



Australian Government

Australian Radiation Protection and Nuclear Safety Agency

**REGULATORY GUIDANCE FOR RADIOACTIVE WASTE
MANAGEMENT FACILITIES: NEAR SURFACE DISPOSAL
FACILITIES; AND STORAGE FACILITIES**

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FOREWORD

The aim of radioactive waste management is to segregate the waste effectively from the environment during the time when it has the potential to give unacceptably high radiation doses to people or to the environment.

A repository for the final disposal of radioactive waste must provide barriers, natural and engineered, and institutional controls to limit the waste entering the environment. The aim is to demonstrate that, while these barriers and controls operate, the waste will not become available to the environment and to people at a level that will provide unacceptable doses. After that time, the waste should have decayed sufficiently such that there does not need to be a reliance on the engineered barriers and institutional controls to assure the ongoing limitation of radiation doses.

In Australia, the great volume of radioactive waste consists of materials with a low level of radioactivity or with a shorter half-life. These wastes are potentially able to be disposed of in a 'near surface' repository. Such a repository involves burial a few metres below ground and a number of barriers to restrict the movement of the radionuclides from the waste into the environment. The site chosen for the repository should support the goal of isolating the radioactive material from the environment for the necessary period.

A repository for radioactive waste that contains materials having higher levels of radioactivity and/or with a longer half-life is generally regarded as needing to be constructed at a much greater depth in the earth. This is because the time that the waste needs to be isolated is much greater than for waste suitable for a near surface repository. The time is beyond the period for which institutional control can be sensibly planned for and the barriers offered by the engineered barriers and the geology must be accordingly greater. Such 'geological' repositories require extended planning and investment. In the meantime, the waste needs to be stored for a significant period in a way that effectively protects it and segregates it from the environment.

Radioactive waste management facilities also involve people being occupationally exposed to radiation during their operation and the potential of the public being exposed arising from operations. In this regard, they are regulated in the same way as any other radiation practice, such as a hospital using radioactive sources for diagnosis or treatment.

Australia needs to deal with both forms of radioactive waste – that suitable for a near-surface repository and lesser volumes needing medium-term storage, pending development of a geological repository (or similar solution). Following announcements by the Australian Government, the Australian Radiation Protection and Nuclear Safety Agency is expecting applications for radioactive waste management facilities. This Regulatory Guidance has been prepared to advise the potential applicant and the public of the issues that will have to be addressed by ARPANSA assessors of these applications.

The Guidance describes the degree of protection for human health and the environment that radioactive waste management facilities need to achieve, drawing upon international best practice in relation to radiation protection and nuclear safety. I may only make a positive decision to issue a licence authorising an applicant to carry out a 'conduct' related to such facilities if an applicant demonstrates that the proposed facility will meet this level of protection. They do this by carrying out and presenting a safety assessment 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 safety barriers, and the arrangements for its construction and operation.

This Regulatory Guidance has been finalised after consideration of many comments made by the public, community groups, government agencies, and the Government of the Northern Territory on draft Regulatory Guidance issued in December 2005. I thank all the people and organisations who submitted comments on the draft.

John Loy PSM
CEO of ARPANSA
December 2006

1 INTRODUCTION

1.1 Scope

This Guidance applies to applications made under the *Australian Radiation Protection and Nuclear Safety Act 1998* (the ARPANS Act) for a licence to prepare a site for, to construct or to operate radioactive waste management facilities, being:

- a radioactive waste disposal facility (near surface)
- a radioactive waste store.

The Guidance is intended to assist applicants in preparing the information that should be provided in any application to prepare a site for, or construct or to operate such facilities. The ARPANS Act identifies these ‘conducts’ separately and each requires an application and a decision to authorise the conduct by the CEO of ARPANSA.

It has been suggested as being international best practice¹ that proposals for significant radioactive waste management facilities are developed on a step-by-step basis and that therefore licensing applications are normally expected to follow a step-wise approach, with ongoing development and analysis of the proposed facility following each licensing stage. It would be expected that more detailed information would be supplied as a facility was developed through the licensing stages.

It is, however, a matter for the applicant to determine whether it believes that it has sufficient information to support simultaneous applications for more than one conduct. The combined application would, however, have to include all relevant information that supported each conduct proposed to be authorised – prepare a site for, construct, operate.

This Guidance is directed at radioactive waste management facilities that have an inventory of radionuclides that would require the facility to be characterised as a nuclear installation under section 13 of the ARPANS Act and Regulations 7 and 8 of the *Australian Radiation Protection and Nuclear Safety Regulations 1999* (ARPANS Regulations). Aspects of the Guidance may be applicable to smaller radioactive waste management facilities that would be defined as prescribed radiation facilities under the ARPANS Act.

The Guidance does not deal with transport of radioactive waste to/from the facilities, except to the extent that transport requirements affect acceptance criteria for waste.

The Guidance is not exhaustive and should not be interpreted as excluding from consideration other matters of significance that may be relevant or that emerge as important factors during the course of preparation and assessment of the application.

¹ ‘An International Peer Review of the Licence Application for the Australian Near Surface Radioactive Waste Disposal Facility’, IAEA 2004, Recommendation para 311

Nor will compliance with all aspects of this Guidance result in an automatic entitlement to the licence which is the subject of the application.

The applicant needs to address all relevant requirements of the legislation. A guide to the sections of the ARPANS Act and Regulations currently in force that are considered relevant to this guidance is at Annex A.

1.2 General Guidance

The application should contain or make reference to sufficient information from any studies or investigations undertaken to enable the safety case to be understood by ARPANSA assessors and members of the public by reference to the application alone.

ARPANSA recognises that there may be a need to make use of material that is considered to be of a confidential nature, for instance information of a commercial nature or subject to claims of public interest immunity, especially on security grounds. The applicant may request that such information not be included in any publicly available document. ARPANSA would generally take the view that, subject to national security considerations, all relevant information would be available to the State/Territory Government where the facility is located.

