per Annex C of this Code.	
3.6.2	Maintain records of occupational and public exposure.	
COMPLIANCE BY WORKERS		**3.2.3**
3.7.1	Have a clear statement of duties for occupationally exposed workers.	
3.7.2	Induct and train workers in safety rules and procedures.	
3.7.3	Train workers in PPE use and monitoring equipment as per Annex G.	
3.7.4	Request relevant information from workers for ensuring safety.	
COOPERATION BETWEEN RESPONSIBLE PERSONS		**3.2.4**
3.8.1	Ensure gauge work is planned & communicated to responsible parties.	
3.8.2	Identify and address conditions and limitations on gauge work with responsible parties.	
3.8.3	Ensure gauge work is coordinated with other works to minimise exposure risk to others.	
3.8.4	Ensure clients are consulted in the planning and preparation of gauge works at their site.	
3.8.5	Ensure source security arrangements comply with RPS 11.	
INFORMATION, INSTRUCTION AND TRAINING		**3.2.7 – 3.2.9**
3.9.1	Ensure workers are trained for controlled & supervised areas as per Annex F.	
3.9.2	Ensure a RSO is appointed with training as per Annex F.	
3.9.3	Ensure worker training records are maintained.	

Annex B The Safety Assessment

B1 Methodology of the Safety Assessment

The radiation risks arising from the use of each radiation source, together with the probability and magnitude of potential exposures due to incidents, are important factors to be considered in the Safety Assessment. A Safety Assessment should consider the following:

a) Dose rates from shielded and unshielded radioactive sources, and from neutron generators including calibration work involving these sources.

b) Exposure of gauge operators, other workers and the public from normal operations, storage of radioactive sources, and potential exposures from reasonably foreseeable incidents (including exposures due to loss of shielding, contamination from a damaged radioactive source, and other scenarios including very low probability events).

c) Limits and technical conditions for the operation of the fixed and portable gauging equipment.

d) Ways in which structures, systems and components, as well as procedures relating to protection and safety, might fail or might otherwise lead to potential exposures, and the consequences of such failures or potential exposures.

e) Ways in which external factors could affect protection and safety.

f) Ways in which operating errors and human factors could affect protection and safety.

g) Evaluation of the implications of any proposed modifications for protection and safety.

h) Any uncertainties or assumptions, and their implications for protection and safety.

B2 Outcomes of the Safety Assessment

The Responsible Person must use the Safety Assessment outcomes to inform decision making, such as:

a) Engineering controls necessary for safety.

b) Administrative controls necessary for safety; e.g. development of safe working procedures (local rules) to be implemented for storage, operation, maintenance of a source inventory, servicing and maintenance, and management of disused sources.

c) Procedures for designating controlled areas and supervised areas and indicating these via appropriate warning signs (see Annex D).

d) Measures necessary for the protection of the public.

e) Assessment of occupational exposure.

f) Training programs for gauge operators and other staff.

g) Effective emergency preparedness and responses to manage reasonably foreseeable events including very low probability events. This would normally include

   (i) information on reasonably foreseeable incidents.

   (ii) measures necessary to minimize the likelihood of occurrence of such incidents.

   (iii) necessary emergency arrangements including emergency plans and procedures, and emergency equipment.

h) Security of radiation sources used in industrial gauging, with the objective of deterring, delaying, detecting and responding to the theft of sources.

B3 Safety Assessment - Considerations for Industrial Gauging

To prepare a Safety Assessment for normal operating conditions and reasonably foreseeable incidents involving fixed and portable radiation gauges, the Responsible Person needs to assess the hazards involved in those situations and identify and document the necessary control measures to deal with such situations. The lists below will aid in the development of the Safety Assessment:

Normal operating conditions include the following:

a) Installation of gauges

b) Operation of gauges

c) Transport of portable gauges

d) Work at a client's site with portable gauges

e) Maintenance of gauges

f) Primary and temporary storage of gauges and sources

g) Disposal of disused sources and gauges.

