Australian Government
Australian Radiation Protection and Nuclear Safety Agency

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Code for Disposal of Solid Radioactive Waste

Radiation Protection Series C-3

Radiation Protection Series

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

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

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

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

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

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

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

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Radiation Protection Series C-3

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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 xxxx 201X.

Acknowledgement of Country

ARPANSA proudly acknowledges Australia's Aboriginal and Torres Strait Islander community 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 people 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.

Forward

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

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

This *Code for Disposal of Solid Radioactive Waste (xxxx)* sets out the requirements in Australia for the protection of occupationally exposed persons, the public and the environment when undertaking the disposal of solid radioactive waste. All arrangements governing the siting, construction, operation and closure of radioactive waste disposal facilities in Australia must satisfy the requirements of this Code and the RPS C-1. Effective waste management strategies also require security provisions, to prevent radioactive material being diverted for malicious purposes. Protection is achieved through use of natural and engineered barriers, implementation of an appropriate management system and institutional controls. Operation of these barriers and controls is required until radiation levels decay to a level that cannot give rise to health or environmental concerns or present an appreciable security risk.

ARPANSA, jointly with state and territory regulators in the Radiation Health Committee (RHC), has developed this Code based on the 'requirements' relating to disposal of radioactive waste described in the Specific Safety Requirements of the International Atomic Energy Agency (IAEA); *Safety Standards Series: Specific Safety Requirements No. 5, Disposal of Radioactive Waste, SSR-5* (IAEA 2011a), generally referred to as SSR-5.

This publication, together with RPS C-1, supersede the Radiation Health Series (RHS) No. 35 *Code of practice for the near surface disposal of radioactive waste in Australia* (NHMRC 1992), while maintaining the protective intent of RHS 35.

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

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Carl-Magnus Larsson
CEO of ARPANSA

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1. Introduction

1.1 Citation

This Code may be cited as the *Disposal Code (201x)*.

1.2 Background

Radioactive waste is **radioactive material** for which no further use is foreseen, and which is under regulatory control by the **Relevant Regulatory Authority**. **Disposal** is the recognised end point for the management of radioactive waste under a hierarchy of waste controls.

The basis for licensing of a proposed disposal facility is the development of a '**safety case'**. The safety case draws upon the organisational and technical arrangements put in place, the nature of the waste to be accepted, the characteristics of the site, the design of the facility including engineered barriers, and the arrangements for its construction, operation, decommissioning or closure and post-closure stages as appropriate, to demonstrate that the proposed facility will achieve the required level of protection for people and the environment. The essential details of the type of waste that can safely be disposed in any given disposal facility (the waste acceptance criteria), and the length of time that institutional control is necessary after closure of the facility, result from development of a detailed safety case for the specific disposal facility.

Six classes of waste form the basis for the Australian radioactive waste classification scheme, *Safety Guide for Classification of Radioactive Waste* (RPS 20) (ARPANSA 2010).

Typically, in accordance with the Australian waste classification scheme:

- Very low level waste (VLLW) is suitable for disposal in a near-surface, industrial or commercial, landfill type facility with limited regulatory control. Such landfill type facilities may also contain other hazardous waste.
- Low level waste (LLW) requires robust isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered near-surface facilities.
- Intermediate level waste (ILW) requires a greater degree of containment and isolation than that provided by **near-surface disposal**, and requires disposal at greater depths, in the order of tens of metres to a few hundred metres. In some cases borehole disposal facilities may be suitable for ILW.

Australia has no high level waste (HLW) and is unlikely to possess any in the foreseeable future.

The generic linkage between the different classes of waste and disposal options is addressed in RPS 20 (ARPANSA 2010) but, notwithstanding such generic linkage, the suitability of waste for disposal in a particular disposal facility is required to be demonstrated by the safety case and supporting **safety assessment** for the facility.

Near-surface disposal is primarily suitable for solid, chemically inert waste containing mainly short lived radionuclides with low concentrations of long lived radionuclides (radionuclides with half-lives of up to about thirty years are considered to be short lived). Deeper geological disposal facilities are required for disposal of radioactive waste comprising higher levels of radioactivity and/or higher concentrations of long lived radionuclides.

The ARPANSA Radiation Protection Series publication, *Fundamentals for Protection against Ionising Radiation* (RPS F-1) (ARPANSA 2014a) sets out the underlying principles that form the basis of the system of **radiation** protection used to manage risks from ionising radiation in Australia. The development of RPS F-1 was informed by the International Atomic Energy Agency (IAEA) *Fundamental Safety Principles, Safety Fundamentals No. SF-1* (SF-1) (IAEA 2006), together with the **ICRP** *Publication 103* (ICRP 2007) recommendations and the guidance on **nuclear security** developed by the IAEA in collaboration with its Member States.

The national *Code for Radiation Protection in Planned Exposure Situations* (RPS C-1) (ARPANSA 2016) is based on the relevant requirements of the IAEA's *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards General Safety Requirements Part 3, GSR Part 3* (GSR Part 3) (IAEA 2014).

This Code, which is a subsidiary document to RPS C-1 (ARPANSA 2016), includes Australian requirements for the disposal of solid radioactive wastes as well as the relevant requirements from the IAEA *Disposal of Radioactive Waste, Specific Safety Requirements No. SSR-5* (SSR-5) (IAEA 2011a).

1.3 Purpose

This Code, Code for Disposal of Radioactive Waste, sets out:

(a) the radiation protection principles and regulatory requirements for the safety and security of disposal of solid radioactive waste that will ensure that the associated risks for people and the **environment** are optimised and kept as low as reasonably achievable

(b) a nationally uniform framework for the safe and secure disposal of solid radioactive waste

(c) an appropriate licensing framework, including the clear allocation of responsibilities and provision for independent regulatory review and inspection

(d) a requirement for the preparation of a 'safety case' that draws upon the organisational and technical arrangements put in place, the nature of the waste to be accepted, the characteristics of the site, the design of the facility including engineered barriers, and the arrangements for its construction, operation, **closure** and post-closure stages.

Radioactive waste may arise initially in various gaseous, liquid and solid forms. In waste management activities, the waste is either discharged directly as gas or liquid, or processed to produce stable and solid forms and reduced in volume and immobilised as far as practicable to facilitate **storage**, transport and disposal (guidance is available in *Predisposal Management of*

Radioactive Waste (ARPANSA 2008)). This Code is concerned with the stage of disposal of solid or solidified materials, which is the last step in the process of radioactive waste management.

This Code is intended for use by those involved in site selection, design, safety assessment, construction, operation, closure and regulation of a radioactive waste disposal facility. It also informs the public and other **stakeholders**, including those who generate radioactive waste for which disposal is required, of the issues that must be addressed in safely disposing of solid radioactive waste.

It is intended that the Code can be incorporated into regulatory instruments, such as conditions attached to waste management licences, as appropriate.

1.4 Scope

As well as providing the Australian context and specific requirements for the safe and secure disposal of solid radioactive waste, this Code implements in Australia the IAEA Safety Standard *Specific Safety Requirements for Disposal of Radioactive Waste* (SSR-5) (IAEA 2011a).

The requirements apply to solid radioactive waste, including:

- all purpose-built facilities for disposal of solid very low level (VLLW), low level (LLW) and intermediate level (ILW) waste
- new and existing disposal facilities
- waste arising from the medical, industrial and research use of radioisotopes
- contaminated plant and equipment resulting from handling or processing of naturally occurring materials which contain radioactive material (contaminants) in low but non-trivial amounts
- waste arising from processing of minerals remote from any mine site and where disposal at the mine site is inappropriate
- bulk quantities of VLLW and LLW including legacy waste not covered under the *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (RPS 9) (ARPANSA 2005)
- legacy and spent disused radiation sources classified as ILW
- other ILW including vitrified ILW arising from reprocessing of spent fuel
- waste arising from the rehabilitation, decontamination or **decommissioning** of sites or facilities where radioactive materials have been produced, stored, used or dispersed.

This Code does not apply to:

- disposal of material below the exemption level prescribed by the relevant regulatory authority; and
- dealings with material below the **clearance** level prescribed by the relevant authority; and

- radioactive residues from mining and mineral processing which are subject to the *Code of Practice and Safety Guide for Radiation protection and Radioactive Waste Management in Mining and Mineral Processing* (RPS9) (ARPANSA 2005).

This code should be used in conjunction with other national codes when applicable.

The Code does not cover nuclear safeguards requirements for **nuclear material**. For advice on nuclear safeguards requirements, contact Australian Safeguards and Non-Proliferation Office (ASNO).

1.5 Interpretation

The presence of the word 'must' in a section indicates that the requirement to which it refers is mandatory.

All of the specified relevant requirements for safety and security in SSR-5 (IAEA 2011a) apply and are to be read as 'must' statements, except where there is any alternative specific to the Australian context that is detailed in this Code or in another Australian Code or Standard in which case the Australian alternative takes precedence.

The meanings of various terms used in this Code that have technical or legal significance, and others that are central to the national radiation protection framework or to radioactive waste safety, are defined in the Glossary.

This Code applies to new disposal facilities, those established prior to its implementation, facilities which are temporarily suspended, and such other facilities as designated by the relevant regulatory authority.

2. Radiation protection of people and the environment

The *Fundamentals* (RPS F-1) (ARPANSA 2014a) outlines the system of radiation protection in Australia. Section 4 of the *Fundamentals* describes the ten principles that guide actions to manage radiation risks to protect human health and the environment from the possible harmful effects of ionising radiation, namely:

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

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

Disposal of radioactive waste is a **planned exposure situation**. In such situations, radiation protection can be planned in advance before exposures occur and the magnitude and extent of exposures can be reasonably predicted.

The approach to managing radiation risks in planned exposure situations is guided by principles 1 – 8 and is described in RPS C-1 (ARPANSA 2016). As such, all requirements in RPS C-1 (ARPANSA 2016) apply to the disposal of radioactive waste.

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

2.1 Justification

The principle of justification requires that any decision that alters a radiation exposure situation should do more good than harm. Introducing a new radiation source, reducing existing exposure or reducing the risk of potential exposure should achieve a sufficient individual or societal benefit to offset any detriment caused. When activities involving an increased or decreased level of radiation exposure, or a risk of potential exposure, are being considered, the expected change in radiation detriment should be explicitly included in the decision-making process.

As the benefits and detriments to be considered encompass all aspects of the proposed practice, the decision-making process covers far more than radiation protection alone and should involve all appropriate governmental and societal decision-making agencies. Further details of this principle are found in RPS F- 1 (ARPANSA 2014a).

2.2 Optimisation

Once a practice has been justified, **optimisation** is employed to make the best use of resources in reducing radiation risks. The broad aim is to ensure that the magnitude of individual doses, the number of people exposed, and the likelihood that **potential exposures** will actually occur should all be kept as low as reasonably achievable, economic and social factors being taken into account (ALARA). The level of protection should be the best under prevailing circumstances and should provide for adequate margin of benefit over harm. There is a potential for the principle of optimisation to be misunderstood as implying a need to minimise exposures regardless of cost. This is partly because the linear no threshold (LNT) hypothesis postulates that there is no level of exposure below which there is no risk. The optimisation principle, however, offers a means to take a **graded approach** to management of radiation risks and focuses on achieving an ethically acceptable outcome, within the boundaries of the legal system, based on balancing risks and benefits.

Optimisation can also be applied to effective management of environmental exposures. For activities that may give rise to environmental concern, it is important that assessments consider both human health and environmental endpoints, so that the best decision can be taken on the basis of a holistic understanding of radiation risks. The measures to reduce exposures that are applied to facilities and activities that give rise to radiation risks are considered optimised if they provide the highest level of protection that can reasonably be achieved throughout the lifetime of the facility or activity, without unduly limiting its utilisation. Radiation risks need to be assessed *a priori* and periodically reassessed throughout the lifetime of facilities and activities.

