Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

Radioactive Waste Storage & Disposal Facilities

Information for stakeholders

This document is intended to provide information to stakeholders regarding the process for licensing a radioactive waste storage or disposal facility in Australia.

Applicants should refer to *Regulatory Guide: Applying for a licence for a radioactive waste storage or disposal facility*.

Contents

1. Introduction

1.1. Background and scope

The Australian Radiation Protection and Nuclear Safety Agency seeks to engage with stakeholders and promote a discussion on the health and safety of people and the environment in connection with management of radioactive waste. The purpose of this *Information for Stakeholders* document is to explain a number of principles, concepts and processes that apply to the management (mainly storage and disposal) of radioactive waste.

The document has been developed for information purposes only, and is a companion document to ARPANSA's Regulatory Guide on ***Applying for a licence for a radioactive waste storage or disposal facility***, which is specifically directed to a licence applicant.

The document outlines, for information, ARPANSA's role and functions as set out in the ***Australian Radiation Protection and Nuclear Safety Act 1998*** (the ARPANS Act). ARPANSA's role (and the object of the ARPANS Act) is to *protect the health and safety of people, and to protect the environment, from the harmful effects of radiation*.

The document also provides brief information on other Commonwealth legislation of importance for the licensing of storage and disposal facilities, and on internationally recognised frameworks and principles for safety that form part of international best practice.

The scope of this information document is the same as for the Regulatory Guide. It is limited to Commonwealth facilities for managing large quantities of radioactive waste *of Australian origin*, including predisposal management and long-term storage of such waste, noting that a storage facility as well as a disposal facility may be operational for more than a century.

The guide is not applicable to:

- short-term storage of small quantities of waste
- disposal of small quantities of low level waste at the point of generation[1]
- management of waste generated during mining and milling of ores
- waste facilities under state or territory jurisdiction.

[1] See ARPANSA's website ***www.arpansa.gov.au*** for guidance relevant to other types of radioactive waste than covered in this Regulatory Guide.

1.2. Style and structure

The intention of this information for stakeholders document is to provide useful and accessible information to a broad range of audiences.

While the intention is to suit a variety of audiences, ARPANSA realises that some of the content is of a technical nature. There are a number of other ARPANSA publications that provide less technical information and outline the basic principles for protection against radiation risks. These include an expanding suite of fact sheets that are regularly updated. They are available on ARPANSA's website, ***www.arpansa.gov.au***.

Information on the general approach to regulating facilities and activities involving radiation is provided in the ***Fundamentals for Protection Against Ionising Radiation*** (RPS F-1), published by ARPANSA in 2014.

Different sections of this information document deal with the Commonwealth legal framework that apply to radioactive waste storage and disposal facilities, the licensing process and international best practice outlined in recognised frameworks for safety.

Throughout the text there are 'hexagons' in either purple or green:

Purple hexagons

Explain protective objectives

Green hexagons

Explain concepts and principles

An important example of explanation of concepts and principles ('green hexagon') is given below, providing a definition of radiation risks. ARPANSA seeks to identify, characterise, manage, reduce and eliminate (as relevant) such risks for the purpose of protecting people and the environment from the harmful effects of radiation.

'Radiation risks' as defined in the Fundamentals for protection against ionising radiation, RPS F-1

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

The term *safety* as used in this information document cover all actions aimed at *protection against radiation risks*.

Terms and definitions are the same as in the ARPANS Act and the Australian Radiation Protection and Nuclear Safety Regulations 2018 (the ARPANS Regulations). To the extent terms that are used here are not found in the ARPANS Act and Regulations, their use is aligned with the International Atomic Energy Agency (IAEA) ***Safety Glossary 2007***.

References to publications that are quoted in this document are provided at the end (in the text they are highlighted in bold and italics like ***this***), together with a list of standards and recommendations that contain additional information on the safety of radioactive waste management.

2. What is radioactive waste?

Radioactive waste results from a variety of practices in medicine, industry and research that are carried out in Australia. The radioactive substances in the waste may be of natural origin or be artificially generated. The material is considered *radioactive* from the regulatory perspective because of its content or concentration of radioactive substances. It is considered *waste* because no further use for the material is foreseen. Although storage of some forms of radioactive waste is often necessary, disposal is the recognised end point for long-term safety.

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Key definitions

Radioactive waste:
Material with a content or concentration of radioactive substances over a certain predefined level for which no further use is foreseen.

Storage:
The retention of radioactive waste in a facility or a location with the intention of retrieving the waste for conditioning (if needed) and ultimate disposal. The period of storage may vary depending on the waste and the type of facility. Storage is, however, always an interim measure.

Disposal:
The emplacement of radioactive waste into a facility or a location with no intention of retrieving the waste. Disposal options are designed to contain and isolate the waste from the accessible environment by means of engineered and natural barriers in a manner that is commensurate with the hazard.

Australia has established a national system for classifying radioactive waste. The classification scheme is described in the ARPANSA Radiation Protection Series (RPS) publication ***Safety Guide for Classification of Radioactive Waste*** (RPS 20). It reflects the international classification scheme developed by the International Atomic Energy Agency and published as ***General Safety Guide No. GSG-1, Classification of Radioactive Waste***.

- ***Images of radioactive waste:*** *Examples of waste stored at the Australian Nuclear Science and Technology Organisation (ANSTO). Left, low level waste in 200 litre drums; right, storage of intermediate level waste in a TN 81 cask* (height 6.5 metres).

The most important factor that determines the classification of the waste is the manner by which it can be safely disposed. This depends on the amounts and concentrations of radioactive substances, their properties including their half-lives (the time it takes for the activity to decay to half its original level), and other properties such as heat generation.

At one end of the spectrum is waste that can be exempted from regulatory control; at the other end is waste with very high activity levels that also generates significant amounts of heat from decay of radioactive substances in the waste.

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Australia's Radioactive Waste Classification Scheme (RPS 20)

Exempt waste (EW):

Waste that meets the criteria for exemption from regulatory control for radiation protection purposes.

Very short lived waste (VSLW):

Waste that can be stored for decay over a limited period of up to a few years and subsequently exempted from regulatory control according to arrangements approved by the relevant regulatory authority, for uncontrolled disposal, use or discharge. This class includes waste containing primarily radionuclides with very short half-lives often used for industrial, medical and research purposes.

Very low level waste (VLLW):

Waste that does not meet the criteria of EW, but does need a moderate level of containment and isolation and therefore 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. Typical waste in this class includes soil and rubble with low activity concentration levels. Concentrations of longer-lived radionuclides in VLLW are generally very limited.

Low level waste (LLW):

Waste that is above exemption levels, but with limited amounts of long lived radioactive substances. Such waste requires robust isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered near-surface facilities. This class covers a very broad range of waste. Low level waste may include short lived radionuclides at higher activity concentration levels and long lived radionuclides, but only at relatively low activity concentration.

Intermediate level waste (ILW):

Waste that, because of its content, particularly of long lived radionuclides, requires a greater degree of containment and isolation than that provided by near-surface disposal. However, ILW needs little or no provision for heat dissipation during its storage and disposal. Intermediate level waste may contain long lived radioactive substances, which will not decay to an activity concentration acceptable for near-surface disposal during the time for which institutional controls can be relied upon. Therefore waste in this class requires disposal at greater depths, in the order of tens of metres to a few hundred metres.

High level waste (HLW):

Waste with activity concentration levels high enough to generate significant quantities of heat by the radioactive decay process or waste with large amounts of long lived radionuclides that need to be considered in the design of a disposal facility for such waste. Disposal in deep, stable geological formations usually several hundred metres or more below the surface is the generally recognised option for disposal of HLW.

Waste intended for disposal must be well characterised in terms of content of radioactive substances and its chemical and physical properties. It must be properly conditioned as part of the predisposal management of the waste to comply with waste acceptance criteria that determine whether the waste is suited for the disposal facility. Waste that is poorly characterised or showing signs of degradation will have to be re-characterised and reconditioned. This may happen with legacy waste from abandoned activities or facilities where the waste has been collected and stored for the purpose of protecting people and the environment from radiation risks but without any specific disposal solution in mind.

It is important to bear in mind that facilities for storage and disposal do not operate in isolation. The *system* for managing radioactive waste may also include facilities for conditioning of the waste, for example, and it may be necessary to transport the waste between different predisposal management facilities.

3. Legal Framework

This section briefly reviews Commonwealth legislation, with focus on the ARPANS Act, that is directly relevant to the protection of people and the environment from the harmful effects of radiation. Any facility for storage or disposal of radioactive waste would also be subject to other Commonwealth legislation (for example, legislation governing work health and safety, maintenance of records). There may also be circumstances where state and territory legislation become relevant.

3.1. The ARPANS Act and Regulations

The object of the ARPANS Act is stated in section 3 of the Act:

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The Object of this Act is to protect the health and safety of people, and to protect the environment, from the harmful effects of radiation.

The ARPANS Act and Regulations constitute the primary legal framework for protection of people and the environment from harmful effects of radiation at the Commonwealth level. The Minister for Health administers the ARPANS Act.