Reasonably foreseeable incidents involving radiation gauges include the following:

a) Neutron generator or X-ray generator failing to de-energize when operation is terminated

b) Loss of shielding

c) Failure of a source deployment / retraction mechanism

d) Damaged source resulting in the spread of radioactive contamination

e) Missing, lost or stolen radioactive source

f) Leaking source (e.g. as detected by a routine leak test)

g) Failure of a safety system (e.g. warning lights, shutter mechanisms)

h) Fire or explosion (e.g. work area, storage area, during transport)

i) Incidents during special procedures (e,g. installation, maintenance, calibration, removal)

j) Accident during movement or transport

k) General internal or external damage due to environmental conditions (e.g. corrosion, vibration, abrasion, pollution, temperature)

For each of the identified operating and incident scenarios, the hazards and the necessary control measures need to be identified and documented.

External Radiation Hazards

The following external radiation hazards require consideration in the Safety Assessment:

a) Beta sources may emit bremsstrahlung radiation which may be challenging to measure

b) Am-241 sources can produce neutron radiation in some circumstances, e.g. when combined with Be

c) Radiation generators will produce an external radiation hazard due to X-rays or neutron radiation.

d) Neutron sources and generators will give rise to gamma radiation.

e) Optimal shielding material, quantity and configuration is dependent on the type and energy of radiation emissions.

Internal Radiation Hazards

A potential for internal exposure exists if a sealed source is damaged. Beta sources are particularly prone to damage as they usually have a thin window to allow the passage of beta radiation.

In stream analysis probes used for X-ray fluorescence often contain americium or plutonium and have thin windows. Damage of gamma and neutron sources is less likely owing to the use of special form containment of the radioactive material. However, in a severe accident or owing to severe environmental conditions, these sources might be damaged with potential for internal exposure.

Engineering Controls

Engineering controls require consideration in the Safety Assessment, including:

a) Safety incorporated in the design of the sealed source, the gauge and the gauging system as a whole

b) Shielding provided by the gauge and any associated containers

c) Demarcation of Controlled Areas and Supervised Areas with barriers and signage as specified in Annex D, and designation of storage areas as specified in Annex E.

d) Safety and warning systems (shutters, interlocks, warning lights and other signals)

e) Special handling tools for installation, maintenance and emergency procedures.

f) Containment systems for protection and security during transport.

Administrative Controls

Administrative controls require consideration in the Safety Assessment, including:

a) Safe working procedures, including local rules and permit-to-work systems

b) Staff training

c) Appointment of radiation safety officer(s)

d) Obtaining advice from a qualified expert

e) Establishing a radiation protection program, including the designation of controlled areas and supervised areas, and workplace monitoring and individual (personal) monitoring

f) Warning signs for fixed gauges and for portable gauges when in use

g) Periodic maintenance and servicing of fixed and portable gauges

h) Periodic checks on the operation and effectiveness of safety systems

i) Periodic safety audits of operations

j) Establishment of dose investigation levels

k) Procedures for leak testing of radioactive sources

l) Inventories for radioactive sources and radiation generators, supported by periodic checks and records, and records of the relocation or transport of radiation sources.

B4 Hazard Assessment for Emergency Exposure Situations

This Code considers practice-specific requirements derived from the general requirements for existing exposure situations specified in RPS C-1. The Safety Assessment should however consider a range of radiological incidents, some of which may be considered a radiological emergency.

The *Guide for Radiation Protection in Emergency Exposure Situations* (RPS G-3; ARPANSA 2019) provides guidance on the development of a Hazard Assessment in preparation for emergency exposure situations, and discusses specific relevant situations that are applicable to radiation gauges such as:

- Material out of regulatory control (Section 2.5.6)
- Misuse of industrial radioactive material (Section 2.5.7)
- Transport emergencies (Section 2.5.8)
- Malicious use of radioactive material (Section 2.5.10)

Arrangements for preparedness and response to a radiological emergency for activities under the responsibility of the operating organisation should be dealt with through the regulatory process. The regulatory authority may require that the Responsible Person addresses applicable guidance provided in RPS G-3, including development of a Hazard Assessment for low-probability events identified in the Safety Assessment.