The application should enable interested stakeholders to understand the safety case relating to the choice of the site, the proposed development and the operation of the radioactive waste management facility, having regard to international best practice in relation to radiation protection and nuclear safety.

Any and all unknown variables or assumptions made in the application should be clearly stated and discussed. The extent to which the limitations, if any, of available information may influence the conclusions of the application should be discussed.

It is envisaged that the application will be based on:

- international best practice in radiation protection and nuclear safety in every relevant aspect
- the results of available research
- studies and data as appropriate.

1.3 Content of the Application

The application for a licence to prepare the site, or construct or to operate the radioactive waste management facility needs to comprise as a minimum:

- the *General Information* referred to in Part 1 of Schedule 3 of the ARPANS Regulations, being:

The applicant's full name, position and business address.

A description of the purpose of the facility that is to be authorised by the facility licence.

A detailed description of the controlled facility and the site for that facility.

Plans and arrangements describing how the applicant proposes to manage the controlled facility to ensure the health and safety of people, and the protection of the environment including the following information:

- (a) the applicant's arrangements for maintaining effective control of the facility;
- (b) the safety management plan for the controlled facility;
- (c) the radiation protection plan for the controlled facility;
- (d) the radioactive waste management plan for the controlled facility;
- (e) the security plan for the controlled facility;
- (f) the emergency plan for the controlled facility.

- Other detailed technical information specifically required by the ARPANS Act, Regulations or this Guidance or otherwise relied on in the application. In particular, this includes a safety assessment as described in sections 2.2 and 3.2 of this Guidance.

There should also be a summary of the application, which should be written in a clear and concise manner so as to be readily understood by general readers.

This Guidance describes the desired content of an application for the various conducts of the two forms of facility. While the format of the application is a matter for the applicant, each of the elements needs to be addressed to meet the requirements of the ARPANS Act, the ARPANS Regulations and the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (see section 1.4). The application should be written so that any submissions made can be independently assessed. To this end, all sources need to be appropriately referenced.

The public will be invited to make submissions² on the application. The application will be the principal source of information on the facility from which interested individuals and groups may gain an understanding of what is proposed and the applicant's arguments for its safety.

² Regulation 40 of the ARPANS Regulations

1.4 The Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management

Australia has ratified this international convention and is bound by its articles. The CEO of ARPANSA has identified the Joint Convention as representing the high level statement of international best practice in relation to radiation protection and nuclear safety with regard to radioactive waste management.

The following articles of the Joint Convention are drawn to attention in this Regulatory Guidance³:

- Article 11 – General Safety Requirements
- Article 13 – Siting of Proposed Facilities
- Article 14 – Design and Construction of Facilities
- Article 15 – Assessment of Safety of Facilities
- Article 16 – Operation of Facilities
- Article 17 – Institutional Measures After Closure
- Article 22 – Human and Financial Resources
- Article 23 – Quality Assurance
- Article 24 – Operational Radiation Protection
- Article 25 – Emergency Preparedness
- Article 26 - Decommissioning
- Article 28 – Disused Sealed Sources

These articles are reproduced at Annex B. An application should address relevant requirements in each of these Articles.

³ Articles 2 and 3 are definitions of terms and the establishment of the scope of the Joint Convention. Articles 4 to 10 refer only to the safety of spent fuel management. Article 12 applies to existing facilities and past practices. Articles 18 to 21 refer to the regulatory framework, rather than regulatory guidance. Article 27 is about transboundary movement. The remaining articles are about meetings of the contracting parties and legal issues.

NEAR SURFACE DISPOSAL FACILITIES

In addition to the requirements of the ARPANS Act and Regulations, the Regulatory Guidance for near-surface radioactive waste disposal facilities draws from and is consistent with the IAEA Safety Requirements *Near Surface Disposal of Radioactive Waste* (WS-R-1, IAEA, 1999) (*Safety Requirements*). As international best practice in radiation protection and nuclear safety with regard to radioactive waste disposal has been developing since the *Safety Requirements* were published, this Guidance also takes into account the outcomes of the IAEA co-ordinated research project *Improvement of Safety Assessment Methodologies for Near Surface Disposal Facilities* (ISAM). It also draws upon, as necessary, the *Code of practice for the near-surface disposal of radioactive waste in Australia* (NHMRC, Radiation Health Series No 35, 1992). Other documents used in establishing the Guidance are referenced within it.

2.1 Requirements for the protection of human health and the environment

The Guidance establishes the required level of protection for human health and the environment that radioactive waste management facilities need to achieve. The applicant needs to demonstrate that the proposed facility will meet this level of protection by carrying out and presenting a safety assessment 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 safety barriers, and the arrangements for its construction and operation.

Paragraph 2.3 of the *Safety Requirements* states:

In the operational phase of a near surface repository, the requirements for the radiological protection and safety of workers at the repository and of members of the public are similar to those applicable to other operating facilities in which radioactive materials are being handled. However, since radioactive waste repositories will continue to present a potential hazard to human health in the future after closure, particular safety requirements are needed to protect future generations.

Operational phase;

During the time the repository is receiving and dealing with waste, the applicant must show that the design and operation of the near-surface disposal facility provides for the protection of workers and members of the public such that:

- radiation doses to the public and workers as a consequence of waste disposal activities do not exceed the dose limits established by Regulations 59 and 60 (Annex A)

- disposal 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 Regulation 58 (Annex A)
- 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 Regulation 58 (Annex A).

These are the same requirements as any facility using radioactive materials needs to meet.

The applicant should propose a dose constraint for workers and members of the public, below which protection will be optimised. It would be expected that the occupational dose constraint would not exceed 5 mSv per annum and the public dose constraint not exceed 0.3 mSv per annum.

Post Closure phase

The applicant should put forward arguments to demonstrate that the repository will achieve in the post closure phase a dose constraint on the doses likely to be received by a member of the public in normal circumstances of no more than 0.3 mSv per year (or the risk-based equivalent).