Further details of this principle are found in RPS F-1 (ARPANSA 2014a) and in the *ICRP Publication 101b The Optimisation of Radiological Protection - Broadening the Process* (ICRP Publication 101b 2006).

A **dose constraint** is a prospective source–related restriction on the individual dose from a source in planned exposure situations, which serves as an upper bound on the predicted dose in the optimisation of protection for a source. For **occupational exposure** it is a value of individual dose used to limit the range of options such that only values of dose below the constraint are considered in the planning process. For **public exposure** the dose constraint is an upper bound on the annual doses that members of the public could receive from a planned operation of a specified controlled source. In each case, the use of a dose constraint guides the optimisation process.

In many cases, experience in similar planned exposure situations will allow a dose constraint to be set. Protection measures should then be undertaken to optimise protection at or below the dose constraint.

Planned exposures may, as noted earlier, be either normal exposures, which are certain or almost certain to occur, or potential which means that they are not expected to occur but may do so under certain circumstances. Such potential exposures may be more appropriately approached by constraining the risk, or setting a **risk target**. The risk constraint or target can be formulated as the product of probability of the exposure (i.e. how likely it is that an exposure occur in a given time period), and resulting consequence, e.g. as a cancer risk should that exposure occur. Optimisation can also be applied to reduce the risk. Dose constraints and risk constraints or targets can be used in combination.

Exceeding a dose constraint does not represent non-compliance with regulatory requirements but should prompt a review of the cause of the dose constraint being exceeded and, if appropriate, follow-up action.

2.3 Limitation of risks

The principle of limitation of an individual's risk of harm applies to the total dose to any individual from regulated sources in planned exposure situations other than the medical exposure of the individual as a patient. The total dose refers to the increase in radiation dose received by those exposed as a consequence of the conduct of the planned exposure situation and are normally defined in law.

Limits are insufficient in themselves to ensure the best achievable protection under the circumstances, and both the optimisation of protection and the limitation of doses and risks to individuals are necessary to achieve the highest standards of safety.

2.4 Aligning safety and security objectives

Radiation safety and security measures have a common purpose – the protection of people, society, and the environment. Many of the principles to ensure protection are common, including communication and consultation with stakeholders, although their implementation may differ. Moreover, many elements or actions serve to enhance both safety and security simultaneously. Likewise, there are also circumstances in which actions to serve one objective can be detrimental to the achievement of the other. It is important that safety and security measures are designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

2.5 The Approvals Process/Phases

The requirement for a staged process for the licensing of a radioactive waste disposal facility is consistent with international best practice.

The stages (phases) of the approvals process for a radioactive waste disposal facility are typically as follows:

- licence application to prepare a site (including conceptual facility design)

- licence application to construct
- licence application to operate
- licence application to decommission (the infrastructure), abandon and close a radioactive waste disposal facility.

Additionally in some jurisdictions, the holder of a licence may seek approval to surrender the licence.

It should be noted that whilst the overall process is staged, there is strong linkage between each successive individual licence application. The licence application for each stage needs to be forward looking and contain sufficient information on the safety and security aspects to demonstrate that the subsequent stage(s) can be carried out safely and securely, and to allow for an informed decision to be made by the relevant regulatory authority.

2.6 A Graded Approach to implementation

The requirements in this Code and associated guidance for disposal are to be applied in accordance with a graded approach, consistent with the intrinsic hazard presented by the waste to be disposed of.

The graded approach is to be applied to safety by both the **operator** and regulatory body, to ensure that resources are focused on the aspects of the facility that are associated with the highest risk and that present the greatest hazard.

In accordance with the graded approach, the ability of a chosen disposal system to contain the waste and isolate it from humans and the accessible biosphere is required to be commensurate with the hazard potential of the waste. This is achieved primarily by appropriate selection of waste forms and packaging, of the site for the disposal facility and of its design including the type and number of barriers. Disposal facilities are not expected to provide complete containment and isolation of the waste forever; this is neither practicable nor demanded by the hazard of the waste, which decreases with time.

2.7 Safety and the Safety Case

The international best practice framework for safety of radioactive waste management has been developed around the concept of the safety case. The safety case is the collection of scientific, technical, administrative and managerial arguments and evidence that demonstrate the safety of a disposal facility, covering the suitability of the selected site and the design of the facility, its construction and operation, the assessment of radiation risks and assurance of the adequacy and quality of all of the safety-related work associated with the disposal facility.

The safety case and supporting safety assessment provide the basis for demonstration of safety and for licensing. They will evolve with the development of the disposal facility, and will assist and guide decisions on its siting, design, operation and closure. The safety case will also be the main basis on which confidence in the safety of the disposal facility will be developed and on which dialogue with interested parties will be conducted.

The safety requirements for radioactive waste disposal include the requirement that a safety case be developed together with a supporting safety assessment.

More details of the safety case and its role in regulation and consultation are presented in Annex A.

2.8 Selecting a Site

A site for a disposal facility will ideally be located in an area with favourable meteorological, geological and geographical characteristics so that the radioactive waste, once in place, will be adequately isolated from the biosphere for the time that the radionuclides originally present, or their progeny, constitute a radiation hazard.

Ideally the natural characteristics of the site will provide the initial effective barrier to the dispersal of radionuclides from the waste or to human intrusion. The location of the disposal site and its characteristics will influence the design of the facility. These will also be considered within the safety case when determining the limits to be placed on the total site activity for the facility, on the radionuclide concentrations in the waste and appropriate conditioning for waste packages.

Throughout the site selection process, it is imperative to address the societal dimension of radioactive waste management through effective dialogue with the community with a view to strengthening confidence in the decision-making processes. The safety case will be the main basis on which dialogue with stakeholders will be conducted and on which confidence in the safety of the facility will be developed. Any sustainable process of deliberation and decision-making during site selection will seek to re-connect the issue of waste with a range of social, environmental, health and economic issues, including issues raised by the stakeholders.

2.9 Reversibility and Retrievability

Disposal is defined as ‘emplacement of waste in a purpose-built facility, which will eventually be closed, without any intention of retrieval’. At the time of disposal, there is *no intention* for retrieval. However, based on international best practice, a licence application for the design, construction and/or operation, and for the post-closure phase of a disposal facility is expected, as appropriate, to include consideration of **reversibility** and **retrievability** principles.

These principles acknowledge that development of any disposal facility for long lived radioactive waste will take place over many years and should be open to progress in science and technology, to evolving societal demands and to adaptation based on lessons learned. In this regard, selecting technologies that are as reversible as possible is a prudent approach, however it is important that reversibility and retrievability considerations do not jeopardise long-term safety.

2.10 Defining ‘Community’

In this Code the term ‘community’ is used to define the level of spatial and social organisation at which the issue of demographics must be addressed by the license applicant in terms of ‘the impact of the facility on the community in which the facility is, or is to be situated’. In general usage ‘community’ refers to a geographical area defined for the purpose of consultation. If the facility impacts on a community without definite spatial boundaries/limitations (e.g. Aboriginal individuals/groups), the term itself is ambiguous and hence defining the appropriate community will always be open to interpretation and conjecture. The licence proponent will need to apply cultural interpretations of what constitutes the appropriate community.

It is essential that traditional landowners at the local level play a part in the process of self-definition of their communities.

3. Safety requirements for disposal of radioactive waste

3.1 General Requirements

Application of the principles of radiation protection

3.1.1 Before a proposal to develop a disposal facility for radioactive waste is approved or commenced, the proposal must be justified.

3.1.2 The principles of radiation protection must be applied.

3.1.3 The siting and design of a disposal facility, its associated equipment and operating methods must be selected to ensure that the radiation doses received by occupationally exposed persons and members of the public are kept as low as reasonably achievable, economic and social factors being taken into account.

3.1.4 The concept of **best available techniques** (BAT) must be incorporated in any proposal to develop a disposal facility for radioactive waste. It is the responsibility of the proponent to suggest the techniques that may be considered BAT (technical, social and economic elements considered) for radioactive waste storage and disposal.

3.1.5 Use of best available techniques must be considered in parallel with optimisation, as the two principles reinforce each other in strengthening radiological outcomes.

3.1.6 It must be demonstrated that the design and operation of the facility provide for the protection of workers and members of the public during the operational phase of a disposal facility, such that:

3.1.7 radiation doses to the public and workers as a consequence of waste management and disposal activities do not exceed the dose limits in the RPS C-1 (ARPANSA 2016);

3.1.8 facilities are designed and operated in such a way that radiation protection of workers and members of the public is optimised according to the principles described in RPS F-1 (ARPANSA 2014a); and

3.1.9 the consequences of any reasonably foreseeable fault or accident condition are such that radiation protection of workers and the public is optimised according to the principles described in RPS F-1 (ARPANSA 2014a).

3.1.10 In the process of developing the safety case for a disposal facility, a dose constraint for workers must be proposed below which protection will be optimised, in accordance with the national standards documents RPS F-1 (ARPANSA 2014a) and RPS C-1 (ARPANSA 2016) and which is agreed to by the Relevant Regulatory Authority.

3.1.11 Regarding the risks to individuals in the case of potential exposures [the principles of which are described in RPS F-1 (ARPANSA 2014a), for members of the public an annual 'risk constraint' (or more accurately the 'risk target' for the period of passive safety) must be set within the range 10^{-5} to 10^{-6} for cancer detriment by use of the ICRP probability coefficients[1], in consultation with the regulatory authority.

Preparation of the Radiation Management Plan

3.1.12 Before the commencement of any stage of an operation to which this Code applies, a Radiation Management Plan for that stage must be devised and presented to the relevant regulatory authority for approval. The Plan must be directed towards meeting the objectives of this Code and the Planned Exposure Code (ARPANSA 2016) and must be in accordance with best practicable technology and take into account the potential dose delivery pathways. The Plan forms part of the Safety Case.

Approvals and Authorisations

3.1.13 Prior to the commencement of any stage of an operation to which this Code applies, the operator must obtain approval for the Safety Case (including the Radiation Management Plan) appropriate for the proposed activities at that stage.

3.1.14 An operator must not commence any of the steps of construction, operation, decommissioning, closure or rehabilitation of any part of a disposal facility to which this Code applies without **authorisation** from the relevant regulatory authority.

3.1.15 The operator must inform the relevant regulatory authority of any proposal for significant changes to an operation to which an approved Safety Case and Radiation Management Plan applies. The relevant regulatory authority may, on receipt of such notification, direct that a new Safety Case, or part thereof must be submitted, and that those changes must not be brought into operation without authorisation.

3.1.16 The operator must review the Safety Case and submit any revised plans for approval, at intervals determined by the relevant regulatory authority.

Consultation

3.1.17 Consultation with stakeholders, including the public, must be an integral part of the regulatory processes. Stakeholders are to be regarded by both proponent and regulator as an asset that will contribute knowledge to those processes. The role of

[1] Refer to Table 1, ICRP Publication 103, p53 (ICRP 2007)

stakeholders and their interaction with the regulatory authority has the objective of achieving the most informed decisions and best practicable outcomes.

3.1.18 Both proponent and regulator must take steps to identify all the relevant stakeholders, and develop strategies for effective and ongoing communication and consultation with those stakeholders.

3.1.19 **Consultation by the proponent:** The safety case (see 2.7), which is the responsibility of the proponent, is the main basis on which dialogue with stakeholders will be conducted and on which confidence in the safety of the facility or activity will be developed.

3.1.20 **Consultation by the regulator:** The relevant regulatory authority must promote the establishment of appropriate means of informing and consulting stakeholders and the public about the possible radiation risks associated with disposal facilities and associated activities, and about the processes and decisions of the regulatory authority.

3.1.21 Upon receiving an application to site, construct, operate, possess and control or close (abandon) a radioactive waste disposal facility, the relevant regulatory authority must publicise the details appropriately, inviting relevant people and bodies to make submissions for consideration by the regulatory authority prior to any decision on the application.