RPS G-3 (clauses 3.1.18 to 3.1.26) provides general guidance for development of a Hazard Assessments.

Annex C The Radiation Management Plan and Supporting Arrangements

C1 The Radiation Management Plan

The Radiation Management Plan (RMP) is the Responsible Person's statement of how the radiation practice will be carried out in a safe and secure manner, and how compliance with this Code and relevant legislative requirements will be met.

The RMP uses the Safety Assessment outputs and must address the minimum requirement listed below:

a) Signed statement of commitment by the Responsible Person to implement the RMP and provide the necessary resources for full implementation of its requirements

b) Circumstances that will lead to a review of the RMP by the Responsible Person

c) Commitment that the RMP will form part of the induction process for persons who may be occupationally exposed

d) Roles and functions of the Radiation Safety Officer(s)

e) Working rules for operators that cover the scenarios considered in the Safety Assessment and have been optimised as part of that process making use of dose constraints that may be task-specific

f) Description of the radiation monitoring program, or a reference to a separate document containing the information

g) Review of monitoring results and dose investigation levels that will trigger a review of work practices

h) Procedures for relocating nuclear gauges within the Responsible Person's establishment, and for safe and secure storage during any field work, such that exposures to persons involved in the relocation are ALARA and of a similar level of safety to that intended by the *Code of Practice for the Safe Transport of Radioactive Material* (RPS C-2; ARPANSA, 2019).

i) Procedures for the safe and secure transport of nuclear gauges that ensure:

   (i) transportation in accordance with RPS C-2.

   (ii) the useful beam is attenuated by a shutter, transport biscuit, or the source control mechanism being retracted and locked.

   (iii) the gauge is packaged in an outer shipping package meeting the requirements of RPS C-2.

   (iv) the gauge is located in a vehicle in order to minimise possible exposure of occupants of the vehicle., including orientation of the potential primary beam away from vehicle occupants.

   (v) arrangements for the security of a radioactive source are in accordance with Radiation Protection Series No. 11, *Code of Practice for the Security of Radioactive Sources* (RPS 11; ARPANSA, 2019). Monitoring at each stage of the transport process to verify the location of a radioactive source should be accounted for.

j) Procedures in the event of an incident or emergency.

k) Procedures for the source storage and accountancy, wipe testing and preventative maintenance.

l) Roles, responsibilities and contact details for managers, regulatory authority and gauge operators.

C2 The Radiation Monitoring Program

A properly constructed radiation monitoring program should ensure the adequacy of the arrangements in place for protection and safety for facilities and activities involving radiation gauges. The program must include measurements of dose rate at all of the following positions, unless specific measurement positions can be justified as unnecessary with endorsement by the RSO:

a) around gauge storage facilities, to ensure that an adequate level of shielding is provided.

b) around gauges during routine operations, to confirm that dose rates remain below any values specified in national regulations or guidance and by the operating organisation.

c) around gauges during maintenance operations on plant and equipment near the gauges, to confirm that the gauge shutter is closed or that the radiation generator is switched off.

d) at the operators' positions during use of portable gauges, to confirm that radiation levels are acceptable.

e) at the operators' positions during source loading and unloading operations.

f) at the entrance to a gauge enclosure, to confirm that the gauge shutter is closed or that the radiation generator has ceased to emit radiation.

g) around the transport package before transporting a gauge to and from the site, to confirm the presence of the source.

h) around vehicles transporting gauges before departure to and from the site.