Achieving this dose constraint would mean that the public in the future is protected to the same degree as applies prior to the closure in normal circumstances. The arguments in support of the achievement of this dose constraint should be presented in the applications to prepare a site, to construct and to operate the repository. It would be expected that the discussion would become more detailed and based upon more complete knowledge in an application for the latter two conducts.

The applicant also needs to address scenarios involving possible accidental human intrusion into the repository post closure. If doses of greater than 100mSv per year to an individual are calculated to occur from a plausible human intrusion scenario, then the repository would need to be re-designed to limit further the possibility of human intrusion or to limit its consequences to well below that dose figure.

Where it is calculated that human intrusion could result in doses of between 10 and 100 mSv, then there needs to be further consideration and discussion of the scenario producing this result.

Protection of the Environment

The ARPANS Act requires that, in deciding whether to issue a licence, in addition to taking into account international best practice in relation to radiation protection and nuclear safety, the CEO must also take into account a number of matters set out in the ARPANS Regulations including:

- (b) whether the information establishes that the proposed conduct can be carried out without undue risk [-----] to the environment;*

Specifically with regard to protection of the environment from the effects of radiation, the applicant should undertake a screening assessment of doses to non-human biota in the vicinity of the repository using one of the internationally currently accepted screening tools. The assessment should demonstrate that the dose rate is below 1 mGy/d for animals and 10mGy/d for plants, these being the dose rates suggested by UNSCEAR where detrimental effects on the most sensitive populations would not be expected to occur. Should the screening tool indicate that these dose rates might be approached, then a more sensitive analysis would need to be carried out.

2.2 Safety assessment and compliance with safety requirements

An application for a licence to prepare a site for, or to construct or to operate a near surface waste repository must include a safety assessment of the repository. It is expected that the safety assessment will be more detailed and more based on the actual design and constructed repository as the project proceeds through these application stages. The safety assessment needs to be maintained and updated during the operational and post-closure phases of a repository, taking into account experience and monitoring results.

The safety assessment is the central means for the applicant to draw together the arguments that the proposed repository – its siting, waste acceptance criteria, its design including engineered and natural barriers, its construction and its arrangements for operation – will achieve the protection requirements of section 2.1. The safety assessment needs to address both the period where institutional controls are relied upon and the subsequent period without such controls. The detailed technical safety assessment should be accompanied by a summary that constitutes an overall drawing together of all the lines of argument that the applicant is relying upon to demonstrate confidence in the long-term safety of the facility.

The *Safety Requirements* state (para 3.1):

Before construction of any repository, the operator shall perform a comprehensive and systematic assessment of the safety of the planned repository throughout its operating lifetime and the period following closure. This safety assessment shall be reviewed by the regulatory body. The regulatory body shall not authorize operation of a near surface repository until it is satisfied, on the basis of the safety assessment and other information, that the operator has demonstrated with reasonable assurance that the safety criteria will be met.

Paras 3.3 and 3.4 of the *Safety Requirements* expand upon the description of a safety assessment:

Safety assessment is a procedure for evaluating the performance of a disposal system and, in particular, its potential radiological effects on human health and the environment. The safety assessment of near surface repositories involves consideration of effects both during operation and in the post-closure phase. Potential radiological impacts following closure of the repository may arise from gradual processes, such as degradation of barriers, and from

discrete events that could affect waste isolation. The potential for inadvertent human intrusion can be assumed to be negligible while active institutional controls are considered fully effective, but may increase afterwards. The acceptability of a repository will depend, among other factors, on the results of the safety assessments, which should provide a basis for giving reasonable assurance that the repository will meet the design objectives and safety criteria.

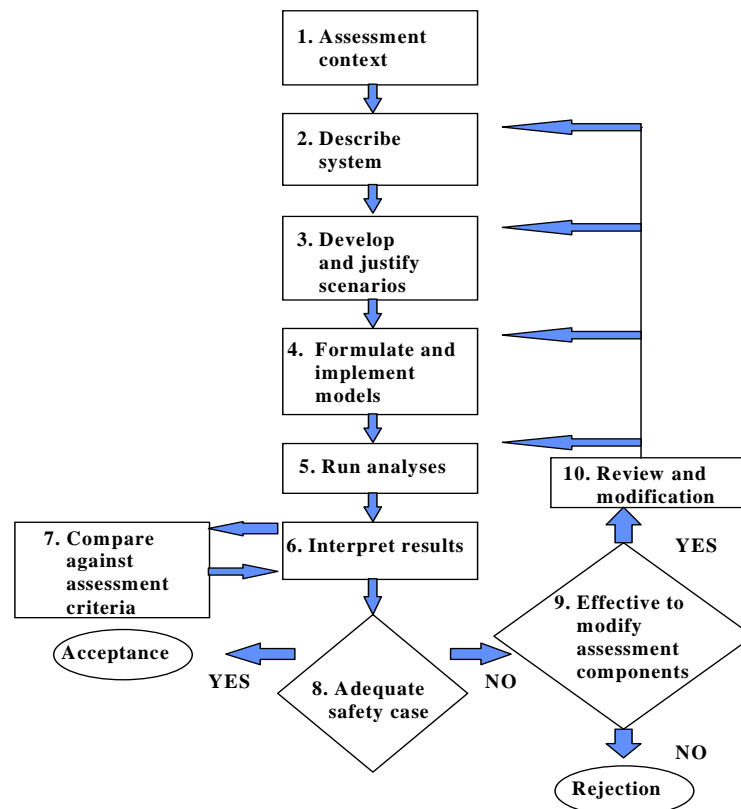
A safety assessment consists of:

- (a) an estimate of system performance for all the situations selected;
- (b) an evaluation of the level of confidence in the estimated performance;
- (c) an overall assessment of compliance with safety requirements.

Additional guidance is available in the IAEA Safety Guide: *Safety Assessment for Near Surface Disposal of Radioactive Waste* (WS-G-1.1, IAEA, 1999).

The applicant should describe its safety assessment methodology against internationally accepted approaches. One such approach is the ‘ISAM’ safety assessment methodology set out in the IAEA report *Safety Assessment Methodologies for Near Surface Disposal Facilities – Results of a co-ordinated research project* (IAEA, 2004).