The Act establishes the office of the chief executive officer (CEO) of ARPANSA. Apart from the regulatory function, the CEO (among other things) provides services, promotes national uniformity in radiation protection and nuclear safety policy and practices across Australian jurisdictions. The CEO also undertakes research and provides expert advice on radiation protection and nuclear safety with the assistance of staff of ARPANSA, an agency within the Health portfolio.

The CEO or ARPANSA has no advocacy role in relation to the establishment of waste management facilities but acts in the interest of protection of health and safety of people, and of the environment.

The importance of effective independence of the regulator from promoting interests is stated in the IAEA ***General Safety Requirements No. GSR Part 1, Governmental, Legal and Regulatory Framework for Safety***.

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Requirement 4: Independence of the regulatory body, GSR Part 1

The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.

The ARPANS Act applies only to the regulation of Commonwealth entities. Among other things, it prohibits the construction and operation of a radioactive waste storage or disposal facility unless the Commonwealth entity has been licensed to do so by the CEO of ARPANSA.

The CEO is supported by the *Radiation Health and Safety Advisory Council* (RHSAC) (with members and chair appointed by the Minister for Health), the *Radiation Health Committee* (RHC) and the *Nuclear Safety Committee*[2] (NSC). Collectively these external statutory bodies provide advice to the CEO on a variety of matters, including emerging issues related to radiation protection and nuclear safety, policies and national uniformity, matters of major concern to the community and safety of nuclear installations.

3.2. The EPBC Act

The objects of the ***Environment Protection and Biodiversity Conservation Act 1999*** (the EPBC Act) are stated in section 3 of that Act:

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(a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance

(b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources

(c) to promote the conservation of biodiversity

(ca) to provide for the protection and conservation of heritage

(d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples

(e) to assist in the co-operative implementation of Australia's international environmental responsibilities

(f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity

(g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge

[2] ***http://www.arpansa.gov.au/AboutUs/Committees/index.cfm***

The EPBC Act is administered by the Minister for the Environment and Energy. It provides a basis for the Minister to decide whether a proposed action that has, will have or is likely to have a significant impact on certain aspects of the environment should proceed. It does so by prohibiting a person from taking an action without the Minister having given approval or deciding that approval is not needed. One such action is a 'nuclear action'.

A proposal to prepare a site for a radioactive waste storage or disposal facility could constitute a 'nuclear action' and would first require the Minister for the Environment and Energy's approval. Other relevant regulatory approvals, such as approval under the ARPANS Act, must then be obtained before the action can ultimately proceed.

The EPBC Act contains provision for how the impact of the facility must be assessed, including provisions for an environmental impact statement.

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What is a 'Nuclear Action'?

Under the EPBC Act, a 'nuclear action' means any of the following:

- establishing or significantly modifying a nuclear installation
- transporting spent nuclear fuel or radioactive waste products arising from reprocessing
- establishing or significantly modifying a facility for storing radioactive waste products arising from reprocessing
- mining or milling uranium ore
- establishing or significantly modifying a large-scale disposal facility for radioactive waste
- de-commissioning or rehabilitating any facility or area in which an activity described in paragraph (a), (b), (c), (d) or (e) has been undertaken
- any other action prescribed by the regulations.

3.3. The Safeguards Act

The objects of the ***Nuclear Non-Proliferation (Safeguards) Act 1987*** (the Safeguards Act) are stated in section 3 of that Act:

PO

(1) The principal object of this Act is to give effect to certain obligations that Australia has as a party to the Non Proliferation Treaty, the Agency Agreement, the Supplementary Agency Agreements and the prescribed international agreements.

(2) A further object of this Act is to give effect to certain obligations that Australia has as a party to the Physical Protection Convention.

(3) A further object of this Act is to give effect to certain obligations that Australia has as a party to the Nuclear Terrorism Convention.

The Safeguards Act is administered by the Minister for Foreign Affairs assisted by the Australian Safeguards and Non-Proliferation Office (ASNO) of the Department of Foreign Affairs and Trade (DFAT). If the radioactive waste to be handled in a radioactive waste storage or disposal facility is also *nuclear material* (which essentially means uranium, thorium and plutonium), the Safeguards Act will operate concurrently with the ARPANS Act so that the entity planning to establish the facility will require a permit under the terms of the Safeguards Act as well as a licence under the ARPANS Act.

The Safeguards Act gives effect to:

- Australia's obligations under the Nuclear Non-Proliferation Treaty, Australia's Comprehensive Safeguards Agreement and Additional Protocol with the International Atomic Energy Agency and to Australia's nuclear cooperation agreements with bilateral partners
- Australia's obligations under the Convention on the Physical Protection of Nuclear Material
- Australia's obligations under the International Convention for the Suppression of Acts of Nuclear Terrorism.

Material may be exempt from the Safeguards Act if the content of relevant material is very low or the characteristics of the waste are such that the material is inaccessible.

Under Australia's *Comprehensive Safeguards Agreement* with the IAEA (this is the Agency Agreement referred to in the objects of the Safeguards Act), all nuclear material in Australia is subject to IAEA safeguards and must be accounted for and controlled, and where required, reported to the IAEA. The nuclear material must be accessible to the IAEA for verification. Under certain circumstances the IAEA may agree to terminate safeguards for some forms of nuclear material.

3.4. The NRWM Act

The object of the ***National Radioactive Waste Management Act 2012*** (the NRWM Act) is stated in section 3 of that Act:

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..... to provide for:

(a) the selection of a site for a radioactive waste management facility on voluntarily nominated land in Australia

(b) the establishment and operation of such a facility on the selected site; to ensure that radioactive waste generated, possessed or controlled by the Commonwealth or a Commonwealth entity is safely and securely managed.

The NRWM Act is administered by the Minister for Industry, Innovation and Science. It provides a mechanism by which a site can be selected for the establishment and operation of a National Radioactive Waste Management Facility (NRWMF) for the safe and secure management of radioactive waste generated, possessed or controlled by the Commonwealth or a Commonwealth entity. Other Australian entities may submit waste for management at the facility, in some cases on payment of a prescribed fee.

The NRWM Act provides that, for the purpose of site selection, a number of activities are permitted in order to facilitate such selection. The EPBC Act is excluded from the operation of the NRWM Act in that regard. However, once a site is selected and the focus turns to establishing the facility, this exclusion ceases to operate.

Early activities conducted under the NRWM Act, including selection and ranking of potential sites and characterisation of the preferred site(s), do not require a licence from ARPANSA.

The NRWM Act is specific for the establishment of the NRWMF; it does not apply to any other potential Commonwealth storage or disposal facility.

The NRWMF is not intended for waste generated overseas. However, it can receive waste that has been segregated from nuclear fuel originally used in research reactors operated by the *Australian Nuclear Science and Technology Organisation* (ANSTO), and subsequently reprocessed overseas.

3.5. National Codes and Guidance

As Australia is a federation, each state and territory, and the Commonwealth, has specific legislation governing dealings with radiation. One of the functions of the CEO of ARPANSA is to promote uniformity of radiation protection and nuclear safety policy and practices across all Australian jurisdictions.

The Australian Health Ministers' Conference (AHMC) endorsed the development of the ***National Directory for Radiation Protection*** (NDRP) in 1999 as the means of achieving national uniformity. The RHC, established under the ARPANS Act and with regulatory members from all Australian jurisdictions (the CEO of ARPANSA is a statutory member representing the Commonwealth), prepared the NDRP for approval by AHMC. The process for issues resolution included meeting the Council of Australian Governments (COAG) requirements for national standard setting.

ARPANSA publishes the ***Radiation Protection Series*** (RPS), which is a suite of publications outlining nationally agreed codes and guidance. The RPS is developed in collaboration with state and territory regulators through the RHC. Some older codes and guidance issued by the National Health and Medical Research Council (NHMRC), and published in its ***Radiation Health Series*** (RHS), are still in use.