The workplace monitoring program should describe the locations to be monitored, the frequency of monitoring and the records to be kept. This information should be included in the local working rules and should also be described in the radiation protection program. Dose rate investigation levels (see SSG-58, para. 4.29) for each measurement location should be prescribed, and the actions to be taken if these values are exceeded should be specified. Records of the workplace monitoring program are required to be made available to appropriate persons, including workers and the regulatory authority.

In circumstances where neutron monitoring is required but a neutron survey meter is not available, the Responsible Person must obtain approval from the relevant regulatory authority to estimate neutron levels based on gamma measurements. The method for estimating neutron dose must be provided or referenced in the radiation monitoring program. See Annex G2 for further details.

The workplace monitoring program should align with exposure and occupancy levels as detailed in: Australian / New Zealand Standard - *Safety in Laboratories Part 4: Ionizing Radiations* (AS/NZS 2243.4:2018)

C3 Working Rules

It is necessary to develop, document, implement and regularly update operational procedures to ensure the safe use of a radiation gauge. Advice from the regulatory authority and the manufacturer of the gauge should be obtained when developing and reviewing these procedures. Working rules incorporated in the Radiation Management Plan should include details of:

a) the expected radiation levels around each fixed radiation gauge under the control of the Responsible Person.

b) where appropriate, tests for non-fixed surface contamination.

c) the occasions on which radiation surveys and contamination tests will be carried out.

d) the methods for conducting the radiation surveys, wipe tests and any other examination required by the Code, and for reporting and recording results.

e) information relating to:

   (i) the operation of source or shutter controls.

   (ii) locking of source containers.

   (iii) de-energising X-ray or neutron generator tubes.

f) the arrangements of locks and safety procedures and equipment for preventing exposure of persons to a radiation beam.

g) the arrangements for preventing or minimising occupational and public radiation exposure.

h) the methods of ensuring that no part of any person can enter the item of equipment to which the gauge is attached while the gauge is in the 'beam on' condition.

i) any licence/registration requirements and conditions of the relevant regulatory authority.

j) any special instructions from, or requirements of, the relevant regulatory authority.

k) the arrangements for security of a gauge when it is in storage or being transported within the establishment.

l) the regular inspection of all equipment including:

   (i) source containers or housings.

   (ii) survey meters.

   (iii) personal monitoring devices.

   (iv) labels.

   (v) markings.

   (vi) notices.

m) the types and occasions for use of personal monitoring devices.

n) the steps to be taken in the event of an emergency (see Annex C4).

o) the arrangements for the calibration, repair and maintenance of a fixed radiation gauge.

p) instructions concerning the posting of radiation warning signs in the vicinity of the gauge (see Annex D).

q) the contact addresses and telephone numbers, including the after-hours emergency number, where relevant, for:

(i) the Responsible Person

(ii) relevant regulatory authority

(iii) the service provider

(iv) the provider of the personal monitoring service

r) the arrangements for disposal of a radioactive source, X-ray tube or neutron generator tube from a fixed radiation gauge, which need to be in accordance with the requirements of the relevant regulatory authority.

s) any other site-specific information that may have a bearing on safety.

t) radiation exposure that could occur as a result of the work and due to any other unforeseen circumstances, including consideration of the following:

(i) the radiation levels around the gauge;

(ii) the locations where work is required;

(iii) the duration of the work; and

(iv) the possibility of unauthorised interference with the gauge.

u) a radiation isolation procedure if there is any risk of exposure to the primary beam. The isolation procedure should be followed before allowing work near the gauge, and account for guidance from the gauge manufacturer. The isolation procedure will typically include instructions to:

(i) close the shutter, retract the source, or remove power from the radiation source

(ii) apply a lock so that the radiation beam cannot be turned on

(iii) verify with a radiation survey meter that the radiation beam has actually been turned off