A summary of the ISAM safety assessment methodology is represented by the following diagram.



2.3 Organisational and technical safety requirements

As noted in Section 1.3 above, an application for a licence to prepare a site for, to construct or to operate a near surface repository needs to include:

- (a) the applicant's arrangements for maintaining effective control of the repository
- (b) the safety management plan for the repository
- (c) the radiation protection plan for the repository
- (d) the radioactive waste management plan for the repository
- (e) the security plan for the repository
- (f) the emergency plan for the repository.

The applicant should describe the arrangements established between the operator of the repository and the waste generators directed at ensuring that the waste generators condition and prepare the waste consistent with the waste acceptance criteria that form the basis of the safety assessment of the repository. The information should include the arrangements for certification and documentation of the conditioning and preparation of the waste and the auditing of these processes.

In order to ensure that later generations have access to sufficient information about the repository to allow them to take any relevant decisions, the application shall propose a record keeping system that stores at least the following information about the repository:

- Physical and chemical form of waste and packaging
- Radionuclide, activity and activity concentration in each package at a specified time
- Placement of packages in the repository

The advice of the National Archives of Australia or other appropriately qualified body shall be sought in relation to data storage media and searching software to confirm that the method of record keeping proposed is likely to be fully effective over the institutional control period.

Further guidance on record keeping for radioactive waste management is available in the IAEA publications *Waste inventory record keeping systems (WIRKS) for the management and disposal of radioactive waste* (IAEA TECDOC 1222) and *Maintenance of records for radioactive waste disposal* (IAEA TECDOC 1097).

2.4 Waste acceptance requirements

The application must include waste acceptance criteria for the radioactive waste disposal facility. The proposed criteria should be derived from:

- the appropriate radiological criteria (section 2.1)
- the conditions of operation
- the planned duration of active institutional controls
- the required characteristics of natural and engineered systems.

On the basis of the safety assessment, the application should detail the limits that shall be proposed on radionuclide inventories and/or concentrations in individual waste packages and in the repository as a whole (*Safety Requirements* para 5.2).

The *Commonwealth Radioactive Waste Management Act 2005* effectively prohibits the Commonwealth radioactive waste management facility from dealing with high level radioactive material or spent fuel. The applicant should demonstrate that the proposed waste acceptance criteria exclude the handling of these materials.

Guidance on determining waste activity limits for near surface disposal facilities may be found in the IAEA publication *Derivation of activity limits for the disposal of radioactive waste in near surface disposal facilities* (IAEA TECDOC 1380).

External dose rates and surface contamination of the waste packages (or any overpack used during transport) must comply with the *Code of Practice on the Safe Transport of Radioactive Materials* (RPS2, ARPANSA, 2001)⁴ and with any other values derived in relation to the radiation protection of workers at the repository.

The application should specify the manner in which the type, characteristics and contents of radionuclides in the waste packages shall be determined, the accuracy needed to provide assurance of compliance with authorised limits, the basis for that level of accuracy and the method used to ensure that accuracy.

The application should also address the following considerations:

- the containment characteristics of the waste packages and surrounding barriers, considering any events that may be reasonably foreseen during the operation of the repository
- limitations on the chemical and biological material in a waste package so that any resulting chemical, biological or radiolytic process does not unacceptably impair the safety and containment characteristics of the waste package or surrounding barriers
- limitations on the quantity of free liquids in waste packages so that any moisture content is at levels that will not compromise the isolation of the radioactive waste in the repository

⁴ Regulation 62A(1) and (2)(c) of the ARPANS Regulations

- requirements for the combustibility, pyrophoricity and other properties of the waste packages so as to mitigate the potential impacts of fire and reduce the propagation of fire between waste packages
- compatibility of waste packages with handling, transport and emplacement equipment (as appropriate)
- compliance with the *Code of Practice on the Safe Transport of Radioactive Materials*
- a unique identifier to be marked on each package to be emplaced in the repository.

Disposal of materials that could present chemical or biological hazards must comply with applicable State and Commonwealth regulations. Their properties need to be taken into account in safety assessments.

2.5 Characteristics of an acceptable site

The characteristics of the site for the repository – along with the waste characteristics, the institutional controls and engineered barriers – are an important part of the safety assessment undertaken to demonstrate that the requirements for the protection of human health and the environment described in 2.1 above are met.

Consistent with Part 1 of Schedule 3 of the ARPANS Regulations, an application for a licence to authorise the preparation of a site for a near surface repository needs to include the *General Information* described in section 1.3 and:

- a detailed site evaluation establishing the suitability of the site
- information describing the characteristics of the site, including the extent to which the site may be affected by natural and man-made events.

The applicant needs to take the site characteristics into account in the safety assessment and the design of the repository. As more is learnt about the site, this needs to be taken into account in the development of the safety assessment.

In preparing the information required, the applicant should take into account the following matters described in the *Safety Requirements*:

The waste disposal system shall provide for the isolation of waste and the limitation of releases of radionuclides needed to ensure that the potential effects of waste disposal on humans and the environment are within acceptable limits and that the overall safety objective is met, with account taken of the waste characteristics, institutional controls, engineered barriers and natural barriers associated with the site.

The site characteristics shall be taken into account in the safety assessment and the repository design. In determining the site characteristics that are important to the assessment of the design and safety, the following shall be considered as a minimum: geology, hydrogeology, geochemistry, tectonics and seismicity, surface processes, meteorology, climate and the impact of human activities.

The selected site shall be located in an area that has geological characteristics conducive to satisfying the requirements of [Section 2.1 of this Guidance] and contributing to the stability of the disposal system.

[With regard to hydrogeology], favourable factors in selecting a site include those characteristics that restrict movement of radionuclides from the site to the accessible environment.

The repository shall be located so as to prevent unacceptable radioactive contamination of groundwater resources, taking into consideration the repository design and the present and likely future use of the resources.