3.6. ARPANSA's Regulatory Guides

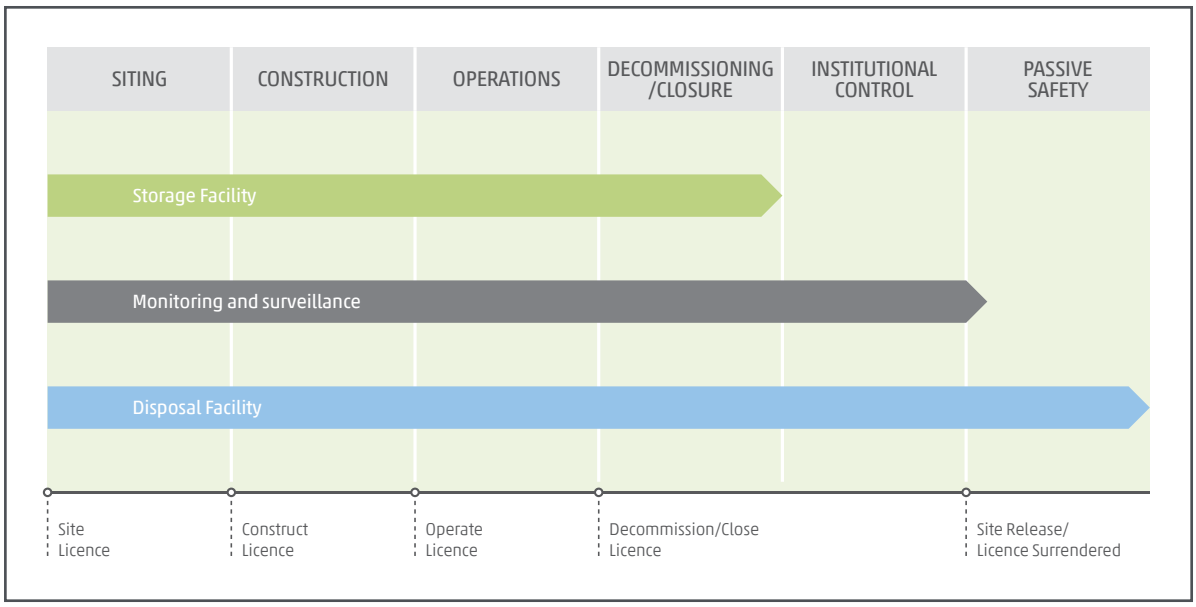
ARPANSA has published Regulatory Guides (see section 6.2.2) in order to assist applicants for a licence under the ARPANS Act in providing relevant information with their applications, and to assist licence applicants, licence holders and stakeholders more broadly in understanding the regulatory requirements. One example is the Regulatory Guide on ***Applying for a licence for a radioactive waste storage or disposal facility***, to which this Information for Stakeholders is a companion document.

4. The Licensing Process

4.1 Staged Process

The establishment of a facility for storage and disposal of radioactive waste goes through a staged licensing process. The different stages of licensing under the *ARPANS Act* are outlined graphically in Figure 1 and include authorisations to do the following:

- prepare a site
- construct
- possess or control (this mainly relates to maintaining facility safety while not in active operation)
- operate
- decommission (or close a disposal facility)
- abandon (release from regulatory control).



- ***Figure 1:*** *The licensing stages for storage and disposal facilities. The operational period may extend over several decades or more than a century, during which waste is contained in the storage facility awaiting final management or (for a disposal facility) decommissioning of ancillary facilities and closure of the disposal facility. Following decommissioning of a storage facility, the site may be abandoned provided this can be done safely. For a disposal facility, a period of active institutional control is expected; this may extend to beyond 100 years. When the site is released from regulatory control and abandoned, and active institutional control terminated, its safety will be entirely dependent on engineered and other features that will not be actively managed or monitored. Information on location, waste inventory, design features and other characteristics of the facility and site, will be retained in archives to preserve the information for the future. Note that this figure illustrates the licensing stages only, not the relative length of those stages. For a disposal facility, the passive safety phase can be very long.*

It should be noted that while the overall process is staged, there are strong linkages between each individual licence application. The licence application for each stage needs to be forward looking and contain sufficient information on the safety aspects of subsequent stage(s) to allow for an informed licensing decision.

Staging of licensing allows for gradual refinement of all aspects of design, operation and closure of a facility, and provides a mechanism for feedback of experience that may inform subsequent licensing stages. The appropriateness of the staged process is recognised in the IAEA ***Specific Safety Requirements No. SSR-5, Disposal of Radioactive Waste***.

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Requirement 11: Step by step development and evaluation of disposal facilities, IAEA SSR-5

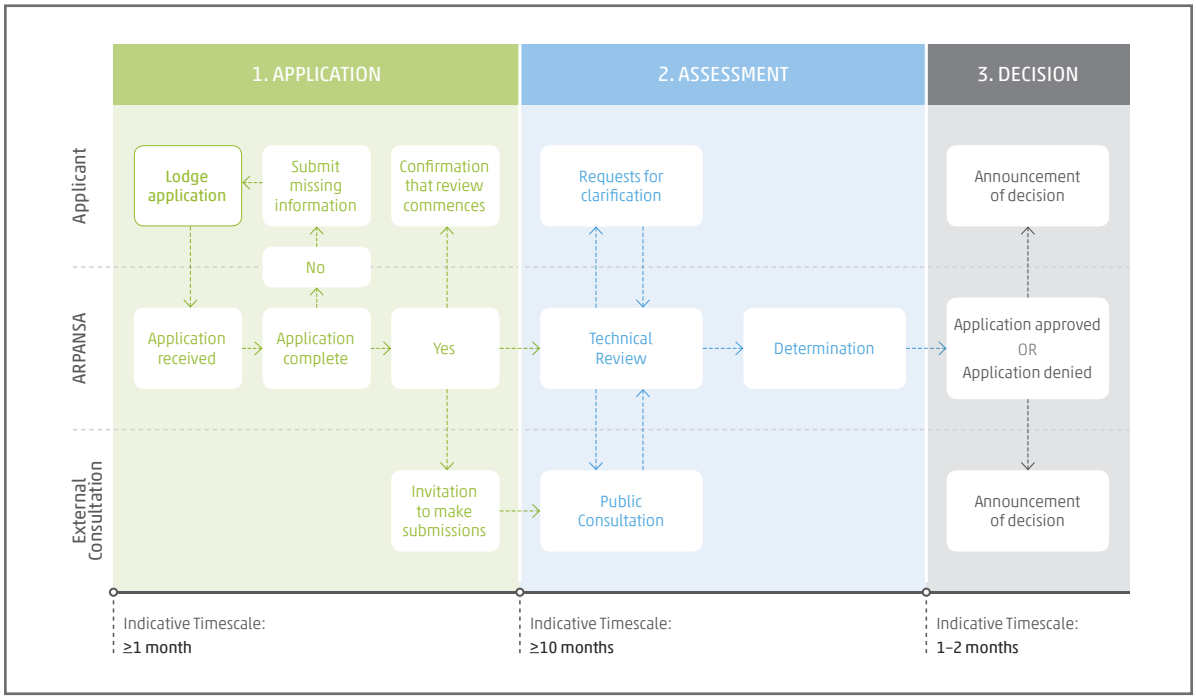
Disposal facilities for radioactive waste shall be developed, operated and closed in a series of steps. Each of these steps shall be supported, as necessary, by iterative evaluations of the site, of the options for design, construction, operation and management, and of the performance and safety of the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

4.2 Review of Application

4.2.1. Sequence of activities

On receipt of an application, ARPANSA officers will assess whether the applicant has provided all required information. This initial assessment will commence only if the relevant application fee has been received. If the application is considered complete or at minimum reviewable, ARPANSA will advise the applicant of the commencement of the review. This does not exclude that further documentation may be requested as the review progresses.

For co-located new facilities, such as a waste store and a disposal facility, ARPANSA anticipates that the applicant will submit separate applications specific to each facility. ARPANSA normally expects a separate application for the different stages of the facility however the CEO may decide to cover more than one stage of a facility with one licence.



- ***Figure 2:*** *The general workflow for the review of an application for a nuclear installation. Note that the 'indicative timescale' is very approximate and highly dependent on complexity of the application; it can be used as an indication of time needed for review of an application for a NRWMF.*

ARPANSA will as soon as practicable publish a notice in the Government Notices Gazette and in a newspaper circulated daily (and by other means as appropriate) stating that the CEO intends to make a decision on the application. The CEO must include in the notice:

- an invitation to people and bodies to make submissions about the application
- a period for making submissions
- procedures for making submissions.

Having received such submissions, the CEO must take them into account when deciding whether to issue a licence.

ARPANSA officers may provide clarification to an applicant regarding requirements in the ARPANS Act and Regulations, and on international best practice documents. Such advice supports safety and is an efficient use of resources however ARPANSA will not prescribe any particular design for a facility. Issues may also arise during the course of the review which will be resolved following appropriate processes. The resolution of such issues will be recorded.

ARPANSA officers will, on the basis of the totality of information, prepare a *Regulatory Assessment Report* with a recommendation to the CEO. The decision of the CEO (or delegate) will be communicated to the applicant and, for nuclear installations, also communicated more broadly and be accompanied by a separate *Statement of Reasons* (SoR) outlining the considerations and rationale for the decision, including information on issues resolved during the review phase. A licence will not be issued if ARPANSA considers there are doubts around the safety of a proposed facility, or the operator's capacity to maintain safety.

The legal basis for the decision, correspondence and meeting minutes that record commitments, operational limits and conditions, conditions of licence, issue resolution records, and other relevant documentation form the *licensing basis*. It will be recorded in ARPANSA's register of licensing basis. ARPANSA reviews the currency and appropriateness of the licensing basis periodically.

A licence is subject to conditions as set out in the ARPANS Act and Regulations as well as additional conditions which may be imposed by the CEO. For example, the frequency of safety and security reviews of the facility may be stated as a condition of licence. Licence conditions are not surrogates for safety. They outline certain additional requirements placed on the licence holder that will assure the CEO of ARPANSA that the licence holder is undertaking the licensed activity safely.