(iv) measure radiation levels in areas where the employees will be working

(v) advise employees that the gauge has been isolated

(vi) advise employees of their responsibilities when working near the gauge

C4 Emergency Procedures

It is necessary to develop, document, implement and regularly update emergency procedures to ensure safety during a radiological incident. Advice from the regulatory authority and the manufacturer of the gauge should be obtained when developing and reviewing these procedures. Emergency procedures incorporated in the Radiation Management Plan should include details of:

a) instructions on the immediate actions that need to be taken to protect human life, limit injury and provide first aid where required

b) instructions for the Responsible Person to be notified immediately:

(i) if a radioactive source is lost or damaged; or

(ii) if the radiation dose to any person, as a result of an incident, exceeded or may have exceeded limits set by the relevant regulatory authority

c) instructions for any employee involved in an incident to immediately report the incident to the Responsible Person, and to the relevant regulatory authority

d) instructions on the immediate procedures needed to bring the incident under control, including details on the action necessary to:

(i) allay panic

(ii) assess the nature and scope of the radiation incident

(iii) assess whether any physical damage has occurred to a radioactive source. Such an incident could have serious consequences in relation to contamination of persons and property

(iv) adequately shield the radiation source, where safe to do so

(v) secure an area of at least 3 metres around any unsecured source(s). It is important to ensure that while securing an area, the source(s) is not lost or carried away by a conveyor belt, vehicle, the process stream or other means

(vi) establish adequate access control over the area

(vii) move persons to a safe distance and prevent unauthorised and unnecessary access to the secured area

(viii) secure the gauge or sources and to prevent any further damage

(ix) remove a radioactive source if necessary and safe to do so

(x) de-energise an X-ray tube or turn the gauge off in the case of an electrically energised device

(xi) monitor persons and equipment leaving the area. A dislodged source could become entangled in clothing or other equipment

(xii) prevent the further spread of contamination (if this possibility arises)

(xiii) implement any further action required to bring the incident under control

(xiv) investigate the circumstances of the incident, including the undertaking of assessments, measurements and calculations needed to:

- determine the optimum corrective action plan; and
- estimate the doses to the operators and members of the public involved in the incident

(xv) assemble the necessary resources and implementation of the required corrective action, taking into account instructions from the Responsible Person and the relevant regulatory authority

(xvi) prepare a detailed report of the incident as soon as possible after the incident and submission of this report to the relevant regulatory authority through the Responsible Person

(xvii) advise the Responsible Person and the relevant regulatory authority on changes required to prevent the recurrence of a similar incident.

e) names, addresses and telephone numbers required in the event of an emergency (these should be checked and updated at least once every 12 months and when changes in arrangements are made);

f) any other instructions to cover possible emergencies, such as:

(i) observed or suspected damage to a gauge, e.g. crushing by a forklift or other vehicle, heavy object dropped on the gauge etc.

(ii) observed or suspected malfunction of the gauge or the source assembly

(iii) suspected or actual loss of the gauge or of a source

(iv) failure of safety procedures or a breach of the working rules

(v) fire, flood, explosion or other disaster

Annex D Controlled and Supervised Area Signage Requirements

A Controlled Area is defined as (from RPS C-1):

> 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.

A Supervised Area is defined as (from RPS C-1):

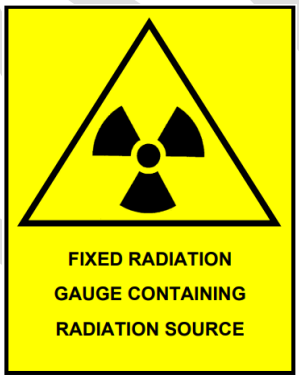
> A defined area not designated as a Controlled Area but for which occupational exposure conditions are kept under review, even though specific protection measures or safety provisions are not normally needed.