The geochemical characteristics of groundwaters and geological media of the site shall be considered for their potential contribution to limiting migration of radionuclides from the repository. At the same time, they should not impair the longevity of engineered barriers.

The tectonics and seismicity of the site and, where appropriate, the region shall be such that significant tectonic processes and events such as faulting, seismic activity or volcanism are not expected to occur with an intensity that would compromise the necessary isolation capability of the repository.

The frequency and intensity of processes affecting the stability of land forms such as flooding, erosion, land sliding or weathering shall be such that they would not significantly affect the ability of the disposal system to isolate the radioactive waste.

The climate characteristics of the site, particularly precipitation and evaporation, and potential effects of expected extreme meteorological conditions shall be evaluated for their impact on repository design and water flow in the repository environment.

Consideration should be given to any effects due to possible climate change during the post-closure phase.

The disposal site shall be located such that activities that can be reasonably expected to take place at or near the site would not be likely to compromise the isolation capability of the repository. Consideration shall be given, in particular, to the resource and development potential of the site and its immediate surroundings.

Good access routes shall be constructed and maintained to allow transport of the waste to the site. Land use and ownership of land shall be considered in connection with foreseeable development and regional planning in the area of interest.

The ARPANS Regulations also require that disposal activities are in accordance with the *National Health and Medical Research Council Code of Practice for the Near*

Surface Disposal of Radioactive Waste (the “NHMRC Near Surface Disposal Code”)⁵. The site selection criteria in the NHMRC Code are:

- the facility site should be located in an area of low rainfall, should be free from flooding and have good surface drainage features, and generally be stable with respect to its geomorphology
- the water table in the area should be at a sufficient depth below the planned disposal structures to ensure that groundwater is unlikely to rise to within five metres of the waste, and the hydrogeological setting should be such that large fluctuations in the water table are unlikely
- the geological structure and hydrogeological conditions should permit modelling of groundwater gradients and movement, and enable prediction of radionuclide migration times and patterns
- the disposal site should be located away from any known or anticipated seismic, tectonic or volcanic activity which could compromise the stability of the disposal structures and the integrity of the waste
- the site should be in an area of low population density and in which the projected population growth or the prospects for future development are also very low
- the groundwater in the region of the site which may be affected by the presence of a facility should ideally not be suitable for human consumption, pastoral or agricultural use
- the site should have suitable geochemical and geotechnical properties to inhibit migration of radionuclides and to facilitate repository operations.

The Code goes on to say that other factors which shall also be considered are:

- the site for the facility should be located in a region which has no known significant natural resources, including potentially valuable mineral deposits, and which has little or no potential for agriculture or outdoor recreational use
- the site should have reasonable access for the transport of materials and equipment during construction and operation, and for the transport of waste into the site
- the site should not be in an area which has special environmental attraction or appeal, which is of notable ecological significance, or which is the known habitat of rare fauna or flora
- the site should not be located in an area which is of special cultural or historical significance

⁵ Regulation 48(3)(b) of the ARPANS Regulations

- the site should not be located in reserves containing regional services such as electricity, gas, oil or water mains
- the site should not be located in an area where land ownership rights or control could compromise retention of long-term control over the facility.

Consistent with the position that the site selection criteria are one part of an overall safety assessment, the NHMRC Code notes that:

A potential site may not necessarily comply with all of these criteria. However, there should be compensating factors in the design of the facility to overcome any deficiency in the physical characteristics of the site.

2.6 Design of disposal facilities

Applications for a licence to prepare a site for, to construct or to operate a near surface repository must describe the design of the facility.

The *Safety Requirements* (paras 7.1 and 7.2) set out the general requirements for the design of the repository:

The repository shall be designed to provide adequate isolation of disposed waste for the required period of time, with account taken of the waste characteristics, the characteristics of the site and the safety requirements applicable to the repository.

The design of the repository shall minimize the need for active maintenance after site closure and complement the natural characteristics of the site to reduce any environmental impact. The design shall take into account operational requirements, the closure plan and other factors contributing to waste isolation and stability of the repository, such as protection of the waste from external events.

In designing the repository, the applicant should have particular regard to the concept of defence in depth (consistent with the hazard posed by the waste) as being the overall strategy for achieving the safety objective⁶. The application should also describe how the repository meets the relevant requirements of the NHMRC Near Surface Disposal Code.

The applicant should consider the appropriate role of different engineered barriers as a part of the repository design. Engineered barriers include the waste package and other human made features such as vaults, covers, linings, grouts and backfills, which are intended to prevent or delay radionuclide migration from the repository to the surroundings.

⁶ The IAEA Fundamental Safety Principles (Principle 8) define defence in depth as the primary means of preventing and mitigating the consequence of accidents.

If the applicant wishes to include in the design means to allow for the retrieval of waste placed in the repository during the operating period or post-closure, it should be considered in the design phase of the project and be included in such a way so that it can be demonstrated that it will not compromise the long term performance capabilities of the repository. The ability to retrieve waste from the repository is not a requirement for approval of a licence to allow operation of a near surface repository.

The design of the repository shall allow for implementation of a monitoring program to verify the containment capability of the disposal system during operation and, as necessary, after closure of the repository. Arrangements for monitoring should not compromise the long term performance of the disposal system.

2.7 Construction

As defined in the *Safety Requirements*:

Construction of a near surface repository includes activities such as: site preparation, erection of buildings and structures, initial excavation and construction of trenches or waste disposal modules and drainage networks, excavation of rock cavities, underground building and installation of any monitoring systems.

Consistent with Part 1 of Schedule 3 of the ARPANS Regulations, an application for a licence to authorise the construction of a near surface repository needs to include the *General Information* described in section 1.3 and:

Authorisation to construct a controlled facility

- 8 The design of the controlled facility, including ways in which the design deals with the physical and environmental characteristics of the site.
- 9 Any fundamental difficulties that will need to be resolved before any future authorisation is given.
- 10 The construction plan and schedule.
- 11 A preliminary safety analysis report that demonstrates the adequacy of the design of the facility and identifies structure, components and systems that are safety related items⁷.
- 12 The arrangements for testing and commissioning safety related items.