4.2.2. Interaction with other acts during review

As stated in section 3.3, the ARPANS Act and the Safeguards Act apply concurrently to some material and facilities. When considered early in the design process for a radioactive waste storage or disposal facility, there is little risk the requirements of the Acts will be incompatible ('safety and security by design'). Under a Memorandum of Understanding, ARPANSA and ASNO, when deemed appropriate in the interest of regulatory efficiency and effectiveness, work jointly in order to reach well-informed regulatory decisions.

If radioactive waste that is also nuclear material is to be stored in a radioactive waste store, the applicant will require a permit for establishing a nuclear facility under the Safeguards Act. This permit is required for providing information to the IAEA. The permit will be required in order to begin construction of the store. Once the waste store is operational a permit is required for possession of nuclear material before any nuclear material is stored. This permit will cover accountancy, access of IAEA and ASNO to the premises, and security requirements.

For a new Commonwealth facility that may potentially require approval under both the EPBC Act and the ARPANS Act, ARPANSA will advise stakeholders, including the Department of Environment and Energy, on best practice safety considerations. ARPANSA will not provide advice that may be perceived as pre-empting the outcome of ARPANSA's subsequent regulatory review should a permission under the EPBC Act be granted.

Should the Minister for the Environment and Energy be satisfied that the risks from a nuclear action are manageable, the review process could commence under both the EPBC Act and the ARPANS Act concurrently. There is no specific statutory requirement for applications and regulatory reviews under the ARPANS Act or EPBC Act to be made in any particular order. Under the ARPANS Act, the CEO may request "any environmental impact statement required or requested by a government agency, and the outcome of the environmental assessment", as part of the application for a licence to prepare a site for a controlled facility. In such cases, it is reasonable to expect that the review under the EPBC Act will be concluded before ARPANSA's review can be finalised.

The NRWM Act provides for the establishment of a regional consultative committee. ARPANSA may be invited to interact with this committee.

4.2.3. Consultation

A decision under the ARPANS Act on a licence application has to be robust and stand up to scrutiny by all interested parties (stakeholders). The decision is reviewable and appeals can be made. One of the main purposes of consultation is to take stock of information and knowledge among interested parties in order to take the best informed decision possible, and in doing so, make the decision more robust. This does not mean that the interested parties' views will determine the outcome of the licensing process however effective consultation ensures that the views of interested parties have been heard and their knowledge considered in a manner that is transparent and reflected in the SoR for the decision.

There is no prescribed format for consultation, apart from an obligation to invite submissions. A variety of models can be considered, depending on the type of facility and the associated radiation risks, as well as available resources. These include information/consultation meetings with the general public; meetings with specific stakeholders; web-based mechanisms for information exchange; hearings; or a combination of several of these activities. The optimal method for consultation is best agreed with the interested parties themselves.

ARPANSA also endeavours as much as practicable to engage with stakeholders regarding storage and disposal of radioactive waste *before* the formal lodging of an application. The purpose is to outline the role and responsibilities of ARPANSA in regards to the protection of health and safety of people, and of the environment and what can be expected from the agency before, during and after a licensing decision. ARPANSA does not take on an advocacy role in relation to any specific plan or concept.

The role of regulators in interacting with stakeholders in matters that relate to the establishment of radioactive waste management facilities is recognised internationally, while also acknowledging that the ultimate responsibility for safety rests with the operator. The Organisation of Economic Co-operation and Development (OECD), through its *Nuclear Energy Agency* (NEA), describes this role in ***The evolving Role and Image of the Regulator in Radioactive Waste Management: Trends over two Decades***, as reflected below.

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The role of the regulator in stakeholder interaction, OECD-NEA

Since the responsibility of nuclear safety regulators is to protect public health and the environment, regulators have a mission in service of the public. Ideally, and subject to any legal constraints, the regulators should be "guarantors" of safety and the "people's expert", acting as an accessible resource to stakeholders addressing safety concerns. Nuclear safety regulators should thus establish and maintain open channels of communication with the general public, implementers, government departments, parliament, concerned action groups and others. Appropriate mechanisms of dialogue must be found with the different stakeholders.

4.2.4. Appeals

The ARPANS Act provides a right of appeal of the CEO's decision in relation to a licence or an application for a licence to the Minister of Health. However this right of appeal is restricted to an applicant for a licence or a licence holder.

Third parties who are sufficiently affected by the decision may seek a judicial review of the CEO's decision under the ***Administrative Decisions (Judicial Review) Act 1977***. However a judicial review involves only a review of whether the CEO made the decision in accordance with the law and not whether the decision was the right one or should have been different.

In general, interested parties who have concerns about the appropriateness of granting a licence to a particular facility should utilise the public consultation process to express and explain those concerns. Where, in a particular licence assessment process, there is no requirement for a formal public consultation, ARPANSA provides a mechanism via its website for concerned individuals to report safety concerns in relation to existing or proposed facilities and activities. This information is treated confidentially to the extent allowable under the law.

Where there are suggestions of impropriety either by the applicant or ARPANSA in the licence application and assessment process, certain individuals (generally public officials or former public officials) can make protected disclosures under the *Public Interest Disclosure Act 2013* (PID Act). For more information on the PID Act and how to make a disclosure see ARPANSA's website.

5. International Best Practice

Under the ARPANS Act the CEO must, in deciding whether to issue a facility licence, take into account international best practice in relation to radiation protection and nuclear safety.

International best practice is not defined in the ARPANS Act. It is interpreted by ARPANSA as having regard to international standards as well as concepts and technologies implemented during construction and operation of facilities in countries with well-developed infrastructure for safety. It also includes relevant experience from the licensing, construction and operation of such facilities.

ARPANSA maintains information on its website on documents published by relevant international organisations[3] , which form part of international best practice.

This section briefly reviews international best practice frameworks and principles aimed at protecting the health and safety of people, and of the environment, from the harmful effects of radiation, with special emphasis on radioactive waste management.

5.1. IAEA Safety Standards and Security Guidance

A primary source for international best practice is the safety standards and security guidance issued by the IAEA. ARPANSA participates in the development of the safety standards through membership in the subject specific safety standards committees on radioactive waste safety; radiation safety; transport safety; nuclear safety; and emergency preparedness and response. ARPANSA also has a seat in the Commission on Safety Standards, which oversees and provides guidance on the work program of the safety committees. The Nuclear Security Guidance Committee oversees the development of nuclear security guidance, with the participation of ASNO and ARPANSA.

At the request of Member States, IAEA coordinates international reviews of a Member State's governmental, legal and regulatory framework for safety, benchmarking the national framework against the IAEA safety standards and security guidance. An example is the Integrated Regulatory Review Service, with missions carried out to the Commonwealth of Australia (ARPANSA) in 2007 and 2011[4], and with a new mission to the Commonwealth and most state/territory jurisdictions planned for 2018.

[3] ***http://www.arpansa.gov.au/Regulation/ibp/index.cfm***

[4] ***http://www.arpansa.gov.au/Regulation/Branch/irrsreview.cfm***

The IAEA takes into account recommendations of the *International Commission on Radiological Protection*[5] (ICRP) in its development of safety standards, as well as the scientific evaluations carried out by the *United Nations Scientific Committee on the Effects of Atomic Radiation*[6] . ARPANSA plays a significant role in both these fora.

The IAEA safety standards comprise three tiers of regulatory documents. The top tier is the Safety Fundamentals, which states the safety objective:

PO

The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation.

The second tier comprises the *Safety Requirements*, with which compliance is expected. These are divided into General Safety Requirements (GSR) and Specific Safety Requirements (SSR). The Safety Guides that form the third tier provide guidance on how to satisfy the requirements.

SAFETY FUNDAMENTALS
Fundamental Safety Principles

General Safety Requirements

Part 1	Governmental, Legal and Regulatory Framework for Safety
Part 2	Leadership and Management for Safety
Part 3	Radiation Protection and the Safety of Radiation Sources
Part 4	Safety Assessment for Facilities and Activities
Part 5	Predisposal Management of Radioactive Waste
Part 6	Decommissioning and Termination of Activities
Part 7	Emergency Preparedness and Response

Specific Safety Requirements

1	Site Evaluation for Nuclear Installations
2 2.1 2.2	Safety of Nuclear Power Plants Design and Construction Commissioning and Operation
3	Safety of Research Reactors
4	Safety of Nuclear Fuel Cycle Facilities
5	Safety of Radioactive Waste Disposal Facilities
6	Safe Transport of Radioactive Material

Collection of Safety Guides

Figure 3: *The hierarchy of IAEA safety standards outlining the three tiers: Fundamentals; Requirements; and, Guides. Adapted from IAEA's Strategy and Processes for the Establishment of IAEA Safety Standards, version 2.2, November 2015.*

[5] ***http://www.icrp.org***

[6] ***http://www.unscear.org***

Similar to the safety standards, the ***Nuclear Security Series*** (NSS) follows a tiered structure. The top tier publication is the ***Fundamentals, Objective and Essential Elements of a State's Nuclear Security Regime*** (NSS 20), published in 2013. It states the objective of a State's nuclear security regime as follows:

PO

The objective of a State's nuclear security regime is to protect persons, property, society, and the environment from harmful consequences of a nuclear security event.

The second tier comprises a suite of recommendations, effectively corresponding to the requirements in the safety standards series.