The Responsible Person must ensure that:

a) A Controlled Area accounts for the magnitude of the exposures expected in normal operation, the likelihood and magnitude of exposures in anticipated operational occurrences and in accident conditions, and the type and extent of the procedures required for protection and safety.

b) A Controlled Area is delineated by physical means or, where this is not reasonably practicable, by some other suitable means.

c) The area in the immediate vicinity of a **fixed** radiation gauge is designated as a Controlled Area, including display of area warning signs compliant with Australian Standard AS1319-1994 along with appropriate instructions regarding activities for the Controlled Area.



d) the area in the vicinity of a **portable** radiation gauge is designated as either a Supervised Area or a Controlled Area, including display of area warning signs compliant with Australian Standard AS1319-1994 along with appropriate instructions regarding activities if a Controlled Area is established.

e) workers other than the **portable** radiation gauge operator must be excluded from a Controlled Area if such is established around a **portable** radiation gauge.

f) the maximum dose rate in the area where **portable** radiation gauges are used must be below 20 µSv/h. However, it is often practicable to achieve a dose rate at the boundary that is below 1 µSv/h.

Annex E Storage of Radiation Gauges

This annex addresses the requirements for the primary radiation source storage facility, or any storage employed for portable radiation gauges during field work.

The store for radiation gauges must:

a) be constructed to reduce the external radiation dose rate to no more than 10 µSv/h (ambient dose equivalent) at any external location.

b) be located to minimize its risk to flooding, fire, corrosive chemicals and explosives.

c) must protect gauges from adverse environmental conditions.

d) have controlled access such that keys or access codes are controlled by a person authorised by the Responsible Person or their delegate.

e) have a record of the radioactive sources held in storage and a source movement logbook for portable and mobile sources.

f) have all direct entrances signposted with a warning sign incorporating the trefoil as well as an all-hours contact number for the organisation's radiation safety officer similar to the one below:

The use of local shielding within the store is an acceptable means of reducing external dose rates to meet requirement, provided the shielding may not be easily removed or re-arranged inside the storage facility.

Temporary stores for field work must provide the same level of protection and safety and security as the main store.

In certain circumstances a vehicle may be used to act as a temporary store. Any vehicle being used for this purpose must provide physical security for the sources and gauges and be fitted with a vehicle alarm and immobilizer.

Annex F Training and Duties

F1 Radiation Safety Officer

The Radiation Safety Officer (RSO) will be a person technically competent in radiation protection matters relevant to the radiation sources and related devices within the radiation practice that they are working.

The RSO will assist the Responsible Person to implement the radiation protection program for the practice.

The RSO will hold a position within the organisation that enables them to maintain oversight of work with radiation sources and will have the authority to intervene to stop an unsafe or non-compliant operation.

The appointment of the radiation protection officer will be in writing, and the roles and responsibilities will be integrated into their job description.

Essential Requirements

The Radiation Safety Officer (RSO) must:

- have sufficient practical experience in the use of radiation sources for the radiation practice they are working in, as deemed appropriate by the regulatory authority.
- possess the training and skills necessary to identify the hazards and risks arising from the types of radiation sources in the radiation practice.
- be authorised by the appropriate regulator to deal with the radiation sources under the control of the responsible person.

Duties

The Radiation Safety Officer must be able to:

a) assist the responsible person to develop and maintain a radiation protection program, including suitable emergency plans, that are appropriate to the radiation practice

b) assist the responsible person to develop and periodically review local rules (including work permits where appropriate)

c) oversee operations involving the use of radiation sources, including requirements for the safe transport of radioactive sources

d) supervise record keeping arrangements as required by the relevant Code of Practice

e) arrange for the inspection and maintenance of engineering controls, safety features and warning features required under the radiation protection program

f) oversee access control requirements for controlled areas

g) advise on the establishment and periodic review of arrangements for personal dosimetry, including maintenance and review of occupational dose records

h) confirm that operators receive suitable training in the use of equipment and in radiation protection, and that they receive regular refresher training

i) supervise workplace monitoring arrangements

j) investigate higher than usual exposures and overexposures

k) investigate and report incidents and accidents

Training Coverage

Radiation Safety Officers must receive and maintain training that covers:

- Work safely in a radiation environment
- Work safely with radiation-sealed source equipment
- Perform basic radiation measurements
- Monitor radiation
- Handle and transport radioactive material
- Participate as a member of a workplace emergency initial response team

F2 Persons Working in Controlled Areas

Persons who work in controlled areas must receive and maintain training that covers:

- Working safely in a radiation environment
- Work safely with radiation-sealed source equipment
- Perform basic radiation measurements

F3 Persons Working in Supervised Areas

Persons who work in supervised areas must receive and maintain training that covers:

- Working safely in a radiation environment

Annex G Radiation Monitor Requirements

G1 Operational Considerations

Protection level survey meters are commonly used for measuring exposure to penetrating gamma radiation and in some applications for the measurement of neutron radiation.

Gamma survey meters are normally calibrated at a single calibration energy (Cs-137) and the manufacturer's energy response specifications are used to correct readings to other energies. Calibration of neutron survey meters is carried out using appropriate neutron calibration sources such as Am/Be or Cf--252.

Correct operation, battery levels and audible alarms or response to radiation need to be confirmed prior to use. A consistency check prior to use can be conducted against a source used in the practice, or a calibration source.

The type of environment in which the survey meter will be used also needs to be considered. For example, meters used in oil or gas facilities may need to be 'intrinsically safe' due to the potentially flammable environment.

G2 Protection Level Survey Meter Requirements

Radiation survey meters used to carry out area survey and transport checks must:

- respond to the gamma and/or neutron radiation emitted by sources intended for measurement
- cover the exposure range 1 µGy/h to 1000 µGy/h Kerma in air
- continue displaying its maximum exposure rate when that rate is exceeded, and clearly indicate that the displayed rate is being exceeded.

The measurement of neutron radiation requires the use of specialised monitoring equipment. It is important that a neutron meter is available whenever an activity using a neutron source is being undertaken.

In circumstances where neutron monitoring is required but a neutron survey meter is not available, the Responsible Person must obtain approval from the relevant regulatory authority to estimate neutron levels based on gamma measurements.

When interpreting this requirement related to neutron monitor unavailability, the following apply:

- 'readily available' or 'accessible' means that a survey meter can be obtained within a reasonable time. This may be achieved by borrowing, hiring or sharing a survey meter. Details of how the availability or accessibility of the survey meter are to be achieved must be included in the Radiation Management Plan. The borrowing, hiring or sharing of a survey meter does not alleviate the Responsible Person from the survey monitoring requirements of this Code.
- Neutron monitoring is required when neutron radiation levels could possibly result in dose rate limits (as specified in this Code or the RMP) being exceeded. This would include situations where damage to the gauge has or may have occurred.
- Gamma-neutron ratios can be highly dependent on the shielding material and thickness.

G3 Meter Calibration Requirements

All radiation survey meters must be calibrated annually by a calibration service that can offer traceability of the calibration to a national standard and provide a report specifying:

- the range of air Kerma used for calibration.
- the dose equivalent quantity which the meter display is calibrated to. Area dosimeters or dose ratemeters must be calibrated in terms of the ambient dose equivalent, H*(10) , or H’(0.07) the directional dose equivalent.
- known response of the meter at specific energies.
- linearity of the response of the meter to ranges of exposure encountered for its intended application.
- correct operation of alarms within ± 15 % of the indication under standard test conditions.
- performance of the meter when it is overloaded or saturated.

Glossary

All definitions in this Glossary are intended to be consistent with the definitions in the IAEA Safety Glossary: [*IAEA Safety Glossary – Terminology Used in Nuclear Safety and Radiation Protection, 2016 Revision* (IAEA 2016)].