3.1.22 To assist in the processes of consultation, the regulatory authority must notify stakeholders and the public of the principles and associated criteria for safety established in its regulations and guides, and must make its regulations and guides available.

Protection of the Environment

3.1.23 The information in an application for a licence for a radioactive waste disposal facility must establish that the proposed conduct can be carried out without undue risk to the health and safety of people, and to the environment.

3.1.24 An Environmental Management Plan (EMP) must be established for the disposal site prior to commencement of construction and operations. The purpose of the EMP is to set out management objectives and practices which will provide for the safe and environmentally sound management of the facility during its construction, operational and post-operational phases. The EMP may be included as part of the Radiation Management Plan approved by the appropriate authority or may be a stand-alone document.

3.1.25 Review of the EMP must be carried out by the operator at intervals of approximately three years during the operational phase of the disposal facility.

3.1.26 The applicant must undertake a screening assessment of doses to **wildlife** (i.e. animals and plants living within their natural environment) in the vicinity of the disposal facility by use of one of the internationally accepted screening tools. The objective of radiation protection of wildlife is to maintain biological diversity, the conservation of species and the health of natural ecosystems (ARPANSA 2015). If a screening assessment indicates that exposures to relevant wildlife in the natural environment are likely to be higher than the screening dose rate (defined in consultation with the regulatory authority) more detailed assessments of potential environmental impact must be undertaken.

Site Selection

3.1.27 For disposal of solid radioactive waste, the site chosen for the facility must have characteristics that will facilitate its long-term stability and provide adequate isolation of the waste so that the objectives in Sections 2.2 and 2.3 are achieved.

3.1.28 Site selection criteria related to radiological protection that must be considered are listed below. A potential site is not required to comply with all of these criteria. However, there must be compensating factors in the design of the facility to overcome any deficiency in the physical characteristics of the site unless such compensating factors are deemed unreasonable, in which case another site should be identified.

The criteria for the site are that:

a) the site is located in an area of low rainfall, free from flooding, with good surface drainage features, and generally stable geomorphology

b) the water table in the area is at a sufficient depth above or below the planned disposal structures to ensure that groundwater is unlikely to impact on the waste, and the hydrogeological setting is such that large fluctuations in the water table are unlikely

c) the geological structure and hydrogeological conditions permit modelling of groundwater gradients and movement, and enable prediction of radionuclide migration times and patterns

d) the site is located away from any known or anticipated seismic, tectonic or volcanic activity of a severity which could compromise the stability of the disposal structures and the integrity of the waste

e) the site is located in an area of low population density where the projected population growth or the prospects for future development are also very low

f) the absence of groundwater suitable for human consumption, pastoral or agricultural use which may be affected by the presence of a facility

g) there are suitable geochemical and geotechnical properties of the site to retard migration of radionuclides and to facilitate repository operations.

3.1.29 Other non-radiological site selection criteria must also be considered. A potential site is not required to comply with all of these criteria. However, supporting, well-founded arguments must be provided in association with the safety case to address any criteria that are not fully met.

The criteria are:

a) the immediate vicinity of the facility has no known significant natural resources, including potentially valuable mineral deposits, and which has little or no potential for agriculture or outdoor recreational use

b) there is reasonable access for the transport of materials and equipment during construction and operation, and for the transport of waste into the site

c) the immediate vicinity of the facility has no special environmental attraction or appeal, no notable ecological significance, and is not the known habitat of rare fauna or flora

d) the immediate vicinity of the facility has no special cultural or historical significance

e) there are no land ownership rights or controls that compromise retention of long-term control over the facility.

Collocation of facilities

3.1.30 If a disposal site is proposed close to or adjacent to another new or existing facility, the impact of each facility on the safety of the other must be considered by the proponent and regulator, including with regard to impacts on redundancy of safety systems.

3.1.31 Where a proposed facility is to be collocated with new or existing facilities, any specific security issues arising from the collocation must be taken into account in the site evaluation for the proposed facility.

Safety and Security Culture

3.1.32 An applicant for any licence covered by this Code must, as part of the licence application, provide information upon which an assessment can be made of the adequacy of the safety and security culture of the applicant organisation. The required information must demonstrate the commitment of senior management within the operator to safety and security, and the establishment and maintenance of a holistic culture within the facility to be licensed.

Security

3.1.33 In implementing measures to meet the requirements contained in this Code, due consideration for security principles must be taken to ensure that they will not create adverse effects to the security system. For example, certain sensitive information may not be able to be publicly disclosed.

3.1.34 All security issues relevant for the appropriate phase of a disposal facility (e.g. siting, construction, operation, closure) must be addressed by the proponent/operator as required under *Code of Practice for the* Security *of Radioactive Sources* (RPS 11) (ARPANSA 2007).

3.1.35 Other relevant recommendations in the IAEA security series standards, *Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities* (IAEA 2011b) and *Nuclear Security Recommendations on Radioactive Material and Associated Facilities* (IAEA 2011c), must be addressed by the proponent/operator.

Recordkeeping

3.1.36 Detailed records must be kept by the operator and by an appropriate authority of all waste consigned to, and received at, the disposal facility. This information must include:

f) the waste generator

g) the type of waste

h) its volume and weight

i) the chemical and physical form and concentration of radionuclides in the waste

j) details of any conditioning.

3.1.37 Records must also be kept of:

a) details of any accidents and incidents at the facility including the impact on personnel, the public and the environment

b) occupational exposure records of all radiation workers, in accordance with RPS C-1 (ARPANSA 2016)

c) environmental and area monitoring data at and around the facility.

3.1.38 Furthermore, site records must be kept at least until the end of the **institutional control** period in at least two widely separated locations, one of which must be the appropriate Commonwealth, state or territory government archives, and must include:

a) the location of all disposal structures;

b) the location of the waste packages or containers within the structures and the date of their emplacement

c) details of the contents of waste packages or containers

d) details of the backfilling and cover materials.

3.1.39 Commonwealth government agencies must comply with the requirements of the Archives Act 1983 (Cth).

3.1.40 Preservation of Information: The management of records for a disposal facility must include a plan for appropriate longevity of recordkeeping and for retrieval of those records into the future.

3.2 International Best Practice Safety Requirements for Disposal of Radioactive Waste

The international safety requirements for disposal of radioactive waste presented here are taken from SSR-5 (IAEA 2011a) which form in part the requirements of this Code. The detailed descriptions that are presented in SSR-5 for each Requirement are reproduced here, and are fully applicable to this Code.

Requirements 1 (Government Responsibilities) and 2 (Responsibilities of the Regulatory Body) from SSR-5 (IAEA 2011a) are not applicable as potential licence conditions for inclusion in an Australian national code, and thus have been removed from inclusion as requirements under this code.

Safety requirements for planning for the disposal of radioactive waste

3.2.1 The prime responsibility for safety rests with the operator, to whom the majority of the requirements apply. However, the assurance of safety and the development of a broader confidence in safety also require a competent regulatory process within a specified legal and regulatory framework and the allocation of responsibilities for pre-operational activities.

3.2.2 The operator might be a single organisation or one of a number of organisations involved. The safety requirements for the planning of a disposal facility apply to those elements that have to be in place prior to the development of the disposal facility, with the purpose of ensuring safety in the operational period and after closure.

3.2.3 Safety in the operation of radioactive waste disposal facilities has to be achieved by means of a variety of engineered and operational controls similar to those used in other facilities in which radioactive material is handled, used, stored or processed. These include the containment and shielding for the radioactive waste and operational control over time of exposure and proximity to the waste. Protection of the public is provided for by preventing or controlling releases from the facility and by controlling access to the site. Operational monitoring programmes provide assurance of these various controls.

3.2.4 Safety after closure is achieved by developing a disposal system in which the various components work together to provide and to ensure the required level of safety. This approach offers flexibility to the designer of a disposal facility to adapt the facility's layout and engineered barriers so as to take advantage of the natural characteristics of the site and the barrier potential of the host geology, if applicable. Assurance of confidence in safety is also necessary and this may require the consideration of a number of complex issues, including the potential impact of operations on the performance of the disposal facility after closure.

Responsibilities of the operator

3.2.5 *The operator of a disposal facility for radioactive waste shall be responsible for its safety. The operator shall carry out safety assessment and develop and maintain a safety case, and shall carry out all the necessary activities for site selection and evaluation, design, construction, operation, closure and, if necessary, surveillance after closure, in accordance with national strategy, in compliance with the regulatory requirements and within the legal and regulatory infrastructure.*

3.2.6 The operator has to be responsible for developing a disposal facility that is practicable and safe and for demonstrating its safety, consistent with the requirements of the regulatory body. This task has to be undertaken in consideration of: the characteristics and quantities of the radioactive waste to be disposed of; the site or sites available; the mining, excavation, construction and engineering techniques available; and the legal and regulatory infrastructure and regulatory requirements. The operator also has to be responsible for developing a safety case, on the basis of which decisions on the development, operation and closure of the disposal facility have to be made (see clauses 3.2.80 to 3.2.91).

3.2.7 The operator has to conduct or commission the research and development work necessary to ensure that the planned technical operations can be practically and safely accomplished, and to demonstrate this. The operator likewise has to conduct or commission the research work necessary to investigate, to understand and to support the understanding of the processes on which the safety of the disposal facility depends. The operator also has to carry out all the necessary investigations of sites and of materials and has to assess their suitability and obtain all the data necessary for the purposes of safety assessment.

3.2.8 The operator has to establish technical specifications that are justified by safety assessment, to ensure that the disposal facility is developed in accordance with the safety case. This has to include waste acceptance criteria (see clauses 3.2.92 to 3.2.95) and other controls and limits to be applied during construction, operation and closure.

3.2.9 The operator has to retain all the information relevant to the safety case and the supporting safety assessment for the disposal facility and has to retain the inspection records that demonstrate compliance with regulatory requirements and with the operator's own specification. Such information and records have to be retained, at least up until the time when the information is shown to be superseded, or until responsibility for the disposal facility is passed on to another organisation. This occurs, for example, at closure of the facility, when all relevant information and records have to be transferred to the organisation assuming responsibility for the facility and its safety.

3.2.10 The operator has to cooperate with the regulatory body and has to supply all the information that the regulatory body may request. The need to preserve the records for long periods of time has to be taken into account in selecting the format and media to be used for records.

Importance of safety in the process of development and operation of a disposal facility

3.2.11 *Throughout the process of development and operation of a disposal facility for radioactive waste, an understanding of the relevance and the implications for safety of the available options for the facility shall be developed by the operator. This is for the purpose of providing an optimised level of safety in the operational stage and after closure.*

3.2.12 Disposal facilities for radioactive waste may be developed and operated over a period of several years or several decades. Key decisions, such as decisions on site selection and evaluation, and on the design, construction, operation and closure of the disposal facility, are expected to be made as the project develops. In this process, decisions are made on the basis of the information available at the time, which may be either quantitative or qualitative, and the confidence that can be placed in that information.

3.2.13 Decisions on the development, operation and closure of the facility are constrained by external factors, which include: national policy and preferences, the capacity and capability of existing storage and disposal facilities to accommodate waste, and the availability of suitable sites and geological formations to host planned new disposal facilities. An adequate level of confidence in the safety of each disposal facility has to be developed before decisions are taken.

3.2.14 At each major decision point, the implications for the safety of the available design options and operational options for the disposal facility have to be considered and taken into account. Ensuring safety, both in the operational stage and after closure, is the overriding concern at each decision point. If more than one option is capable of providing the required level of safety, then other factors also have to be considered. These factors could include public acceptability, cost, site ownership, existing infrastructure and transport routes.

3.2.15 Consideration has to be given to locating the facility away from significant known mineral resources, geothermal water and other valuable subsurface resources. This is to reduce the risk of human intrusion into the site and to reduce the potential for use of the surrounding area to be in conflict with the facility. The safety of the facility has to be considered at every step in the decision making process to ensure that safety is optimised in the sense discussed in the Appendix of SSR-5 (IAEA 2011a).