Australia has also formally committed, in 2004, to the IAEA ***Code of Conduct on the Safety and Security of Radioactive Sources***. Requirements on source security have been implemented in Australia through the ***Code of Practice for the Security of Radioactive Sources*** (RPS 11), published in 2007. This Code is mandated as a licence condition under the ARPANS Regulations. ARPANSA is also implementing the ***Supplementary Guidance on the Import and Export of Radioactive Sources***.

5.2. The Joint Convention

The ***Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*** (the 'Joint Convention') was ratified by Australia in 2003. The objectives of the Joint Convention are as follows:

PO

(i) to achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management, through the enhancement of national measures and international co-operation, including where appropriate, safety-related technical co-operation

(ii) to ensure that during all stages of spent fuel and radioactive waste management there are effective defenses against potential hazards so that individuals, society and the environment are protected from harmful effects of ionizing radiation, now and in the future, in such a way that the needs and aspirations of the present generation are met without compromising the ability of future generations to meet their needs and aspirations

(iii) to prevent accidents with radiological consequences and to mitigate their consequences should they occur during any stage of spent fuel or radioactive waste management.

The Joint Convention includes provisions on establishment and maintenance of a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management, and to ensure that individuals, society and the environment are adequately protected against radiological and other hazards. These obligations extend to appropriate siting, design and construction of waste storage and disposal facilities and ensuring the safety of facilities both during their operation and after their closure.

The Joint Convention imposes obligations on Australia in relation to the trans-boundary movement of spent fuel and radioactive waste, and an obligation to take appropriate steps to ensure that disused sealed radiation sources are managed safely.

Australia, through ARPANSA, submits reports to the Secretariat of the Convention every third year, as an input to the review meetings carried out under the terms of the Convention. These reports are available on ***ARPANSA's website***[7].

5.3. Principles and Safety Approaches in International Guidance

5.3.1. The Fundamental Safety Principles

The IAEA published its ***Fundamental Safety Principles***[8] in 2006, which include 10 safety principles. ARPANSA, in collaboration with state and territory regulators through the Radiation Health Committee, promotes the 10 principles nationally in Australia in accordance with ***Fundamentals for Protection Against Ionising Radiation*** (RPS F-1).

[7] ***http://www.arpansa.gov.au/AboutUs/Collaboration/jointconv.cfm***

[8] Jointly sponsored by the European Atomic Energy Community, the Food and Agriculture Organization of the United Nations, the International Atomic Energy Agency, the International Labour Organization and the International Maritime Organization.

CP

The Fundamental Safety Principles (RPS F-1)

Principle 1:
The prime responsibility for management of radiation risks must rest with the person or organisation responsible for facilities and activities that give rise to radiation risks.

Principle 2:
An effective framework including legislation, regulation and guidance to promote management of radiation risks, including an independent regulatory body, must be established and sustained.

Principle 3:
Effective leadership and management of radiation risks must be established and sustained in organisations concerned with, and facilities and activities that give rise to, radiation risks.

Principle 4:
Facilities and activities that give rise to radiation risks must yield an overall benefit.

Principle 5:
Protection must be optimised so that radiation risks are as low as reasonably achievable.

Principle 6:
Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm, and that the environment is protected.

Principle 7:
People and the environment, present and future, must be protected against radiation risks.

Principle 8:
All practical efforts must be made to prevent and mitigate accidents, and acts with malicious intent, that may give rise to radiation risks.

Principle 9:
Arrangements must be made for emergency preparedness and response for incidents, accidents and malicious acts that may give rise to radiation risks.

Principle 10:
Protective actions to reduce existing or unregulated radiation risks must be justified and optimised.

5.3.2. Defence in Depth

The concept of defence in depth applies to the protective capability of a facility through a hierarchy of controls and engineering features that perform safety functions independently of each other. Failure of one component of the system should not jeopardise protection of the health and safety of people, and of the environment.

The defence in depth concept was introduced for nuclear facilities several decades ago, and comprises five levels of objectives and controls, as outlined in Table 1 (see the International Nuclear Safety Advisory Group [INSAG] publication ***Defence in Depth in Nuclear Safety, INSAG-10***).

Level of defence in depth	Safety objective	Essential means to achieve the objective
Level 1	Prevention of abnormal operation and failures	Conservative design and high quality in construction and operation
Level 2	Control of abnormal operation and detection of failures	Control, limiting and protection systems and other surveillance features
Level 3	Control of accidents within the design basis	Engineered safety features accident procedures
Level 4	Control of severe plant conditions, including prevention of accident progression and mitigation of the consequences of severe accidents	Complementary measures and accident management
Level 5	Mitigation of radiological consequences of significant release of radioactive materials	Off-site emergency response

- ***Table 1:*** *The five levels of defence in depth. Based on INSAG-10.*

Commonly, containment of waste is accomplished by multiple physical barriers where the barrier functions are associated with the physical and chemical properties of the waste matrix (e.g. concrete, glass or ceramics), the waste packages and overpacks, material used to backfill a disposal facility, and the environment surrounding the facility.

The importance of multiple safety functions is emphasised in the IAEA ***Specific Safety Requirements No. SSR-5 Disposal of Radioactive Waste***.

CP

Requirement 7: Multiple safety functions, IAEA SSR-5

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.

Through application of the defence in depth concept to a facility for radioactive waste storage or disposal, the radioactive substances can be effectively contained and isolated from the surrounding environment. If properly designed, constructed and operated, this will reduce radiation exposure in the vicinity of the facility to extremely low levels.

5.3.3. Radiation Protection Principles

The international framework for radiation protection rests on three principles, *justification, optimisation* and *dose limitation*, outlined in the ***2007 Recommendations of the International Commission on Radiological Protection*** in its ***Publication 103***. These principles are also reflected in the IAEA's ***General Safety Requirements No GSR Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards***[9] and are considered in licensing decisions under the ARPANS Act and Regulations.

CP

The principles of radiation protection, based on ICRP Publication 103

Justification involves a demonstration that there is a net benefit from a practice which leads to exposure to radiation. 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.

Optimisation is employed to make the best use of resources in reducing radiation risks, once the practice has been justified. 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.

Limitation of exposure applies to protection of individuals in occupational settings as well as to the individuals within the general public. Such limits are normally defined in the legal framework for safety; for the Commonwealth they are defined in Part 5 Division 5.2 of the ARPANS Regulations. Limits are insufficient in themselves to ensure best achievable protection, and should be applied in conjunction with optimisation.

Conclusions as to whether an activity is justified can sometimes be a professional judgement, for example when assessing whether the benefit from a medical procedure involving radiation outweighs its associated risks. In other cases, the benefit is a societal judgement where decisions on justification rest with government.

[8] Jointly sponsored by the European Commission, the Food and Agriculture Organization of the United Nations, the International Atomic Energy Agency, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization, the United Nations Environment Programme and the World Health Organization.

The overarching principle for protection (once an activity has been deemed justified), is that of optimisation, which provides an effective means of reduction of radiation exposures. Optimisation of protection in research facilities and industry will, other than in rare instances, lead to actual exposures that are far below the statutory limits for both workers and members of the public and will cause no harm to the health of the environment.

CP

Radiation exposure of the 'average Australian' from different sources in a year. Source: ARPANSA

The main (more than 50%) source of exposure of the Australian population is medical examination where there is significant health benefit resulting from the exposure. The second largest contributor is natural background radiation, including cosmic radiation. Artificial radiation sources, other than those used in medicine, cause minor exposures of the general population. Some occupational environments may require careful management to control and reduce exposures, and the likelihood of accidents or security events should be reduced as far as possible.

Source of exposure	Percentage	mSv
Medical	53%	1.7
Terrestrial	20%	0.6
Cosmic	9%	0.3
Radon and progeny	6%	0.2
Potassium-40 in the body	6%	0.2
Uranium/Thorium in the body	6%	0.2

The exposures in the above table are given in the quantity effective dose, which is a risk-related quantity used for radiation protection (not for detailed risk estimation) that takes into account the properties of different types of radiation and sensitivities of different organs in the human body. It is measured in the unit sievert (Sv), normally as millisievert (mSv).

The radiation protection framework applies to planned exposure situations (where radiation protection can be planned in advance to manage activities that may lead to radiation exposure), emergency exposure situations (loss of control of a source or facility due to accidents or acts with malicious intent) and existing exposure situations (where the exposure already exists at the time a decision on control has to be taken, including exposure during recovery from emergencies).

Storage and disposal of radioactive waste are managed as planned exposure situations. The justification of a waste management facility has to be judged in connection with the activity that generates the waste. However the justification for past activities that have generated waste currently in storage, whether these activities were carried out under a licence or not, cannot be reassessed when decisions have to be made regarding its management. The ICRP considers this aspect in ***Publication 122***:

CP

On the justification of waste management and disposal, ICRP *Publication 122*

..... radioactive waste management and disposal operations are an integral part of the practice generating the waste. It is wrong to regard them as a free standing practice that needs its own justification. Therefore, justification of the practice should include the management options of the waste generated, e.g. geological disposal. The justification of a practice should be reviewed over the lifetime of that practice whenever new and important information becomes available: such information may arise for societal, technical and scientific reasons. If the management of waste was not considered in the justification of a practice that is no longer into operation, the Commission recommends to optimize the protection of humans and the environment independently of considering the justification of such practice.