The application should describe in detail the knowledge, skills and experience of the constructor of the repository.

⁷ The applicant should draw upon the guidance in section 2.2 in preparing the safety analysis report

Construction is likely to extend through the operational phase to provide additional disposal space for waste as it is received. If so, the applicant should confirm this is the case and should provide details of the provisions that have been made to preserve the integrity of the operational part of the repository. In addition the applicant should detail the relationship between the operator of the operational part of the repository and the operator of the further construction.

The part of construction that is safety related should be specified in the detailed design, with all appropriate specifications for materials, technologies and control methods.

2.8 Operation

The *Safety Requirements* state that *the operation of a near surface repository comprises commissioning, waste reception, waste emplacement, engineering and all associated tasks, which may include temporary storage or final conditioning of wastes.*

Consistent with Part 1 of Schedule 3 of the ARPANS Regulations, an application for a licence to authorise the operation of a near surface repository needs to include the *General Information* described in section 1.3 and:

Authorisation to operate a controlled facility

- 15 A description of the structures, components, systems and equipment of the controlled facility as they have been constructed.
- 16 A final safety analysis report that demonstrates the adequacy of the design of the controlled facility, and includes the results of commissioning tests⁸.
- 17 The operational limits and conditions of the controlled facility.
- 18 The arrangements for commissioning the controlled facility.
- 19 The arrangements for operating the controlled facility.

The most likely concept for the operation of a repository in Australia is that after an initial construction and operation phase, the repository is closed until subsequent campaigns of gathering and transporting waste and construction and operation of the repository take place. When this approach is proposed, the applicant needs to develop clear procedures for campaign closures as part of its set of operating procedures.

The application should describe in detail the knowledge, skills and experience of the operator for the initial operating campaign of the repository and the requirements that will be placed upon operators for subsequent campaigns.

⁸ The applicant should draw upon the guidance in section 2.2 in preparing the safety analysis report

With regard to the control of operation, the applicant should address the following matters as stated in the *Safety Requirements*:

The operator shall prepare a set of rules, incorporating limits and conditions, to ensure that the repository is operated safely in compliance with national regulations.

These rules shall reflect consideration of:

- (a) protection criteria for occupationally exposed workers and members of the public in normal operation and accidents;*
- (b) the limiting assumptions used in the safety assessment;*
- (c) regulatory requirements for operation.*

Operations shall be carried out in accordance with written procedures and instructions to ensure that identified limits and conditions for operations are observed. The operator shall ensure that these procedures and instructions are carefully and properly followed by the workers. This will ensure that appropriate attention is given to safety, especially during the modification of equipment or operating procedures.

The applicant needs to describe the system, including arrangements with waste generators or owners, to ensure that only those wastes that comply with the approved waste acceptance requirements are accepted for disposal. The system should include the actions to be taken in the event that waste is received at the repository that does not conform to the waste acceptance requirements. It should ensure that waste is emplaced in the repository in accordance with the established limits and conditions and with the operating procedures and instructions, and consistent with the design concept of the repository.

The applicant must describe the arrangements for the transport of radioactive waste to the repository to be consistent with the *Code of Practice for the Safe Transport of Radioactive Material (RPS 2)*.

The application should include arrangements for ensuring the provision and maintenance of monitoring to measure any radioactive releases during repository operation. This shall include appropriate emergency plans and arrangements for testing monitoring measurements at reasonable intervals.

In keeping with the *Safety Requirements* with respect to operating personnel, the applicant must provide a detailed plan for the operating staff at the repository. This plan shall:

- define and analyse tasks and activities to be performed for the safe operation of the repository
- implement an organizational structure
- clearly delineate the responsibilities and authorities of personnel
- identify the appropriate number of staff

- determine the necessary qualifications and experience of staff for posts at all relevant levels of the organization
- provide for the recruitment of personnel with adequate expertise
- ensure consistency in the standard of this expertise across the range of disciplines needed to operate the repository
- establish a training program to ensure that personnel involved at all levels of operation of the repository have the requisite competence. The training program shall:
 - identify the activities that are significant for safety
 - provide for the acquisition of the knowledge and practical experience needed for these activities and foster the development of a safety culture
 - be regularly updated to incorporate experience gained from analysing system performance, incidents encountered, the major modifications carried out and personnel performance.
 - allow for retraining to be carried out on a continuing basis during repository operation in order to minimize the potential for human error
 - be such that operational personnel have a high degree of awareness of the design features of the repository that are significant for safety.

2.9 Closure

The *Safety Requirements* define closure as *a systematic action that is conducted after the receipt of waste ceases and waste emplacement operations have been completed with the intention of providing a final configuration for the disposal system.*

A closure may be a ‘campaign closure’ – referring to the receipt of waste during a certain period and configuring the disposal system pending receipt of waste at a later time - or ‘final closure’ when no more waste will be received.

Closure is a part of facility operation and campaign closure plans should be included as a part of the overall operating procedures for the facility.

Before commencing any closure operations (campaign or final closure), the operator must set out a closure plan for approval by ARPANSA. The detailed closure plan shall include the following, drawn from the *Safety Requirements*:

an updated safety assessment based on available pertinent data indicating the safe post-closure performance of the repository. In particular, the closure plan shall describe any controls intended for the post-closure phase, including the radiological monitoring plan, the surveillance programme and the record keeping system, and shall identify the organization responsible for implementing these.

The closure method, including the materials and techniques to be used, and its expected performance shall be outlined in the closure plan. The closure method shall be optimized in the light of available materials and techniques, so as to enhance confidence in the safety assessment.

A campaign closure plan will address the above requirements to the extent required by the period of closure proposed.

ARPANSA will carry out an inspection of the repository after the closure activities have been finalised to confirm that the activities have been acceptably completed and that the closed repository is in a proper condition, that the appropriate documentation is available, and provision has been made for the post-closure controls.