Authorisation

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

Disposal

Emplacement of waste in a purpose-built facility, which will eventually be closed, without any intention of retrieval of waste packages or recovery of the radioactive material in it for any purpose.

Practice-Specific Note: Disposal of a radiation gauge requires a regulatory process be undertaken that ultimately releases ownership of and responsibility for the gauge and/or radiation source. The Responsible Person is required to inform the regulator of the intention to dispose of a gauge, and provide details and undertake actions as deemed necessary by the regulator to ensure a safe and secure disposal process.

Dose

1. A measure of the energy deposited by radiation in a target
2. A generic term that may mean 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 restriction on the individual dose from a source, which provides a basic level of protection for the most highly exposed individuals from a source, and serves as an upper bound on the dose in optimisation of protection for that source. For occupational exposures, the dose constraint is a value of individual dose used to limit the range of options considered in the process of optimisation. For public exposure, the dose constraint is an upper bound on the annual doses that members of the public should receive from the planned operation of any controlled source.

Effective Dose

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

$$E = \sum_{T} w_T \, . \, H_T$$

where H_T is the equivalent dose in tissue or organ T, and
w_T is the tissue weighting factor for tissue or organ T.

The unit of effective dose is J kg^{-1}, termed the sievert (Sv).

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.

Equivalent Dose

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 deterministic effects.

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

Existing Exposure Situation

A situation of exposure that already exists when a decision on the need for control needs to be taken, including prolonged exposure situations after emergencies.

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

An application of safety requirements that is commensurate with the characteristics of the practice or source and with the magnitude and likelihood of the exposures.

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.

(Nuclear) Security

The prevention and detection of, and response to, theft, sabotage, unauthorised access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities.

Occupational Exposure

Exposure of workers incurred in the course of their work.

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). Note that this is not the same as optimisation of the process or practice concerned.

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.

Potential exposure includes prospectively considered (i.e. hypothetical or postulated) exposures due to a radiation source in an event or sequence of events of a probabilistic nature, including exposures resulting from inadvertent human intrusion (such as a human intrusion into a near surface disposal facility after institutional control is removed).

Practice

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

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 Code, 'protection and safety' includes the protection of people against ionising radiation and associated safety measures; 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 from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation but including exposure from authorised sources and practices (planned exposure situations), and including exposure incurred in emergency and existing exposure situations.

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 Gauge

A device that employs an ionising radiation source for monitoring and analysis purposes, typically deployed across a wide range of industrial and commercial processes. The gauge typically consists of a sealed radioactive source or an electrically powered radiation generator integrated into a secure and shielded housing.

Radiation Generator

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

Practice-Specific Note: A radiation generator in a gauge is typically assumed to be electrically powered, and thus capable of being electrically isolated. Some radiation generators may contain a relatively small amount of radioactive material (such as tritium in a neutristor), however the device is generally not considered to contain a radioactive source for the purposes of this Code.

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, w_R

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.

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.

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/Regulators.

Responsible Person

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 Code, '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.

Safety Assessment

Assessment of all aspects of a practice that are relevant to protection and safety; for a disposal facility, this includes siting, design and construction, operation and closure of the facility. This will normally include formalised risk assessment.

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.

Storage

The holding of radioactive sources, radioactive material, spent fuel and/or radioactive waste in a facility that provides for their/its containment, with an intention of retrieval.

Tissue Weighting Factor, w_T

Multiplier of the equivalent dose to a tissue or organ used to account for the different sensitivities of different tissues or organs to the induction of stochastic effects of radiation.

Transfer (of ownership)

Practice-Specific Note: Transfer of ownership of a radiation gauge requires a regulatory process be undertaken that ultimately releases ownership of and responsibility for the gauge and/or radiation source. The Responsible Person is required to inform the regulator of the intention to transfer ownership of a gauge and provide details and undertake actions as deemed necessary by the regulator to ensure a safe and secure transfer of ownership process.

Wildlife

An animal or plant living within its natural environment.

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