Passive means for the safety of the disposal facility

3.2.16 *The operator shall evaluate the site and shall design, construct, operate and close the disposal facility in such a way that safety is ensured by passive means to the fullest extent possible and the need for actions to be taken after closure of the facility is minimised.*

3.2.17 In the operational stage of a disposal facility for radioactive waste, certain active control measures have to be applied. However, where passive features such as the shielding and containment provided by the packaging material can provide safety, then safety has to be ensured by such passive means.

3.2.18 To some extent, the safety of a disposal facility can depend on some future actions such as maintenance work or surveillance. However, this dependence has to be minimised to the extent possible. This is necessary because of the possibility that safety measures that depend on future actions, such as maintenance work or surveillance, will not be taken or will not be continued. The cumulative probability of the failure of such safety measures will gradually increase. Furthermore, and consistent with SF-1 (IAEA 2006) and RPS F-1 (ARPANSA 2014a), disposal of radioactive waste is intended to discharge the responsibility for safety of the waste producers and the operator to the fullest extent possible, thereby minimising the responsibilities that are retained or are passed on to successor organisations.

3.2.19 For a geological disposal facility, it is possible to provide for safety after closure by means of passive features. It is likewise possible to provide for the safety of a borehole disposal facility after closure by means of passive features, owing to the host geology. In the case of a near surface disposal facility, actions such as maintenance, monitoring or surveillance may be necessary for a period of time after closure to ensure safety.

3.2.20 Providing for the safety of a disposal facility after closure by means of passive features will entail proper closure of the facility and ending the need for its active management. The cessation of management means that the disposal facility, with its associated radiological hazard, is no longer under active control. It is the performance of the natural and engineered barriers that provides safety after closure, together, for a near surface disposal facility, with institutional controls.

3.2.21 In practice, even in those cases in which passive features are the primary means for providing a reasonable assurance of safety, institutional controls, including restrictions on land use, and a programme for monitoring may be necessary in the post-closure period. Institutional controls and monitoring are the subject of clauses 3.2.96 to 3.2.109.

Understanding of a disposal facility and confidence in safety

3.2.22 *The operator of a disposal facility shall develop an adequate understanding of the features of the facility and its host environment and of the factors that influence its safety after closure over suitably long time periods, so that a sufficient level of confidence in safety can be achieved.*

3.2.23 Confidence has to be assured by the results of safety assessment for a disposal facility. The features of the facility and its host environment that provide for safety have to be identified, in addition to those factors that might be detrimental. It has to be demonstrated that these features and factors are sufficiently well characterised and understood. Any uncertainties have to be taken into consideration in the assessment of safety.

3.2.24 The purpose of this demonstration is to establish, with a high level of confidence, that the disposal facility and its host environment can be relied on to provide the necessary containment and isolation over the timescales envisaged. Certain features of the disposal facility and its environment may contribute to safety, but may be less quantifiable, such as the remoteness of the site. The reasoning with regard to such factors has to be based on more qualitative arguments, and such factors provide a safety margin.

3.2.25 An understanding of the features of a disposal facility and how it will perform over time is necessary in order to be able to demonstrate the dependability of certain design features. This demonstration is assisted if such design features are robust (i.e. their performance is of low sensitivity to possible events and processes causing disturbances). Sufficient evidence has to be obtained of their feasibility and effectiveness before construction activities are commenced.

3.2.26 In this regard, the range of possible events and processes causing disturbances that it is reasonable to include in such considerations has to be subject to agreement by the regulatory body and subsequent approval by inclusion in the safety case. These considerations permit the development of an understanding of whether or not such events and processes cause disturbances that could lead to the widespread loss of safety functions.

3.2.27 Understanding of the performance of the disposal system and its safety features and processes evolves as more data are accumulated and scientific knowledge is developed. Early in the development of the concept, the data obtained and the level of understanding gained have to assure sufficient confidence to be able to commit resources for further investigations. Before the start of construction, during emplacement of waste and at closure of the facility, the level of understanding has to be sufficient to support the safety case for fulfilling the regulatory requirements applicable for the particular stage of the project.

3.2.28 In establishing these regulatory requirements, it has to be recognised that there are various types and components of uncertainty inherent in modelling complex environmental systems. It also has to be recognised that there are, inevitably, significant uncertainties associated with projecting the performance of a disposal system over time.

Design concepts for safety

3.2.29 A disposal facility is designed to contain the radionuclides associated with the radioactive waste and to isolate them from the accessible biosphere. The disposal facility is also designed to retard the dispersion of radionuclides in the geosphere and biosphere and to provide isolation of the waste from aggressive phenomena that could degrade the integrity of the facility. The various elements of the disposal system, including physical components and control procedures, contribute to performing safety functions in different ways over different timescales.

3.2.30 Requirements are established in this section for ensuring that there is adequate defence in depth, so that safety is not unduly dependent on a single element of the disposal facility, such as the waste package; or a single control measure, such as verification of the inventory of waste packages; or the fulfilment of a single safety function, such as by containment of radionuclides or retardation of migration; or a single administrative procedure, such as a procedure for site access control or for maintenance of the facility.

3.2.31 Adequate defence in depth has to be ensured by demonstrating that there are multiple safety functions, that the fulfilment of individual safety functions is robust and that the performance of the various physical components of the disposal system and the safety functions they fulfil can be relied upon, as assumed in the safety case and supporting safety assessment. It is the responsibility of the operator to demonstrate fulfilment of the following design requirements to the satisfaction of the regulatory body.

Multiple safety functions

3.2.32 *The host environment shall be selected, the engineered barriers of the disposal facility shall be designed and the facility shall be operated to ensure that safety is provided by means of multiple safety functions. Containment and isolation of the waste shall be provided by means of a number of physical barriers of the disposal system. The performance of these physical barriers shall be achieved by means of diverse physical and chemical processes together with various operational controls. The capability of the individual barriers and controls together with that of the overall disposal system to* *perform as assumed in the safety case shall be demonstrated. The overall performance of the disposal system shall not be unduly dependent on a single safety function.*

3.2.33 The engineered and physical barriers that make up the disposal system are physical entities, such as the waste form, the packaging, the backfill, and the host environment and geological formation. A safety function may be provided by means of a physical or chemical property or process that contributes to containment and isolation, such as: impermeability to water; limited corrosion, dissolution, leach rate and solubility; retention of radionuclides; and retardation of radionuclide migration.

3.2.34 Active controls can also fulfil safety functions or contribute to confidence in natural and engineered barriers and safety functions. The presence of a number of physical and other elements performing safety functions gives assurance that even if any of them do not perform fully as expected (e.g. owing to an unexpected process or an unlikely event), a sufficient margin of safety will remain.

3.2.35 The physical elements and their safety functions can be complementary and can work in combination. The performance of a disposal system is thus dependent on different physical elements and on other elements that perform safety functions, which act over different time periods. For example, the roles of the waste package and the host geological formation for a geological disposal facility may vary in different time periods.

3.2.36 The safety case has to explain and justify the functions performed by each physical element and other features. It also has to identify the time periods over which physical components and other features are expected to perform their various safety functions, and also the alternative or additional safety functions that are available if a physical element does not fully perform or another safety function is not fulfilled.

Containment of radioactive waste

3.2.37 *The engineered barriers, including the waste form and packaging, shall be designed, and the host environment shall be selected, so as to provide containment of the radionuclides associated with the waste. Containment shall be provided until radioactive decay has significantly reduced the hazard posed by the waste. In addition, in the case of heat generating waste, containment shall be provided while the waste is still producing heat energy in amounts that could adversely affect the performance of the disposal system.*

3.2.38 The containment of radioactive waste implies designing the disposal facility to avoid or minimise the release of radionuclides. Releases of small amounts of gaseous radionuclides and of small fractions of other highly mobile species from some types of radioactive waste may be inevitable. Such releases, nevertheless, have to be demonstrated to be acceptable by means of safety assessment. The containment may be provided by the characteristics of the waste and the packaging and by the characteristics of other engineered components of the disposal system and the host environment and geological formation.

3.2.39 The containment of the radionuclides in the waste form and the packaging over a defined period has to ensure that the majority of shorter lived radionuclides decay in situ. For low level waste, such periods would be of the order of several hundred years; for high level waste the period would be several thousands of years. For high level waste, it also has to be ensured that any migration of radionuclides outside the disposal system would occur only after the heat produced by radioactive decay has substantially decreased.

3.2.40 Radioactive waste from mining and mineral processing may include radionuclides with very long half-lives. Providing assurance of the integrity of the containment features of disposal facilities for such waste over the corresponding timescales requires particular consideration. If the waste has activity levels for which the dose and/or risk criteria for human intrusion into such facilities might be exceeded, alternative disposal options will have to be considered. Possible alternative options include, for example, disposal of the waste below the surface, or separation of the radionuclide content giving rise to the higher dose, as determined by the safety case for the disposal facility.

3.2.41 Containment is most important for more highly concentrated radioactive waste, such as intermediate level waste and vitrified waste from fuel reprocessing, or for spent nuclear fuel. Attention also has to be given to the durability of the waste form. The most highly concentrated waste has to be emplaced in a containment configuration that is designed to retain its integrity for a long enough period of time to enable most of the shorter lived radionuclides to decay and for the associated generation of heat to decrease substantially. Such containment may not be practicable or necessary for low level waste. The containment capability of the waste package has to be demonstrated by means of safety assessment to be appropriate for the waste type and the overall disposal system.

Isolation of radioactive waste

3.2.42 *The disposal facility shall be sited, designed and operated to provide features that are aimed at isolation of the radioactive waste from people and from the accessible biosphere. The features shall aim to provide isolation for several hundreds of years for short lived waste and at least several thousand years for intermediate level waste. In so doing, consideration shall be given to both the natural evolution of the disposal system and events causing disturbance of the facility.*

3.2.43 For near surface facilities, isolation has to be provided by the location and the design of the disposal facility and by operational and institutional controls. For geological disposal of radioactive waste, isolation is provided primarily by the host geological formation as a consequence of the depth of disposal.

3.2.44 Isolation means design to keep the waste and its associated hazard apart from the accessible biosphere. It also means design to minimise the influence of factors that could reduce the integrity of the disposal facility. Sites and locations with higher hydraulic conductivities have to be avoided. Access to waste has to be made difficult to gain without, for example, violation of institutional controls for near surface disposal. Isolation also means providing for a very slow mobility of radionuclides to impede migration from disposal facilities.

3.2.45 Location of a disposal facility in a stable geological formation provides protection of the facility from the effects of geomorphological processes, such as erosion and glaciation. The disposal facility has to be located away from known areas of significant underground mineral resources or other valuable resources. This will reduce the likelihood of inadvertent disturbance of the facility and will avoid resources being made unavailable for exploitation.

3.2.46 In some cases, it may not be possible to provide sufficient assurance of separation from the accessible biosphere, owing to phenomena such as uplift, erosion and glaciation. In such cases, and if the remaining activity in the waste is still significant at the time such phenomena occur, the possibility of human intrusion has to be evaluated in determining the degree of isolation provided.

3.2.47 Over time periods of several thousand years or more, the migration of a fraction of the longer lived and more mobile radionuclides from the waste in a geological disposal facility (or in other facilities that may include longer lived radionuclides, such as borehole facilities) may be inevitable. The safety criteria to apply in assessing such possible releases are set out in section **Error! Reference source not found.**. Caution needs to be exercised in applying criteria for periods far into the future. Beyond such timescales, the uncertainties associated with dose estimates become so large that the criteria might no longer serve as a reasonable basis for decision making. For such long time periods after closure, indicators of safety other than estimates of dose or individual risk may be appropriate, and their use has to be considered.