The purpose of institutional controls post the final closure of the repository is to reduce the likelihood of human intrusion into the repository. The period of application of controls is an important parameter in the safety assessment of the repository. A period of application of the controls between 100 and 300 years after final closure is to be proposed by the applicant and taken into account in the safety assessment.

Controls are also required to be implemented in the intervals between campaigns of operation of the repository. The applicant also needs to address the scope and application of the institutional controls to apply between campaigns to ensure that the likelihood of human intrusion is very low.

2.10 Quality Assurance

As stated in the *Safety Requirements*:

A comprehensive quality assurance programme shall be applied to all safety related activities, structures, systems and components of the disposal system. This includes all related activities, from planning through siting, design, construction, operation, the various steps in the safety assessment process, closure, long term record keeping and institutional control activities associated with the repository. This will help to provide assurance that the relevant safety requirements and criteria are met.

The elements of the quality assurance programme shall take account of the potential effects of activities, structures, systems and components on the safety of the repository and shall be designed accordingly. Activities, structures, systems and components important to safe operation and disposal shall be identified on the basis of results of a systematic safety assessment of the operational and post-closure phases of the repository.

An application for a licence to prepare a site, to construct or to operate a near surface repository needs to include a quality assurance programme in keeping with the *Safety Requirements* and consistent with the stage of the project. The quality assurance program should take into account that the safety of the repository depends on both activities undertaken by the repository operator and activities undertaken by the waste generators or waste owners.

RADIOACTIVE WASTE STORES

The storage of radioactive waste is an inevitable stage in the pre-disposal management of radioactive waste. However, this Guidance refers to storage as the placement of radioactive waste in a specific facility where appropriate isolation and monitoring are provided and designed to last for a period of at least tens of years. This Guidance is directed towards stores with an anticipated duration of storage of 50-100 years.

This Guidance has been framed to assist in the assessment under the ARPANS Act of any application for a long term purpose-built radioactive waste store that would constitute a nuclear installation and that would be accepting waste from various waste producing entities. The Guidance may be applied in a graded approach to the assessment of stores that constitute prescribed radiation facilities and that address the shorter-term storage needs of particular Commonwealth entities.

The Guidance for radioactive waste stores draws from and is consistent with the IAEA Safety Requirements *Predisposal Management of Radioactive Waste, Including Decommissioning* (WS-R-2, IAEA, 2000), the IAEA Safety Guide *Storage of Radioactive Waste* (WS-G-6.1, IAEA, to be published) (*the Safety Guide*) and sections of the IAEA Safety Guide *Management of Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education* (WS-G-2.7, IAEA, 2005).

3.1 Requirements for the protection of human health and the environment

The Guidance establishes the required level of protection for human health and the environment that radioactive waste management facilities need to achieve. The applicant needs to demonstrate that the proposed facility will meet this level of protection by carrying out and presenting a safety assessment 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 safety barriers, and the arrangements for its construction and operation.

Consistent with the *Safety Guide*:

The design and operation of waste storage facilities are required to provide for the protection of workers and members of the public and the protection of the environment in accordance with the requirements and principles of [the IAEA Basic Safety Standards - BSS] such that:

- (a) Radiation doses to the public and workers as a consequence of waste storage activities do not exceed the relevant limits established in the BSS;*
- (b) Storage facilities are designed and operated in such a way that radiation protection of workers and members of the public is optimized according to the principles described in the BSS;*

- (c) *The consequences of any reasonably foreseeable fault or accident condition should be such that protective actions are optimized according to the principles described in the BSS.*

The applicant must show that the design and operation of the radioactive waste store provides for the protection of workers and members of the public such that:

- radiation doses to the public and workers as a consequence of waste storage do not exceed the dose limits established by Regulations 59 and 60 (Annex A)
- storage 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 Regulation 58 (Annex A)
- 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 Regulation 58 (Annex A).

These are the same requirements as any facility using radioactive materials must meet.

The applicant should propose a dose constraint for workers and members of the public, below which protection will be optimised. It would be expected that the occupational dose constraint would not exceed 5 mSv per annum and the public dose constraint not exceed 0.3 mSv per annum.

Protection of the Environment

The ARPANS Act requires that, in deciding whether to issue a licence, in addition to taking into account international best practice in relation to radiation protection and nuclear safety, the CEO must also take into account a number of matters set out in the ARPANS Regulations including:

- (b) *whether the information establishes that the proposed conduct can be carried out without undue risk [-----] to the environment;*

With respect to any anticipated, significant discharges to the environment from the operation of a radioactive waste store, pending further developments in international guidance in this area, the applicant should undertake a screening assessment of doses to non-human biota in the vicinity of the store using one of the internationally currently accepted screening tools. The assessment should demonstrate that the dose rate is below 1 mGy/d for animals and 10mGy/d for plants, these being the dose rates suggested by UNSCEAR where detrimental effects on the most sensitive populations would not be expected to occur. Should the screening tool indicate that these dose rates might be approached, then a more sensitive analysis would need to be carried out.

3.2 Safety assessment and compliance with safety requirements

An application for a licence to prepare a site for, to construct or to operate a long term radioactive waste store must include a safety assessment of the store as a part of the

application. It is expected that the safety assessment will become more detailed and more based on the actual design and constructed store as the project proceeds through these application stages. The safety assessment needs to be maintained and updated during the operation of the store, taking into account experience and monitoring results.

The safety assessment is the central means for the applicant to draw together the arguments that the proposed store – its siting, waste acceptance criteria, its design including engineered and natural barriers, its construction and its arrangements for operation – will achieve the protection requirements of section 3.1. The detailed technical safety assessment should be accompanied by a summary that constitutes an overall drawing together of all the lines of argument that the applicant is relying upon to demonstrate confidence in the safety of the facility.