Under circumstances where barriers perform as planned, containment of the waste should provide for isolation of the waste from the surrounding environment for long periods of time which leads to exposure of members of the public that are very low or effectively zero. Actual measurements of exposure would be very difficult and would not allow separation of the (possible) exposure from the facility from exposure emanating from natural sources. Likewise, detection of radioactive substances in the environment may not be feasible.

For the purpose of radiation protection of the public, the exposure analysis will have to be based on simulations using a real or hypothetical *representative individual* (or person) as the subject of the exposure calculations, as detailed in ICRP ***Publication 101a***.

CP

The Representative Individual, from ICRP Publication 101a

For the purpose of radiation protection of the public, a representative individual is a person, either hypothetical or specific, who is characterised to be representative of the more highly exposed individuals in the population. It is considered that protection of the public is achieved when the dose to the representative individual is less than the dose constraint, and when radiation protection is optimised.

When considering dose to the representative individual, it is important to ensure that the most exposed population is included in the assessment, that realistic cultural and lifestyle data are considered, and that specific age categories are addressed.

In some cases human error, negligence or reckless behaviour; or events such as natural disruptive events, accidents or acts with malicious intent, may cause higher exposures. The defence in depth measures are intended to, as far as is reasonably practicable, reduce the likelihood that such potential exposures occur and limit the consequences should they occur.

The likelihood of harm from disruptive events and accidents may be best approached by using the concept of risk. The risk is made up of two components: the probability that an event occurs over a certain period of time; and the consequence in terms of health of people and the environment should this event occur. An event that has a high probability to occur but where the consequences are minor may carry a similar risk as an event that is very unlikely to occur but with more severe consequences.

For longer time periods credible analysis of actual radiation risks becomes increasingly difficult to perform. While an analysis over long-term is still useful and promotes an understanding of the protective capability of the facility, actual estimates of risk become uncertain. This is because of uncertainty in the long-term performance of the barriers and uncertainties in the assumptions on evolution of the site, including future land use, demographics and societal circumstances.

The effectiveness of protective measures in mitigating exposures is correspondingly difficult to estimate. The protective capability under such circumstances is promoted by the application of *best available technique* or BAT (see ICRP ***Publication 122***). This is an internationally recognised practice in management and disposal of waste and particularly relevant when assessing long-term safety under conditions where radiation risks are difficult to quantify or very uncertain. BAT refers to the preferred technology for managing and disposing of radioactive waste, selected from among others after taking into account factors related to technology, economics, public policy, and other parameters such as the nature of the site.

Radiation protection also considers protection of the environment, specifically the populations of organisms that inhabit the natural environment. There are no established dose limits for such organisms. Ranges of environmental dose rates have been identified, based on our knowledge of radiation effects, where there may be a risk of some detrimental effects on populations of organisms in the environment (ICRP ***Publications 108*** and ***124***). These 'environmental reference levels' of exposure can guide optimisation efforts. Further guidance that builds on international best practice is available in ARPANSA's Guide for ***Radiation Protection of the Environment*** (RPS G-1).

5.3.4. Safety Analysis and Safety Assessment

The understanding of safety of the facility is gained through performing a safety analysis. The safety analysis is the evaluation of the potential hazards associated with a facility or an activity. The formal safety analysis is part of the overall safety assessment, i.e. it is part of the systematic process that is carried out throughout the design process (and throughout the lifetime of the facility or the activity) to ensure that all the relevant safety requirements are met by the proposed (or actual) design.

This also requires analysis of uncertainties which may be large, in particular in relation to long-term protective capability and sensitivities, i.e. what are the most significant elements of the safety analysis that determine our overall understanding of safety.

The relationship between the safety analysis and the safety assessment in understanding the performance of the facility is explained in the IAEA ***General Safety Requirements No. GSR Part 4 (Rev 1), Safety Assessment for Facilities and Activities***, published in 2016.

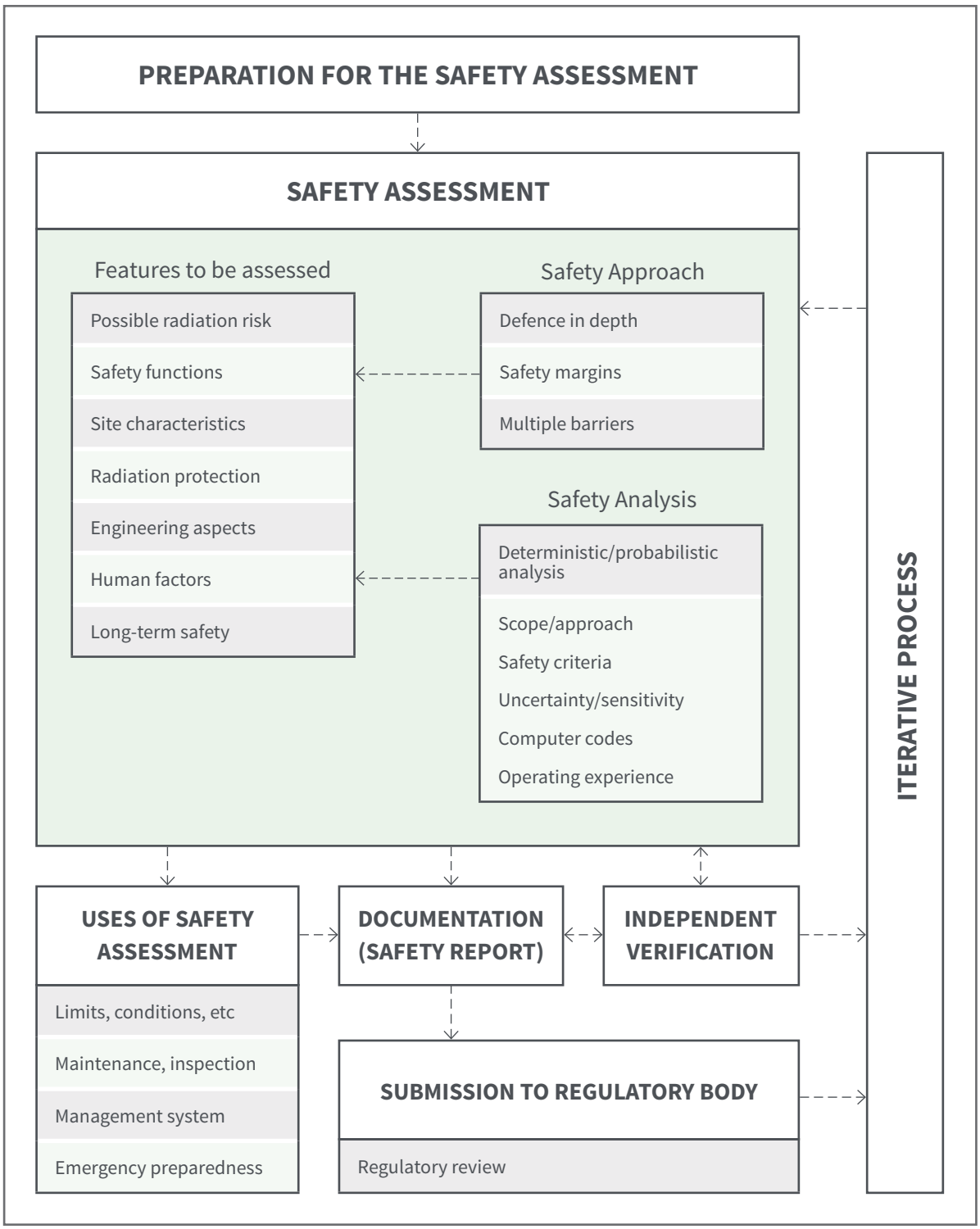

Figure 4: *Interaction between different elements of the safety assessment, illustrating the iterative nature of the process which allows for feedback and gradual refinement as a project evolves. Adapted from IAEA Safety Requirements No. GSR Part 4 (Rev 1), Safety Assessment for Facilities and Activities.*

5.3.5. The Safety Case

The available knowledge and information on the performance of storage and disposal facilities will evolve with time and through the different licensing stages. In particular, successive safety assessments and the operational experience will be important for improved understanding of the performance of a disposal facility after closure, and after the period of active institutional control.

The information will be collated in a *safety case* for the facility. The safety case is the collection of scientific, technical, administrative and managerial arguments and evidence in support of the safety of a facility covering the suitability of the site and the design, construction and operation, the assessment of radiation risks, and assurance of the adequacy and quality of all of the safety related work that is associated with the facility.

The safety case, with its supporting safety assessment, provides the basis for demonstration of safety and for licensing. It will evolve with the development of the facility. For each of the principal stages of the licensing process, an updated safety case is required. The safety case must demonstrate that throughout the facility's life, the facility will comply with the statutory radiation dose limits and explicitly describe how radiation exposures will be kept as low as reasonably achievable (ALARA). The safety case includes the operational limits and conditions within which the facility must operate, and a safety analysis that is documented in a safety analysis report.