Surveillance and control of passive safety features

3.2.48 *An appropriate level of surveillance and control shall be applied to protect and preserve the passive safety features, to the extent that this is necessary, so that they can fulfil the functions that they are assigned in the safety case for safety after closure.*

3.2.49 For geological disposal and for the disposal of intermediate level radioactive waste, the passive safety features (barriers) have to be sufficiently robust so as not to require repair or upgrading. The long term safety of a disposal facility for radioactive waste is required not to be dependent on active institutional control (see clauses 3.2.100 to 3.2.109). For near surface disposal facilities, including those for radioactive waste from the mining and processing of minerals, measures for surveillance and control of the disposal facility might be instituted. These measures might include restrictions on access by people and animals, inspection of physical conditions, retention of appropriate maintenance capabilities, and surveillance and monitoring as a method of checking whether performance is as specified (i.e. checking for degradation). The intent of surveillance and monitoring is not to measure radiological parameters but to ensure the continuing fulfilment of safety functions.

Requirements for the Development, Operation and Closure of a Disposal Facility

Step by step development and evaluation of disposal facilities

3.2.50 *Disposal facilities for radioactive waste shall be developed, operated and closed in a series of steps. Each of these steps shall be supported, as necessary, by iterative evaluations of the site, of the options for design, construction, operation and management, and of the performance and safety of the disposal system.*

3.2.51 A step by step approach to the development of a disposal facility for radioactive waste refers to the steps that are imposed by the regulatory body and by political decision making processes. This approach is taken to provide an opportunity to ensure the quality of the technical programme and the associated decision making. For the operator, it provides a framework in which sufficient confidence in the technical feasibility and safety of the disposal facility can be built at each step in its development.

3.2.52 Confidence has to be developed and refined by means of iterative design and safety studies as the project progresses (OECD 1999). The process has to provide for: the collection, analysis and interpretation of the relevant scientific and technical data; the development of designs and operational plans; and the development of the safety case for safety in the operational stage and after closure. The step by step process provides access for all interested parties to the safety basis for the disposal facility. This facilitates the relevant decision making processes that enable the operator to proceed to the next significant step in the development of the facility, and on to its operation and, finally, its closure.

Preparation, approval and use of the safety case and safety assessment for a disposal facility

3.2.53 *A safety case and supporting safety assessment shall be prepared and updated by the* operator*, as necessary, at each step in the development of a disposal facility, in operation and after closure. The safety case and supporting safety assessment shall be submitted to the regulatory body for approval. The safety case and supporting safety assessment shall be sufficiently detailed and comprehensive to provide the necessary technical input for informing the regulatory body and for informing the decisions necessary at each step.*

3.2.54 A facility specific safety case has to be prepared early in the development of a disposal facility to provide a basis for licensing decisions and to guide activities in research and development, site selection and evaluation and design. The safety case has to be developed progressively and elaborated as the project proceeds. It has to be presented to the regulatory body at each step in the development of the disposal facility. The regulatory body might require an update of, or revision to, the safety case before given steps can be taken, or such an update or revision may be necessary to gain political or public support for taking the next step in the development of the disposal facility or for its operation or closure. The formality and level of technical detail of the safety case will depend on the stage of development of the project, the decision in hand, the audience to which it is addressed and specific national requirements.

3.2.55 Safety assessment in support of the safety case has to be performed and updated throughout the development and operation of the disposal facility and as more refined site data become available. Safety assessment has to provide input to ongoing decision making by the operator. Such decision making may relate to subjects for research, development of a capability for assessment, allocation of resources and development of waste acceptance criteria.

3.2.56 Safety assessment also has to identify key processes relevant to safety and to contribute to the development of an understanding of the performance of disposal facilities. It has to support judgements with regard to alternative management options as an element of optimising protection and safety. Such an understanding has to provide the basis for the safety arguments presented in the safety case. The operator has to decide on the timing and the level of detail of the safety assessment, in consultation with, and subject to the approval of, the regulatory body.

Scope of the safety case and safety assessment

3.2.57 *The safety case for a disposal facility shall describe all safety relevant aspects of the site, the design of the facility and the managerial control measures and regulatory controls. The safety case and supporting safety assessment shall demonstrate the level of protection of people and the environment provided and shall provide assurance to the regulatory body and other interested parties that safety requirements will be met.*

3.2.58 The safety case for a disposal facility has to address safety both in operation and after closure. It may also address safety in transport, for which requirements are established in *Code for the Safe Transport of Radioactive Material* (ARPANSA 2014b). All aspects of operation relevant to safety are considered, including surface and underground excavation, construction and mining work, waste emplacement, and backfilling, sealing and closing operations. Consideration has to be given to both occupational exposure and public exposure resulting from conditions of normal operation and anticipated operational occurrences over the operating lifetime of the disposal facility.

3.2.59 Accidents of a lesser frequency, but with significant radiological consequences (i.e. possible accidents that could give rise to radiation doses over the short term in excess of annual dose limits), have to be considered with regard to both their likelihood of occurrence and the magnitude of possible radiation doses. The adequacy of the design and of the operational features also has to be evaluated.

3.2.60 With regard to safety after closure, the expected range of possible developments affecting the disposal system and events that might affect its performance, including those of low probability, have to be considered in the safety case and supporting assessment by the following means:

(a) By presenting evidence that the disposal system, its possible evolutions and events that might affect it are sufficiently well understood;

(b) By demonstrating the feasibility of implementing the design;

(c) By providing convincing estimates of the performance of the disposal system and a reasonable level of assurance that all the relevant safety requirements will be complied with and that radiation protection has been optimised;

(d) By identifying and presenting an analysis of the associated uncertainties.

3.2.61 The safety case may include the presentation of multiple lines of reasoning based, for example, on studies of natural analogues and palaeohydrogeological studies, suitable characteristics of the site, properties of the host geological formation, engineering considerations, operational procedures and institutional assurances.

3.2.62 The performance of the disposal system under expected and less likely evolutions and events, which can be outside the design performance range of the disposal facility, has to be analysed in the safety assessment. A judgement of what is to be considered the expected evolution and less likely evolutions has to be discussed between the regulatory body and the operator. If necessary, sensitivity analyses and uncertainty analyses would be undertaken to gain an understanding of the performance of the disposal system and its components under a range of evolutions and events.

3.2.63 The consequences of unexpected events and processes may be explored to test the robustness of the disposal system. In particular, the resilience of the disposal system has to be assessed. Quantitative analyses have to be undertaken, at least over the time period for which regulatory requirements apply. However, the results from detailed models for safety assessment purposes are likely to be more uncertain for timescales extending into the far future.

3.2.64 For timescales extending into the far future, arguments may be needed to illustrate safety, on the basis, for example, of complementary safety indicators, such as concentrations and fluxes of radionuclides of natural origin in the geosphere and biosphere and bounding analyses. While such assessments cannot yield precise levels of possible doses or risks, the results may provide a tool to indicate the level of safety and verify that no alternative design would have obvious advantages.

3.2.65 The management systems established to provide assurance of quality in these design features and operational features have to be addressed in the safety case.

Documentation of the safety case and safety assessment

3.2.66 *The safety case and supporting safety assessment for a disposal facility shall be documented to a level of detail and quality sufficient to inform and support the decision to be made at each step and to allow for independent review of the safety case and supporting safety assessment.*

3.2.67 The necessary scope and structure of the documentation setting out the safety case and supporting safety assessment will depend on the step reached in the project for the disposal facility and on national requirements. This includes consideration of the needs of different interested parties for information. Important considerations in documenting the safety case and supporting safety assessment are justification, traceability and clarity.

3.2.68 Justification concerns explaining the basis for the choices that have been made and the arguments for and against the decisions, especially those decisions concerning the main arguments for safety. Traceability concerns the ability of an independent qualified person to follow what has been done. The traceability has to enable technical and regulatory review. Justification and traceability both require a well-documented record of the decisions made and the assumptions made in the development and operation of a disposal facility, and of the models and data used in deriving a particular set of results for safety assessment purposes.

3.2.69 Clarity concerns good structure and presentation at an appropriate level of detail so as to allow an understanding of the safety arguments. This requires the results of work to be presented in the documents in such a way that interested parties for whom the material is intended can gain a good understanding of the safety arguments and their basis. Different types and styles of document may be necessary to provide material that is useful to different parties.

Steps in the development, operation and closure of a disposal facility

Site characterisation for a disposal facility

3.2.70 *The site for a disposal facility shall be characterised at a level of detail sufficient to support a general understanding of both the characteristics of the site and how the site will evolve over time. This shall include its present condition, its probable natural evolution and possible natural events, and also human plans and actions in the vicinity that may affect the safety of the facility over the period of interest. It shall also include a specific understanding of the impact on safety of features, events and processes associated with the site and the facility.*

3.2.71 An understanding of the site for a disposal facility has to be gained in order to present a convincing scientific description of the disposal system on which the more conceptual descriptions that are used in the safety assessment can be based. The focus has to be on features, events and processes relating to the site that could have an impact on safety and that are addressed in the safety case and supporting safety assessment. In particular, this has to demonstrate that there is adequate geological, geomorphological or topographical stability (as appropriate to the type of facility), and features and processes that contribute to safety. It also has to demonstrate that other features, events and processes do not undermine the safety case.

3.2.72 Characterisation of the geological aspects has to include activities such as the investigation of: long term stability, faulting and the extent of fracturing in the host geological formation; seismicity; volcanism; the volume of rock suitable for the construction of disposal zones; geotechnical parameters relevant to the design; groundwater flow regimes; geochemical conditions; and mineralogy. The extent of characterisation necessary will depend on the types of disposal facility and the site in question.

3.2.73 A graded approach has to be adopted, depending on the hazard potential of the waste and the complexity of the site and disposal facility design. Site characterisation undertaken in an iterative manner has to provide input to, and has, in turn, to be guided by, the safety case. Additionally, investigation of, for example, natural background radiation and the radionuclide content in soil, groundwater and other media may contribute to a better understanding of the characteristics of the site of the disposal facility. It may also assist in the evaluation of radiological impacts on the environment by providing a reference for future comparisons.

3.2.74 Characterisation of the surface environmental features has to include natural aspects, such as hydrological and meteorological aspects and flora and fauna. It also has to cover human activities in the vicinity of the site relating to normal residential settlement patterns and industrial and agricultural activities. Due regard has to be given to the probable natural evolution of the site, including effects of erosion and climate change.

Design of a disposal facility

3.2.75 *The disposal facility and its engineered barriers shall be designed to contain the waste with its associated hazard, to be physically and chemically compatible with the host geological formation and/or surface environment, and to provide safety features after closure that complement those features afforded by the host environment. The facility and its engineered barriers shall be designed to provide safety during the operational period.*

3.2.76 The designs of disposal facilities for radioactive waste may differ widely, depending on the types of waste to be disposed of and the host geological formation and/or surface environment. In general, optimal use has to be made of the safety features offered by the host environment. This has to be done by designing a disposal facility that does not cause unacceptable long term disturbance of the site, is itself protected by the site and performs safety functions that complement the natural barriers.

3.2.77 The layout has to be designed so that waste is emplaced in the most suitable locations. In the event that fissile materials are present in the waste, maintaining a subcritical configuration has to be part of the design considerations. Key features, such as shafts and seals in geological disposal facilities, have to be appropriately located. Materials used in the facility have to be resistant to degradation under the conditions prevailing in the facility (e.g. conditions of chemistry and temperature) and selected also to limit any undesirable impacts on the safety functions of any element of the disposal system.

3.2.78 Disposal facilities, in particular disposal facilities for high level and intermediate level waste, are expected to perform over much longer timescales than the periods usually considered in engineering applications. Investigation of the ways in which analogous natural materials have behaved in geological formations in nature, or how ancient artefacts and structures have behaved over time, may contribute to confidence in the assessment of long term performance.

3.2.79 Demonstration of the feasibility of fabrication of waste containers and of the construction of engineered barriers with the necessary features, for example, in underground laboratories, is important for the purpose of assessment and for contributing to confidence that an adequate level of performance can be achieved.