For a disposal facility, the safety case provides an understanding of the behaviour of the facility under normal conditions and disruptive events over the time frames where the radioactive waste poses risks to the health and safety of people, and of the environment.

The safety case will be the main basis on which dialogue with interested parties will be conducted and on which confidence in the safety of the disposal facility will be based. Stakeholders can contribute valuable knowledge and input in developing the safety case. Their involvement and contributions during consultation form part of the safety case development process, and must be documented in the safety case.

The requirements for a safety case for predisposal facilities are stated in the IAEA ***General Safety Requirements No. GSR Part 5 Predisposal Management of Radioactive Waste***, and for disposal facilities in the ***Specific Safety Requirements No. SSR-5 Disposal of Radioactive Waste***.

CP

GSR Part 5 Requirement 13: Preparation of the safety case and supporting safety assessment

The operator shall prepare a safety case and a supporting safety assessment. In the case of a step by step development, or in the event of modification of the facility or activity, the safety case and its supporting safety assessment shall be reviewed and updated as necessary.

SSR-5 Requirement 12: Preparation, approval and use of the safety case and safety assessment for a disposal facility

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.

SSR-5 Requirement 13: Scope of the safety case and safety assessment

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.

Detailed guidance on the content of the safety case is given in the IAEA ***Specific Safety Guide No. SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste***; and in the IAEA ***General Safety Guide No. GSG-3, The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste***.

5.3.6. Management System

The arrangements put in place to establish a facility, and the interdependencies between such arrangements, should be consolidated and documented in a *management system*. A management system designed to support the achievement of the object of the ARPANS Act will integrate safety, health, environmental, security, quality, societal and economic elements. The management system shall ensure that international best practice is taken into account in such arrangements and promote a culture of safety. The ***General Safety Requirements No. GSR Part 2, Leadership and Management for Safety*** sets out, among other things, the following:

CP

Requirement 6: Integration of the management system, GSR Part 2

The management system shall integrate its elements, including safety, health, environmental, security, quality, human performance, societal and economic elements, so that safety is not compromised.

4.8 The management system shall be developed, applied and continuously improved. It shall be aligned with the safety goals of the organization.

4.9 The management system shall be applied to achieve goals for safely, to enhance safety and to foster a strong safety culture by:

(a) bringing together in a coherent manner all the necessary elements for safely managing the organization and its activities

(b) describing the arrangements made for management of the organization and its activities

(c) describing the planned and systematic actions necessary to provide confidence that all requirements are met

(d) ensuring that safety is taken into account in decision making and is not compromised by any decisions taken.

One of the features of a management system is to allow for resources to be directed to areas where the safety outcome can be anticipated to be greatest. A *graded approach* to management of safety will ensure the efficient and effective use of available, and often limited, resources.

CP

Requirement 7: Application of the graded approach to the management system, GSR Part 2

The management system shall be developed and applied using a graded approach.

4.15 The criteria used to grade the development and application of the management system shall be documented in the management system. The following shall be taken into account:

a) the safety significance and complexity of operation of the organization or facility or conduct of the activity

b) the hazards and the magnitude of the potential impacts (risks) associated with the safety, health, environmental, security, quality and economic elements of each facility or activity

c) the possible consequences for safety if a failure or an unanticipated event occurs or if an activity is inadequately planned or improperly carried out.

Human error is a main contributor to events that may be of safety significance or lead to accidents. A number of contributing factors to such errors can be identified. These include inadequate training, lack of managerial support, poor reporting practices, complacency, neglect and others.

Safety is not implemented effectively if managers and workers do not approach it with the right mindset. A culture of safety shall be an integral component of all activities. A good safety culture cannot be imposed but needs to be continually fostered, where the role modelling of managers is a prerequisite for success.

GSR Part 2 states as follows:

CP

Requirement 12: Fostering a culture for safety, GSR Part 2

Individuals in the organization, from senior managers downwards, shall foster a strong safety culture. The management system and leadership for safety shall be such as to foster and sustain a strong safety culture.

5.1. All individuals in the organization shall contribute to fostering and sustaining a strong safety culture [1, 2].

5.2. Senior managers and all other managers shall advocate and support the following:

A common understanding of safety and of safety culture, including: awareness of radiation risks and hazards relating to work and to the working environment; an understanding of the significance of radiation risks and hazards for safety; and a collective commitment to safety by teams and individuals;

(a) Acceptance by individuals of personal accountability for their attitudes and conduct with regard to safety.

(b) An organizational culture that supports and encourages trust, collaboration, consultation and communication.

(c) The reporting of problems relating to human and organizational factors and reporting of any deficiencies in structures, systems and components to avoid degradation of safety, including the timely acknowledgement of, and reporting back of, actions taken.

(d) Measures to encourage a questioning and learning attitude at all levels in the organization and to discourage complacency with regard to safety.

(e) The means by which the organization seeks to enhance safety and to foster safety culture, and using a systemic approach (i.e. an approach relating to the system as a whole).

(f) Safety oriented decision making in all activities.

(h) The exchange of ideas between, and the combination of, safety culture and security culture.

ARPANSA uses the concept of holistic safety (or systems safety) in order to analyse, and to provide advice on, integration of different components that contribute to overall safety. These include technology; the organisational elements of the operating organisation and the responsibilities that supports safety; and the approach and perceptions around safety of individual members of staff at all levels.

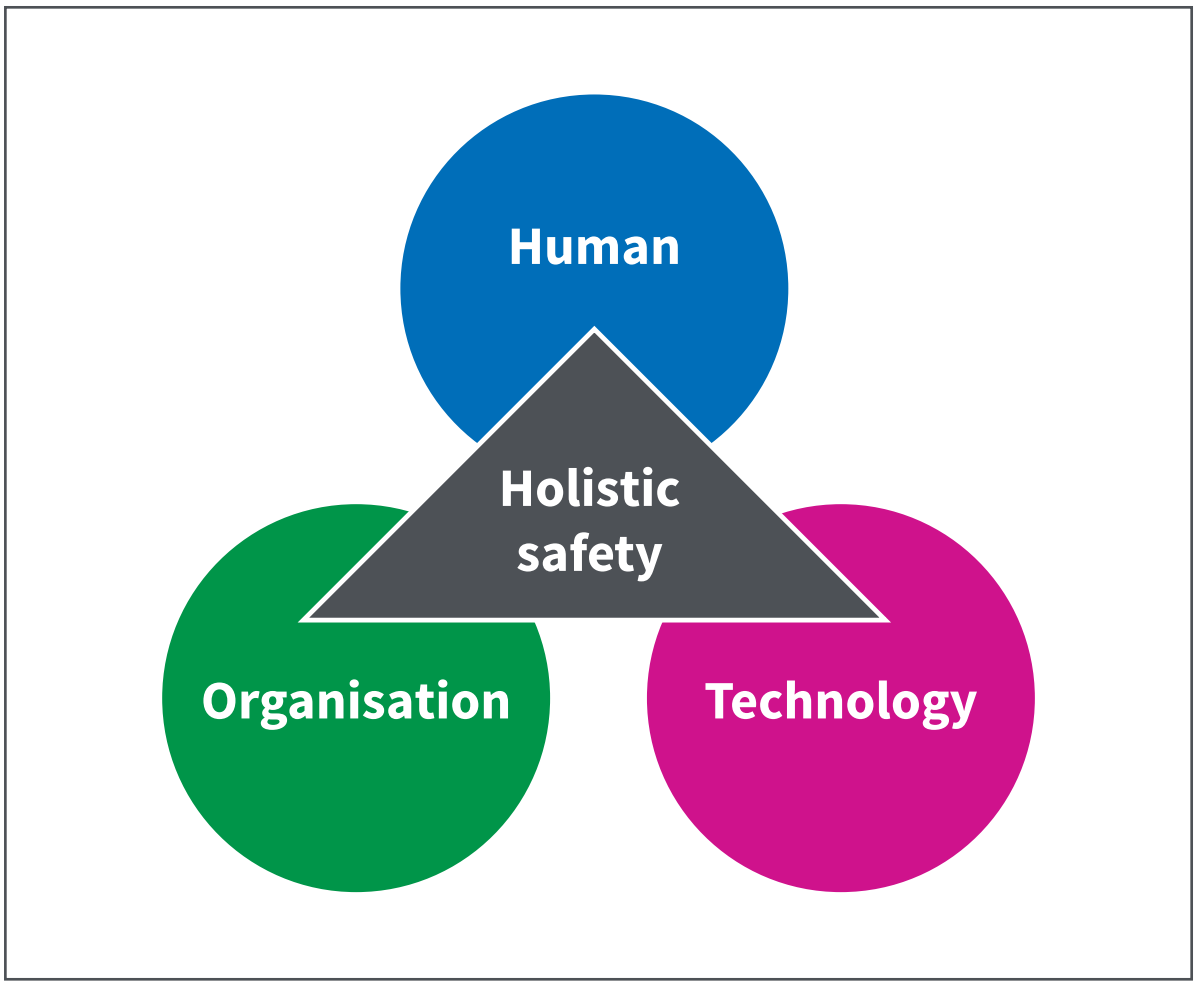

Figure 5: *The components of holistic safety. Source: ARPANSA.*

6. References

This section lists all documents that have been referenced in this information document. It also provides reference to sources of other information of national and international best practice in radioactive waste management.