Construction of a disposal facility

3.2.80 *The disposal facility shall be constructed in accordance with the design as described in the approved safety case and supporting safety assessment. It shall be constructed in such a way as to preserve the safety functions of the host environment that have been shown by the safety case to be important for safety after closure. Construction activities shall be carried out in such a way as to ensure safety during the operational period.*

3.2.81 Construction of a disposal facility can be a complex technical undertaking that might be constrained, particularly if it is carried out underground, by the conditions and the properties of the host geological formation and by the techniques that are available for underground excavation and construction. An adequate level of characterisation has to be completed before construction is begun. Excavation and construction activities have to be carried out in such a way as to avoid unnecessary disturbance of the host environment. Sufficient flexibility in engineering techniques has to be adopted to allow for variations to be encountered, such as variations in rock conditions or groundwater conditions in underground facilities.

3.2.82 Excavation and construction of a disposal facility could continue after the commencement of operation of part of the facility and after the emplacement of waste packages. Such overlapping of construction and operational activities has to be planned and carried out so as to ensure safety, both in operation and after closure.

Operation of a disposal facility

3.2.83 *The disposal facility shall be operated in accordance with the conditions of the licence and the relevant regulatory requirements so as to maintain safety during the operational period and in such a manner as to preserve the safety functions assumed in the safety case that are important to safety after closure.*

3.2.84 All operations and activities important to the safety of a disposal facility have to be subjected to limitations and controls and emergency plans have to be put in place. The various procedures and plans have to be documented and the documentation has to be subject to appropriate control procedures (IAEA 2016a). The safety case has to address and justify both the design and the operational management arrangements that are used to ensure that the safety objective and criteria (see **Error! Reference source not found.**) are met. Additional, facility specific criteria may be established by the regulatory body or by the operator.

3.2.85 The safety case also has to demonstrate that hazards and other radiation risks to workers and to members of the public under conditions of normal operation and anticipated operational occurrences have been reduced as low as reasonably achievable. Active control of safety has to be maintained for as long as the disposal facility remains unsealed, and this may include an extended period after the emplacement of waste and before the final closure of the facility.

3.2.86 Fissile material, when present, has to be managed and has to be emplaced in the disposal facility in a configuration that will remain subcritical. This may be achieved by various means, including the appropriate distribution of fissile material during the conditioning of the waste and the proper design of the waste packages. Assessments have to be undertaken of the possible evolution of the criticality hazard after waste emplacement, including after closure.

Closure of a disposal facility

3.2.87 *A disposal facility shall be closed in a way that provides for those safety functions that have been shown by the safety case to be important after closure. Plans for closure, including the transition from active management of the facility, shall be well defined and practicable, so that closure can be carried out safely at an appropriate time.*

3.2.88 The safety of a disposal facility after closure will depend on a number of activities and design features, which can include the backfilling and sealing or capping of the disposal facility. Closure has to be considered in the initial design of the facility, and plans for closure and seal or cap designs have to be updated as the design of the facility is developed. Before construction activities commence, there has to be sufficient evidence that the performance of the backfilling, sealing and capping will function as intended to meet the design requirements.

3.2.89 The disposal facility has to be closed in accordance with the conditions set for closure by the regulatory body in the facility’s authorisation, with particular consideration given to any changes in responsibility that may occur at this stage. Consistent with this, the installation of closure features may be performed in parallel with waste emplacement operations.

3.2.90 Backfilling and the placement of seals or caps may be delayed for a period after the completion of waste emplacement, for example, to allow for monitoring to assess aspects relating to safety after closure or for reasons relating to public acceptability. If such features are not to be put in place for a period of time after the completion of waste emplacement, then the implications for safety during operation and after closure have to be considered in the safety case.

3.2.91 Availability of the necessary technical and financial resources to achieve closure has to be assured, including by means of clauses 3.2.5 to 3.2.10.

Assurance of Safety

Waste acceptance criteria in a disposal facility

3.2.92 *Waste packages and unpackaged waste accepted for emplacement in a disposal facility shall conform to criteria that are fully consistent with, and are derived from, the safety case for the disposal facility in operation and after closure.*

3.2.93 Waste acceptance requirements and criteria for a given disposal facility have to ensure the safe handling of waste packages and unpackaged waste in conditions of normal operation and anticipated operational occurrences. They also have to ensure the fulfilment of the safety functions for the waste form and waste packaging with regard to safety in the long term. Examples of possible parameters for waste acceptance criteria include the characteristics and performance requirements of the waste packages and the unpackaged waste to be disposed of, such as the radionuclide content or activity limits, the heat output and the properties of the waste form and packaging.

3.2.94 Modelling and/or testing of the behaviour of waste forms has to be undertaken to ensure the physical and chemical stability of the different waste packages and unpackaged waste under the conditions expected in the disposal facility, and to ensure their adequate performance in the event of anticipated operational occurrences or accidents.

3.2.95 Waste intended for disposal has to be characterised to provide sufficient information to ensure compliance with waste acceptance requirements and criteria. Arrangements have to be put in place to verify that the waste and waste packages received for disposal comply with these requirements and criteria and, if not, to confirm that corrective measures are taken by the generator of the waste or the operator of the disposal facility. Quality control of waste packages has to be undertaken and is achieved mainly on the basis of records, preconditioning testing (e.g. of containers) and control of the conditioning process. Post-conditioning testing and the need for corrective measures have to be limited as far as practicable.

Monitoring programmes at a disposal facility

3.2.96 *A programme of monitoring shall be carried out prior to, and during, the construction and operation of a disposal facility and after its closure, if this is part of the safety case. This programme shall be designed to collect and update information necessary for the purposes of protection and safety. Information shall be obtained to confirm the conditions necessary for the safety of workers and members of the public and protection of the environment during the period of operation of the facility. Monitoring shall also be carried out to confirm the absence of any conditions that could affect the safety of the facility after closure.*

3.2.97 Monitoring has to be carried out at each step in the development and in the operation of a disposal facility. The purposes of the monitoring programme include:

(a) obtaining information for subsequent assessments

(b) assurance of operational safety

(c) assurance that conditions at the facility for operation are consistent with the safety assessment

(d) confirmation that conditions are consistent with safety after closure.

3.2.98 Guidance is provided in *Environmental and Source Monitoring for Purposes of Radiation Protection* (IAEA 2005). Monitoring programmes have to be designed and implemented so as not to reduce the overall level of safety of the facility after closure.

3.2.99 A discussion of monitoring relating to the safety of geological disposal facilities after closure is given in an IAEA TECDOC (IAEA 2001). Plans for monitoring with the aim of providing assurance of safety after closure have to be drawn up before the construction of a geological disposal facility to indicate possible monitoring strategies. However, plans have to remain flexible and, if necessary, they will have to be revised and updated during the development and operation of the facility.

The period after closure and institutional controls

3.2.100 *Plans shall be prepared for the period after closure to address institutional control and the arrangements for maintaining the availability of information on the disposal* *facility. These plans shall be consistent with passive safety features and shall form part of the safety case on which authorisation to close the facility is granted.*

3.2.101 The long term safety of a disposal facility for radioactive waste has not to be dependent on active institutional control. Even the violation of passive safety features cannot give rise to the criteria for intervention being exceeded. Additionally, the safety of the disposal facility has not to be dependent solely on institutional controls. Institutional controls cannot be the sole or main component of safety for a near surface disposal facility. The ability of the institutional controls to provide the contributions to safety envisaged in the safety case has to be demonstrated and justified in the safety case.

3.2.102 The risk of intrusion into a disposal facility for radioactive waste may be reduced over a longer timescale than that foreseen for active controls by the use of passive controls, such as the preservation of information by the use of markers and archives, including international archives.

3.2.103 Institutional controls over a disposal facility for radioactive waste have to provide additional assurance of the safety and nuclear security of the facility. Examples include provision for preventing access to the site by intruders and post-operational monitoring capable of providing early warning of the migration of radionuclides from the disposal facility before they reach the site boundary.

3.2.104 Near surface disposal facilities are generally designed on the assumption that institutional control has to remain in force for a period of time. For short lived waste, the period will have to be several tens to hundreds of years following closure. Such controls will be either active or passive in nature. For near surface disposal of waste from mining and mineral processing that includes very long lived radionuclides, and which generally comprises large volumes, activity concentrations have to be limited so that ongoing active institutional control does not have to be relied on as a safety measure. Waste with activity concentrations above the limitations has to be disposed of below the ground surface.

3.2.105 The status of a disposal facility beyond the period of active institutional control differs from the release of a nuclear installation site from regulatory control after decommissioning inasmuch as release of the site of a disposal facility for unrestricted use is generally not contemplated. The site location and the facility design have to reduce the likelihood of intrusion.

3.2.106 For near surface disposal facilities, the waste acceptance criteria will limit any consequences of human intrusion to within the specified criteria (see **Error! Reference source not found.**) even if control over the site is lost. The dose constraint (see **Error! Reference source not found.**) adopted for doses to members of the public applies for the anticipated normal evolution of the site following the period of institutional control.

3.2.107 Geological disposal facilities have not to be dependent on long term institutional control after closure as a safety measure (see clauses 3.2.16 to **Error! Reference source not found.**). Nevertheless, institutional controls may contribute to safety by preventing or reducing the likelihood of human actions that could inadvertently interfere with the waste or degrade the safety features of the geological disposal system. Institutional controls may also contribute to increasing public acceptance of geological disposal.

3.2.108 Disposal facilities may not be closed for several tens of years or more after operations have commenced. Plans for possible future controls and the period over which they would be applied may initially be flexible and conceptual in nature, but plans have to be developed and refined as the facility approaches closure. Consideration has to be given to: local land use controls; site restrictions or surveillance and monitoring; local, national and international records; and the use of durable surface and/or subsurface markers. Arrangements have to be made to be able to pass on information about the disposal facility and its contents to future generations to enable any future decisions on the disposal facility and its safety to be made.

3.2.109 While the facility remains licensed, the operator has to provide institutional controls. It is envisaged that the responsibility for whatever passive measures for institutional control are necessary following termination of the licence will have to revert to the government at some level.

Consideration of Australia's system of accounting for, and control of nuclear material

3.2.110 *In the design and operation of disposal facilities subject to agreements on accounting for, and control of, nuclear material, consideration shall be given to ensuring* that *safety is not compromised by the measures required under the system of accounting for, and control of, nuclear material.*

3.2.111 The system of accounting for, and control of, nuclear material applies to materials that include significant quantities of fissile material in potentially extractable form (IAEA 1968, IAEA 1997, IAEA 1972). Such materials, if declared to be waste, are likely to require disposal in a geological disposal facility for reasons of long term safety. Placement in a geological disposal facility would also provide long term passive nuclear security and would be consistent with the objective of IAEA nuclear safeguards. Clauses 3.2.110 to 3.2.115, therefore, apply in particular to geological disposal facilities (IAEA 1996).

3.2.112 State systems of accounting for, and control of, nuclear material were developed primarily to provide for accountability for nuclear material, in order to detect its possible diversion for unauthorised or unknown purposes in the short and medium terms. As organised at present, IAEA nuclear safeguards activities depend on active surveillance and controls.

3.2.113 During the operation of a disposal facility for waste that includes fissile material, surveillance for the purposes of IAEA safeguards is aimed at ensuring the continuity of knowledge concerning the fissile material and the absence of any undeclared activities at the site in relation to such material. For some radioactive waste, such as spent nuclear fuel, certain requirements for safeguards have to apply even after the waste has been sealed in a geological disposal facility (IAEA 1988).

3.2.114 For a closed geological disposal facility, IAEA nuclear safeguards might, in practice, be applied by remote means (e.g. satellite monitoring, aerial photography, microseismic surveillance and administrative arrangements). Intrusive methods, which might compromise safety after closure, have to be avoided.