6.1. Publications quoted in the main text

6.1.1. Australian Radiation Protection and Nuclear Safety Agency

www.arpansa.gov.au

- Safety Guide for Classification of Radioactive Waste, Radiation Protection Series No. 20, 2010
- National Directory for Radiation Protection, Radiation Protection Series No. 6, 2014
- Guide for Radiation Protection of the Environment, Radiation Protection Series G-1, 2015
- Fundamentals for Protection Against Ionising Radiation, Radiation Protection Series F-1, 2014
- Regulatory Guide on Applying for a Licence for a Radioactive Waste Storage or Disposal Facility, 2017
- Code of Practice for the Security of Radioactive Sources, Radiation Protection Series No. 11, 2007

6.1.2. International Atomic Energy Agency

www-ns.iaea.org

- Fundamental Safety Principles, Safety Fundamentals, No. SF-1, 2006
- IAEA Safety Glossary, Terminology Used in Nuclear Safety and Radiation Protection, 2007 Edition
- Classification of Radioactive Waste, General Safety Guide, No. GSG-1, 2009
- Disposal of Radioactive Waste, Specific Safety Requirements, No. SSR-5, 2011
- The Safety Case and Safety Assessment for the Disposal of Radioactive Waste, Specific Safety Guide No. SSG-23, 2012
- The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste, General Safety Guide, No. GSG-3, 2013

- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements, No. GSR Part 3, 2014
- Governmental, Legal and Regulatory Framework for Safety, General Safety Requirements, No. GSR Part 1, 2016
- Safety Assessment for Facilities and Activities, General Safety Requirements, No. GSR Part 4, 2016
- Leadership and Management for Safety, General Safety Requirements, No. GSR Part 2, 2016
- Objective and Essential Elements of a State's Nuclear Security Regime, Nuclear Security Series No. NSS 20, 2013
- Code of Conduct on the Safety and Security of Radioactive Sources, 2004
- Supplementary Guidance on the Import and Export of Radioactive Sources, 2004
- Predisposal Management of Radioactive Waste, General Safety Requirements Part 5, No. GSR Part 5, 2009

6.1.3. International Commission on Radiological Protection

www.icrp.org

- Assessing Dose of the Representative Person for the Purpose of the Radiation Protection of the Public, ICRP Publication 101a, 2006
- The 2007 Recommendations of the International Commission on Radiological Protection, ICRP Publication 103, 2007
- Radiological Protection in Geological Disposal of Long-lived Solid Radioactive Waste, ICRP Publication 122, 2013
- Environmental Protection - the Concept and Use of Reference Animals and Plants, ICRP Publication 108, 2008
- Protection of the Environment under Different Exposure Situations, ICRP Publication 124, 2014

6.1.4. International Nuclear Safety Advisory Group

www-ns.iaea.org/committees/insag.asp

- Defence in Depth in Nuclear Safety, INSAG-10, 1996

6.1.5. Organisation for Economic Co-operation and Development/ Nuclear Energy Agency

www.oecd.org

- The evolving Role and Image of the Regulator in Radioactive Waste Management: Trends over two Decades, 2012

6.2. Other sources of information

6.2.1. Selected IAEA publications

www-ns.iaea.org

1. **Regulations for the Safe Transport of Radioactive Material, Specific Safety Requirements No. SSR-6, International Atomic Energy Agency (IAEA), 2012 (Adopted as ARPANSA RPS C 2, 2014)**

   These Regulations establish requirements that must be satisfied to ensure safety and to protect persons, property and the environment from the effects of radiation in the transport of radioactive material.

2. **Site Evaluation for Nuclear Installations, Safety Requirement, No. NS-R-3 (rev.1), International Atomic Energy Agency (IAEA), 2016**

   The document establishes the requirements for the elements of a site evaluation for a nuclear installation so as to characterise fully the site specific conditions pertinent to the safety of the nuclear installation.

   This publication encompasses site related factors and site–installation interaction factors relating to operational states and accident conditions, including those that could warrant emergency response actions, and natural and human induced events external to the installation that are important to safety.

3. **Preparedness and Response for a Nuclear or Radiological Emergency, General Safety Requirements, No. GSR Part 7, International Atomic Energy Agency (IAEA), 2015**

   This publication establishes the requirements for an adequate level of preparedness and response for a nuclear or radiological emergency. The application of these requirements is also intended to mitigate the consequences of a nuclear or radiological emergency if such an emergency arises despite all efforts made to prevent it.

   The requirements apply for preparedness and response for a nuclear or radiological emergency in relation to all those facilities and activities, as well as sources, with the potential for causing radiation exposure, environmental contamination or concern on the part of the public warranting protective actions and other response actions.

5. **The Management System for the Disposal of Radioactive waste, Safety Guide No. GS-G-3.4, International Atomic Energy Agency (IAEA), 2008**

   This Safety Guide provides recommendations on developing and implementing management systems for all phases of facilities for the disposal of radioactive waste and related activities.

6. **The Management System for the Processing, Handling and Storage of Radioactive Waste, Safety Guide No. GS-G-3.3, International Atomic Energy Agency (IAEA), 2008**

This Safety Guide is to provide recommendations on developing and implementing management systems for the pre-treatment, treatment, conditioning and storage of radioactive waste.

7. **Near Surface Disposal Facilities for Radioactive Waste, Specific Safety Guide No. SSG-29, International Atomic Energy Agency (IAEA), 2014**

This Safety Guide provides guidance and recommendations relating to the development, operation, closure and regulatory control of facilities for the near-surface disposal of radioactive waste to meet the safety requirements established in SSR-5.

8. **Site Survey and Site Selection for Nuclear Installations, Specific Safety Guide No. SSG-35, International Atomic Energy Agency (IAEA), 2015**

This Safety Guide provides recommendations and guidance on meeting the requirements [NS-R-3] for the consideration of safety in the siting process for a nuclear installation in order to meet the fundamental safety objective of SF-1.

9. **Monitoring and Surveillance of Radioactive Waste Disposal Facilities, Specific Safety Guide No. SSG 31, International Atomic Energy Agency (IAEA), 2014**

This Safety Guide provides guidance for the monitoring and surveillance of radioactive waste disposal facilities throughout their entire lifetime.

10. **Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors, Specific safety Guide No. SSG-40, International Atomic Energy Agency (IAEA), 2016**

This document provides guidance on the predisposal management of all types of radioactive waste generated at nuclear power plants and research reactors (including subcritical and critical assemblies). It covers all stages in the lifetime of a waste management facility, including its siting, design, construction, commissioning, operation, shutdown and decommissioning. Recommendations on how to meet the requirements for the predisposal management of radioactive waste generated from such facilities are presented in this guide.

11. **Contents and Example Arguments for a safety Case for Radioactive Waste Disposal, Draft Technical Document, IAEA-TECDOC-xxxx, International Atomic Energy Agency (IAEA), 2016**

This technical document provides the components of a Safety Case defined by the PRISM (Practical Illustration of the use of the Safety Case in the Management of near-surface disposal) and the example arguments or content of Safety Cases for two facilities developed by PRISMA (which is the follow-up project to the PRISM).

12. **Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/REVISION 5), Nuclear Security Series No. 13, International Atomic Energy Agency (IAEA), 2011**

This publication provides a set of recommended requirements to achieve the four Physical Protection Objectives and to apply the twelve Fundamental Principles that were endorsed by the IAEA Board of the Governors and General Conference in September 2001.

The recommended requirements apply to the physical protection of nuclear material, including its physical protection during transport, and of nuclear facilities against malicious acts.

13. **Nuclear Security Recommendations on Radioactive Material and Associated Facilities, Nuclear Security Series No. 14, International Atomic Energy Agency (IAEA), 2011**

This publication provides a set of recommendations to ensure a consistent level of security of radioactive material and to ensure that there is a balance between managing radioactive material securely while still enabling it to be used safely by authorised persons without unduly limiting the use of radioactive material for societal benefits.

These recommendations apply to the security of radioactive material, associated facilities and associated activities for the prevention of malicious acts intended or likely to cause harmful radiological consequences.

6.2.2. Other References

Administrative Decisions (Judicial Review) Act
www.austlii.edu.au/au/legis/cth/consol_act/adra1977396/

ARPANS Act and Regulations
www.arpansa.gov.au/Regulation/Legislation/index.cfm

ARPANSA Regulatory Guides
http://www.arpansa.gov.au/Regulation/guides.cfm

EPBC Act
https://www.legislation.gov.au/Series/C2004A00485

EPBC Act, approval process
http://www.environment.gov.au/epbc/what-is-protected/nuclear-actions

International best practice
http://www.arpansa.gov.au/Regulation/ibp/index.cfm

NRWM Act
https://www.legislation.gov.au/Details/C2012A00029

Safeguards Act
https://www.legislation.gov.au/Details/C2012C00394