3.2.115 Since IAEA nuclear safeguards are internationally supervised, their continuation might increase confidence in the longevity of administrative controls and this would also help to prevent inadvertent disturbance of the geological disposal facility. The continuation of safeguards inspections and monitoring after closure of a geological disposal facility may, thus, be beneficial to augmenting confidence in safety after closure. A discussion of interface issues between the system of accounting for, and control of, nuclear material (and IAEA nuclear safeguards) and radioactive waste management is included in IAEA-TECDOC-909 (IAEA 1996).

Requirements in respect of nuclear security measures

3.2.116 *Measures shall be implemented to ensure an integrated approach to safety* measures *and nuclear security measures in the disposal of radioactive waste.*

3.2.117 Where nuclear security measures are necessary to prevent unauthorised access by individuals and to prevent the unauthorised removal of radioactive material, safety measures and nuclear security measures have to be implemented in an integrated approach (IAEA 2006a, IAEA 2016).

3.2.118 The level of nuclear security has to be commensurate with the level of radiological hazard and the nature of the waste (IAEA 2006, IAEA 2016, IAEA 2004, IAEA 1999).

Management systems

3.2.119 *Management systems to provide for the assurance of quality shall be applied to all safety-related activities, systems and components throughout all the steps of the development and operation of a disposal facility. The level of assurance for each element shall be commensurate with its importance to safety.*

3.2.120 An appropriate management system that integrates quality assurance programmes will contribute to confidence that the relevant requirements and criteria for site selection and evaluation, design, construction, operation, closure and safety after closure are met. The relevant activities, systems and components have to be identified on the basis of the results of systematic safety assessment. The level of attention assigned to each aspect has to be commensurate with its importance to safety. The management system is required to comply with the relevant IAEA safety standards on management systems (IAEA 2016, IAEA 2008).

3.2.121 The management system specifies the role of management and the organisational structure to be used for implementing processes for all safety related activities. It also specifies the responsibilities and authorities of the various personnel and organisations involved in managing and implementing the processes and assessing the quality of all work relating to safety.

3.2.122 While the host environment of a disposal facility is important to safety, it cannot be designed or manufactured, but only characterised, and that to only a limited extent. The elements of the management system that provide assurance of the quality of the relevant safety related processes have to be designed with account taken of the nature of the host environment.

3.2.123 The design, characterisation and assessment of a disposal facility have to include several sequential and sometimes overlapping steps with an increasing degree of detail and accuracy. However, a degree of irreducible uncertainty that is impossible to eliminate by any measures might always remain. The significance of this uncertainty is assessed in the evaluation of the safety case and supporting safety assessment.

3.2.124 The management system for a disposal facility has to provide for the preparation and retention of documentary evidence to illustrate that the necessary quality of data has been achieved; that components have been supplied and used in accordance with the relevant specifications; that the waste packages and unpackaged waste comply with established requirements and criteria; and that they have been properly emplaced in the disposal facility. The management system also has to ensure the collation of all the information that is important to safety and that is recorded at all steps of the development and operation of the facility, and the preservation of that information. This information is important for any reassessment of the facility in the future.

Existing Disposal Facilities

Existing disposal facilities

3.2.125 *The safety of existing disposal facilities shall be assessed periodically until termination of the licence. During this period, the safety shall also be assessed when a safety-significant modification is planned or in the event of changes with regard to the conditions of the authorisation. In the event that any requirements set down in this Code are not met, measures shall be put in place to upgrade the safety of the facility, economic and social factors being taken into account.*

3.2.126 Periodic safety assessment for a disposal facility has to be aimed at providing an overall assessment of the status of protection and safety at the facility. It has to include an analysis of the operational experience acquired and possible improvements that could be made, with account taken of the existing situation and of whatever new technological developments or changes in regulatory control there might be. Periodic safety assessments cannot replace the activities for analysis, control and surveillance that are continuously carried out at disposal facilities.

3.2.127 Disposal facilities that were not constructed to present safety standards may not meet all the safety requirements established in this Safety Requirements publication. In assessing the safety of such facilities, there may be indications that safety criteria will not be met. In such circumstances, reasonably practicable measures have to be taken to upgrade the safety of the disposal facility. Possible options may include the removal of some or all of the waste from the facility, making engineering improvements, or putting in place or enhancing institutional controls. Evaluation of these options has to include broader technical, social and political issues.

Annex A: The Safety Case – Australian Guidance

A1 Safety Case and Safety Assessment

The development of a safety case and supporting safety assessment for review by the regulatory body and interested parties is central to the development, operation and closure of a disposal facility for radioactive waste. The safety case:

- substantiates the safety of the disposal facility and contributes to confidence in its safety
- is an essential input to all important decisions concerning the disposal facility
- provides the basis for understanding the disposal system and how it will behave over time
- addresses site aspects and engineering aspects, providing the logic and rationale for the design;
- has to be supported by safety assessment
- addresses the management system put in place to ensure quality for all aspects important to safety.

At any step in the development of a disposal facility, the safety case also has to identify and acknowledge the unresolved uncertainties that exist at that stage and their safety significance, and approaches for their management.

The impact of the disposal facility on the community in which the facility is, or is to be, situated should also be addressed. All relevant societal aspects need to be considered including transport routes within Australia and public concerns regarding local transport conditions.

The safety case should include the output of the safety assessment together with additional information, including supporting evidence and reasoning on the robustness and reliability of the facility, its design, the logic of the design, and the quality of safety assessment and underlying assumptions.

The safety case may also include more general arguments relating to the disposal of radioactive waste and information to put the results of safety assessment into perspective. Any unresolved issues at any step in the development or in the operation or closure of the facility have to be acknowledged in the safety case and guidance has to be provided for work to resolve these issues.

Safety assessment is the process of systematically analysing the hazards associated with a disposal facility and assessing the ability of the site and the design of the facility to provide for the fulfilment of safety functions and to meet technical requirements. Safety assessment has to include quantification of the overall level of performance, analysis of the associated uncertainties and comparison with the relevant design requirements and safety standards. The assessments have to be site specific since the host environment of a disposal system, in contrast to engineered systems, cannot be standardised.

As site investigations and design studies progress, safety assessment will become increasingly refined and specific to the site. At the end of a site investigation, sufficient data have to be available for a complete assessment. Any significant deficiencies in scientific understanding, data or analysis that might affect the results presented also have to be identified in the safety assessment. Depending on the stage of development of the facility, safety assessment may be used in focusing research, and its results may be used to assess compliance with the safety objective and safety criteria.

A2 Role of the Safety Case in Regulation

An applicant for a licence under this Code is required to demonstrate that the proposed radioactive waste disposal facility will meet the required level of protection by carrying out and presenting a safety case that draws upon the organisational and technical arrangements put in place, the nature of the waste to be accepted, the characteristics of the site, the design of the facility including any engineered safety barriers, and the arrangements for its construction and operation. Detailed requirements involving the safety case are presented above in Section 3 of this Code (particularly clauses 3.2.53 to 3.2.69), and international guidance for developing a safety case is available (e.g. IAEA 2012; IAEA 2017).

It is important for an application to prepare a site for a facility to include details of the conceptual design as well as other aspects as further detailed in this Code. At each stage, a safety assessment must be included and as the process proceeds through the various stages, the safety assessment and safety case will develop accordingly, in sufficient detail. The staged approach allows for continuous improvement in design, operation and safety throughout the lifetime of the facility. Under some circumstances, an applicant may choose to submit applications for more than one licence simultaneously.

A3 Role of the Safety Case in Consultation

The role of the safety case in communication and consultation with stakeholders is highlighted in the *Safety Assessment for Facilities and Activities* (GSR Part 4) (IAEA 2009; Requirements 22 – 24). The operator is responsible for communicating the results and insights from the safety assessment to a wide range of interested parties, including the designers, the operating organisation, the regulatory body and other professionals. Communication of the results from the safety assessment to stakeholders has to be commensurate with the possible radiation risks arising from the facility or activity and the complexity of the models and tools used.

A4 Waste Acceptance Criteria

Conformance with radiation protection principles by means of the safety case forms the basis for developing acceptance criteria for classifying waste for disposal by near-surface burial or for disposal at greater depths.

The Code requires the development of qualitative and quantitative waste acceptance criteria which are based upon primary dose limitation and safety assessments in the form of:

- derived activity concentration limits for radionuclides in the waste
- a restriction on the total activity of radionuclides to be disposed of at any particular disposal facility
- performance standards for waste forms and waste packages
- restrictions on public access and land use during the operation of the facility and during a subsequent specified period of institutional control.

The safety case should demonstrate that the waste acceptance criteria (form, volume, radionuclide inventory, chemical composition, toxicity, stability and all other physical, chemical and radiological characteristics) are appropriate for the facility.

A licence application should also demonstrate that the proposed waste acceptance criteria exclude the handling of high-level radioactive waste and spent fuel, which are prohibited for disposal in Australia by Commonwealth legislation.

For near-surface disposal facilities, the waste acceptance criteria are expected to limit any consequences of human intrusion to within the specified dose criteria, even if control over the site is lost.

A5 Human Intrusion during the Period of Passive Safety

A licence applicant is required to address reasonably possible scenarios involving inadvertent human intrusion into the disposal facility in the period of passive safety (post-closure phase, no active or institutional controls).

If doses of greater than 10 mSv per year are calculated for an individual from a plausible human intrusion scenario, then additional controls are required for the disposal facility to further limit the possibility of human intrusion or to limit its consequences to below that dose figure. This may involve re-design of the facility.

Where it is calculated that human intrusion could result in doses of between 1 and 10 mSv for any human associated with the intrusion, there needs to be further evaluation of the scenario producing this result.

Deliberate intrusion may result from any future attempt to alter the engineered barriers or retrieve the waste, or any other reason that today could only be speculated upon. Whilst it is difficult to forecast such events and their probabilities, they would be considered as planned actions. The framework for institutional control and preservation of information must be developed with potential for future planned actions in mind.

Deliberate intrusion may also arise from malicious intent. The concern here is with the safety of those indirectly affected by the intrusion. The arrangements for institutional control including security will have to reduce the worker, public and environmental risks associated with such intrusion to the level as low as reasonably achievable.

A6 Post closure uncertainties

Based on international best practice, an applicant for a licence to close a radioactive waste disposal facility, and/or intending to surrender a licence for such a facility, needs to undertake a post-closure safety assessment. This process will effectively take into consideration the uncertainties arising from changes in human behaviour and environmental and facility conditions over the very long timescales that are deemed appropriate by the Relevant Regulatory Authority (e.g. 10,000 years for disposal of intermediate level waste).

A7 Remediation Preparedness

The purpose of the information presented in this Code is to assist in preventing any radiation accident associated with the operation of a radioactive waste disposal facility in Australia. However, world-wide history has clearly demonstrated that nuclear and radiation accidents that affect public and environmental health do occur.

As highly improbable as such an accident is in the operation of radioactive waste disposal facilities in accordance with the requirements of this Code, international best practice in light of the Fukushima nuclear accident dictates that an application for any licence covered by this Code must provide information on remediation preparedness. Demonstration of adequate preparedness to remediate the effects of any environmental contamination arising from a radiation accident, including accidents associated with the transport of radioactive materials, should be included in the safety case. Information should be included on:

- division of responsibilities in accident recovery, including the role of stakeholders
- approaches to defining targets for remediation and end states
- potential methods and technology available for environmental remediation
- development of a generic waste management program, including the use of the concepts of exemption and clearance, predisposal management and conditioning, storage and disposal of the potentially large amounts of waste arisings from environmental remediation.

The purpose of such remediation preparedness, as well as helping to build trust and provide assurance for relevant stakeholders, is the recognition within the international radiation safety community, based on lessons learned from past major nuclear accidents, that it is too late to begin planning for accident recovery after an accident has occurred.

An additional aspect of remediation preparedness for a radioactive waste disposal facility is the awareness that for any nuclear or radiation accident, an urgent need may arise for rapid disposal of unplanned waste arising from an accident or emergency. It is anticipated that such contingencies to the extent possible and practicable, as well as the limitations, will be considered as part of the remediation preparedness planning for any disposal facility.

Annex B: Demonstrating Compliance

B1 Identification of Representative Individuals of the Public

In accordance with the ICRP recommendations in Publication 103 (ICRP 2007), the goal of protection of the public is achieved if the relevant dose constraint for the appropriately characterised representative individual is met and radiological protection is optimised.

The representative individual may be chosen to be characteristic of reasonably foreseeable exposure scenarios at the site of the facility, or reasonably foreseeable exposure scenarios resulting from handling, including transport, of the waste.

B2 Compliance with Requirements for Public Protection

The Operational Phase

During the operational phase, the proponent should demonstrate that the public exposure is below the dose constraint as defined in **Error! Reference source not found.**. Any indication of exposure above that level would need separate investigation, and corrective actions as necessary.

Post-closure

For the post-closure phase of a waste disposal facility, the proponent should put forward arguments to demonstrate that the disposal facility will not exceed an annual risk for a member of the public in the foreseeable normal evolution of the disposal facility and its environment in the range of 10^{-5} to 10^{-6} for detriment (by use of detriment-adjusted nominal risk coefficients for stochastic effects in the population as a whole, as outlined in Table 1, page 53, ICRP Publication 103 (ICRP 2007)). The arguments in support of meeting this criterion must be presented in the applications to prepare a site, to construct, and to operate the facility. It is expected that the discussion would become more detailed and based upon more complete knowledge as the application process proceeds.

The concept of risk as used in this Code integrates the probability of an event with the probability of harm should the event occur (the consequence). A high probability event with a low probability of harm may thus pose the same risk as a low probability event with high probability of harm (or, expressed differently, with severe consequences). Thus, the applicant will need to define the scenarios that govern the risk estimates, in order to provide a means for assessing the average risk (often done by performing a number of realisations in a probabilistic approach to the assessment of risk), and the time frames within which these events are assessed.

The analysis of the design basis for the risk calculations are may include reasonably foreseeable natural disruptive events as well as accidents.

For the post-closure period, the proponent is expected to separately and deterministically assess and report on a suite of severely disruptive events that may result in an annual dose of ≥1 mSv if such scenarios exist (i.e. at or above the dose limit for the public). The potential impact of severe disruptive events may be estimated at the design stage by use of stylised or simplified calculations, and must be updated at subsequent licensing phases. The rationale for selecting scenarios and their associated assumptions must be explained in order for the relevant regulatory authority to determine whether the design is adequate and the proposed time of institutional control is appropriate.

The proponent may impose a time cut-off in the assessment of passive safety. The reason for cut-off must be explained and, based on expectations from international best practice, for disposal of intermediate level waste should not be less than 10,000 years.

Appendix 1: Derivation of the disposal of solid radioactive waste code clauses from the SSR-5 requirements

The following table cross-references each clause in Section 3 of this Code to the relevant requirement in the Trusted International Standard, IAEA Safety Standards Series: Specific Safety Requirements No. 5, Disposal of Radioactive Waste, SSR-5 (IAEA 2011a). SSR-5 is published on the IAEA website.

Requirements 1 (Government Responsibilities) and 2 (Responsibilities of the Regulatory Body) from SSR-5 are not applicable as potential licence conditions for inclusion in an Australian national code, and thus have been removed from inclusion as requirements under this Code.

IAEA SSR-5	RPS C-3	
Requirement	**Requirement**	**Clause(s)**
Requirement 3	Responsibilities of the operator	3.2.5 to 3.2.10
Requirement 4	Importance of safety in the process of development and operation of a disposal facility	3.2.11 to 3.2.15
Requirement 5	Passive means for the safety of the disposal facility	3.2.16 to **Error! Reference source not found.**
Requirement 6	Understanding of a disposal facility and confidence in safety	3.2.22 to 3.2.28
Requirement 7	Multiple safety functions	3.2.32 to 3.2.36
Requirement 8	Containment of radioactive waste	3.2.37 to 3.2.41
Requirement 9	Isolation of radioactive waste	3.2.42 to 3.2.47
Requirement 10	Surveillance and control of passive safety features	3.2.48 to 3.2.49
Requirement 11	Step by step development and evaluation of disposal facilities	3.2.50 to 3.2.52
Requirement 12	Preparation, approval and use of the safety case and safety assessment for a disposal facility	3.2.53 to 3.2.56
Requirement 13	Scope of the safety case and safety assessment	3.2.57 to 3.2.65
Requirement 14	Documentation of the safety case and safety assessment	3.2.66 to 3.2.69

Requirement 15	Site characterisation for a disposal facility	3.2.70 to 3.2.74
Requirement 16	Design of a disposal facility	3.2.75 to 3.2.79
Requirement 17	Construction of a disposal facility	3.2.80 to 3.2.82
Requirement 18	Operation of a disposal facility	3.2.83 to 3.2.86
Requirement 19	Closure of a disposal facility	3.2.87 to 3.2.91
Requirement 20	Waste acceptance in a disposal facility	3.2.92 to 3.2.95
Requirement 21	Monitoring programmes at a disposal facility	3.2.96 to 3.2.99
Requirement 22	The period after closure and institutional controls	3.2.100 to 3.2.109
Requirement 23	Consideration of the State system of accounting for, and control of, nuclear material	3.2.110 to 3.2.115
Requirement 24	Requirements in respect of nuclear security measures	3.2.116 to 3.2.118
Requirement 25	Management systems	3.2.119 to 3.2.124
Requirement 26	Existing disposal facilities	3.2.125 to 3.2.127

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, 2007 Edition*). **Note:** Terms that are described in this Glossary appear in **bold type** on their first occurrence in the text.

Authorisation

A written permission by the relevant regulatory authority that a proposal may be put into effect.

Best Available Techniques

Best available techniques (BAT) means the most effective and advanced stage in the development of facilities and their methods of operation for achieving the required levels of protection of people, society, and the environment, where:

- ‘techniques’ include both the technology used and the way in which the facility is designed, built, maintained, operated and decommissioned
- ‘available’ techniques means those developed on a scale which allows implementation, under economically and technically viable conditions, taking into consideration the costs and advantages
- ‘best’ means most effective in achieving a high general level of protection.

Clearance

Removal of radioactive material or radioactive objects within authorised practices from any further regulatory control by the regulatory authority.

Closure

Administrative and technical actions directed at a disposal facility at the end of its operating lifetime — e.g. covering of the disposed waste (for a near-surface disposal facility) or backfilling and/or sealing (for a geological facility and the passages leading to it) — and the termination and completion of activities in any associated structures.

For other facilities, the term decommissioning is used.

Decommissioning

Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for a facility used for the disposal of radioactive waste which is ‘closed’ and not ‘decommissioned’).

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.

Dose

A generic term that may mean absorbed dose, **equivalent dose** or **effective dose** depending on 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 sum of the tissue equivalent doses, each multiplied by the appropriate tissue weighting factor.

The unit of effective dose is J kg^{-1}, with the special name 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

A measure of dose in organs and tissues which takes into account the type of radiation involved.

The unit of equivalent dose is the same as for absorbed dose, J kg^{-1}, with the special name sievert (Sv).

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.

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.

ICRP

The International Commission on Radiological Protection. It is an independent organisation that provides general guidance on radiation protection. The recommendations of the ICRP are not legally binding, but are generally followed by countries framing national regulatory requirements.

Institutional Control

Control of a radioactive waste site by an authority or institution designated under the laws of a jurisdiction. Control may be active (monitoring, surveillance, remedial work) or passive (land use control) and may be a determining factor in the design of a waste management facility (e.g. near surface repository).

Justification

The principle of justification requires that any decision that alters a radiation exposure situation should do more good than harm.

Near-Surface Disposal

Radioactive waste disposal located at or within a few tens of metres of the Earth’s surface.

Nuclear Material

Plutonium except that with isotopic concentration exceeding 80% in plutonium-238; uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore residue; depleted uranium; thorium; any material containing one or more of the foregoing (IAEA Safety Glossary). For the purposes of IAEA safeguards agreements, see the Commonwealth Nuclear Non-Proliferation (Safeguards) Act 1987.

(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

All exposure of workers incurred in the course of their work, with the exception of excluded exposures[2] and exposures from exempt practices or exempt sources

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[2] Excluded exposure means the component of exposure that arises from natural background radiation.

Operator

The operator of a disposal facility is the licence applicant or holder.

Optimisation (of Protection and Safety)

Optimisation of protection (and safety) is the process of determining what level of protection and safety makes exposures, and the probability and magnitude of potential exposures, ‘as low as reasonably achievable, economic and societal factors being taken into account’ (ALARA), as required by the ICRP System of Radiological Protection. Note that this is not the same as optimisation of the process or practice concerned.

Planned Exposure Situation

A situation involving the deliberate introduction and operation of sources. Planned exposure situations may give rise both to exposures that are anticipated to occur (normal exposures) and to exposures that are not anticipated to occur (potential exposures).

Potential Exposure

For some human activities, there will be a potential for exposure but no certainty that it will occur. For example, there is a risk that an accident may occur that results in radiation exposure. Such hypothetical exposures are called ‘potential exposures’. It is often possible to apply some degree of control to potential exposure by restricting both the probability that an accident will occur and the magnitude of the exposure which could result if the accident did 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.

Radiation

Electromagnetic waves or quanta, and atomic or sub-atomic particles, propagated through space or through a material medium.

Radioactive Material

Material which spontaneously emits ionising radiation as a consequence of radioactive decay, and which has been designated in law or by a regulatory authority as being subject to regulatory control because of its radioactivity.

Radioactive Waste

‘Radioactive waste’ is defined for regulatory purposes as “waste that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body” (IAEA Safety Glossary). Importantly, waste is material for which no further use is foreseen. Radioactive waste comprises radioactive material in solid, liquid or gaseous form but only solid radioactive waste is suitable for disposal under the scope of this Code.

Relevant Regulatory Authority

The radiation protection authority or authorities designated, or otherwise recognised, for regulatory purposes in connection with protection and safety in disposal of radioactive waste. Sometimes abbreviated to ‘the regulator’.

Retrievability

The ability in principle to recover waste or entire waste packages once they have been emplaced in the disposal facility. For a waste disposal facility, retrievability denotes making provisions in order, should it be required, to allow retrieval, which is the concrete action of removal of the waste.

Reversibility

The ability in principle to reverse or reconsider decisions taken during the progressive implementation of a waste disposal facility.

Risk Target

A constraint applied to potential exposure (sometimes called a ‘risk constraint’).

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.

Safety Case

A collection of arguments and evidence in support of the safety of a facility or activity. This will normally include the findings of a safety assessment and a statement of confidence in these findings together with any safety analysis report that is a regulatory requirement. For a disposal facility, the safety case may relate to a given stage of development. In such cases, the safety case should acknowledge the existence of any unresolved issues and should provide guidance for work to resolve these issues in future development stages.

Stakeholder

Stakeholder means an interested party — whether a person or a group — with an interest or concern in ensuring the success of a venture. To ‘have a stake in’ something, figuratively, means to have something to gain or lose by, or to have an interest in, the turn of events. In this Code, the term does not include the major players in the licensing process (proponent, operator, regulator) but does include other national and regional governments and agencies.

Storage

The emplacement of radioactive waste in a regulated facility that provides for its containment, pending actions relating to its further management or ultimate disposal. Strictly, a ‘store’ refers to the building or structure within a ‘storage facility’ in which the waste is housed. The ‘storage facility’ encompasses the store and its surrounding infrastructure within a perimeter ‘boundary’ including loading bays in the case of a large facility.

Wildlife

An animal or plant living within its natural environment.

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