Consistent with the *Safety Guide* (para 4.2), the applicant should describe the extent to which the radioactive waste will be stored according to principles of passive safety, which include (taking into account the design life of the store):

- (a) the radioactivity should be immobile
- (b) the waste form and its container should be physically and chemically stable
- (c) energy should be removed from the waste form, where required
- (d) a multibarrier approach should be adopted in ensuring containment
- (e) the waste form and its container should be resistant to degradation
- (f) the storage environment should optimize waste package lifetime
- (g) the need for active safety systems to ensure safety should be minimized
- (h) the need for monitoring and maintenance to assure safety should be minimized
- (i) the need for human intervention to assure safety should be minimized
- (j) the storage building should be resistant to foreseeable hazards
- (k) access should be provided for response to incidents
- (l) there should be no need for prompt remedial action
- (m) the waste packages should be able to be inspected
- (n) the waste packages should be retrievable for inspection or reworking
- (o) the lifetime of the storage building should be appropriate for the storage period prior to disposal
- (p) the storage facility should enable retrieval of wastes
- (q) the waste package should be acceptable for final disposal or at least not preclude future disposal options.

Consistent with the *Safety Guide* (Annex A), the safety assessment should be based upon site-specific data and include:

- (a) a system description (including an estimate for maximum inventory of radioactive materials)
- (b) the systematic identification of conditions, processes, and events associated with normal and abnormal conditions and external events (e.g., fire, handling accidents that involve breach of waste containers)
- (c) hazard evaluation through screening of combinations of conditions, processes, and events that may result in the release of radioactivity from

- the waste storage facility to eliminate those of insufficient likelihood or consequence from further consideration
- (d) risk calculation through assessment of the probability and consequences of the release(s) of radioactivity identified by the hazard evaluation with quantitative analysis and comparison with the limits in the ARPANS Regulations
 - (e) establishment of limits, conditions and controls based on the safety analysis
 - (f) documentation of the safety assessment.

The safety assessment should identify the key drivers of risk so that limiting safety systems can be identified and a level of confidence in the parameters supporting the safety analysis can be determined commensurate with their significance.

The safety analysis should include an assessment of risk during normal operations, abnormal operations, under external event conditions, and provide an assessment of site boundary doses and potential exposures at areas where there is unrestricted access.

3.3 Organisational and technical safety requirements

As noted in Section 1.3 above, an application for a licence to prepare a site for, to construct or to operate a long term radioactive waste store needs to include:

- (a) the applicant's arrangements for maintaining effective control of the store
- (b) the safety management plan for the store
- (c) the radiation protection plan for the store
- (d) the radioactive waste management plan for the store
- (e) the security plan for the store
- (f) the emergency plan for the store.

The application needs to describe the arrangements established between the operator of the store and the waste generators directed at ensuring that the waste generators condition and prepare the waste consistent with the waste acceptance criteria that form the basis of the safety assessment of the store. The information needs to include the arrangements for certification and documentation of the conditioning and preparation of the waste and the auditing of these processes.

The applicant needs to propose and have approved a record keeping system that maintains at least the following information about the store:

- physical and chemical form of waste and packaging
- radionuclide, activity and activity concentration in each package at a specified time
- placement of packages in the store.

3.4 Waste acceptance requirements

The application must include the waste acceptance criteria for the store, taking into account all relevant operational limits.

The *Commonwealth Radioactive Waste Management Act 2005* effectively prohibits the Commonwealth radioactive waste management facility from dealing with high level radioactive material or spent fuel. The applicant should demonstrate that the proposed waste acceptance criteria exclude the handling of these materials.

The wastes are to be in a packaging form that is retrievable at the end of the storage period. The application should demonstrate that the design life of the packages exceeds the design life of the radioactive waste store or should describe the broad arrangements envisaged for re-packaging the waste at the end of the life of the packages.

The application should describe how, within a quality assurance system, waste packages are to be checked for leakage, surface contamination, and to ensure that they are consistent with the documentation.

The application should show how any special properties that may apply to the radioactive waste are taken into account in the design of containers and/or stores.⁹

The application should take into account the following relevant parts of the *Safety Guide*:

6.14. The requirements for the performance of the container, in the event of incidents and accidents, should be defined to ensure the protection of workers and the public.

6.15. The design of storage containers should take into account the storage environment (e.g., range of ambient temperature and humidity). As appropriate, containers should be sufficiently resistant to corrosion over the storage duration. Placement of storage containers on surfaces where condensation cycles can develop, for example, should be avoided.

6.16. For certain types of waste (particularly corrosive liquid waste), special precautions such as double walled containers and/or lining of the storage room with stainless steel or other corrosion resistant material may be necessary. Also, liquid waste may need a collection and recovery system below containers (secondary containment) with provision for monitoring of any leakage. In keeping with passive safety principles, liquid wastes should be converted to solids as early as practical.

6.17. Consideration should be given to the dynamic and static loads resulting from handling and stacking of the waste packages. The wall thickness of the containers, their filled weight and the stacking orientation should be taken into account at the design stage.

6.18. Some waste may have the potential for generating airborne radionuclides within the container; many storage containers will vent

⁹ *Safety Guide* Para 6.12

naturally but some may require a purpose built vent. The need for package venting should be considered as part of the safety assessment.

6.19. The design of waste storage containers should facilitate monitoring in order to allow early detection of any failure of the containment, as appropriate (e.g., for gases, liquids).

6.20. Liquid waste may contain suspended solids which could settle on the bottom of a container (e.g., tank waste) or may contain substances that could precipitate out of solution. For such wastes, solids should be kept suspended by means of a mixing device such as a mechanical stirrer, a pneumatic mixer or a circulation pump. Sluicers may need to be part of the design in order to facilitate the removal of waste that may have precipitated on the interior surfaces of a tank. Additional internal hardware should be minimized to limit obstructions.

In considering waste acceptance criteria, the applicant should also demonstrate that it has considered possible final disposal options for the waste packages and avoided precluding any disposal options that are likely to be considered.

3.5 Characteristics of an acceptable site

The characteristics of the site for the store – along with the waste characteristics, the institutional controls and engineered barriers – are an important part of the safety assessment undertaken to demonstrate that the requirements for the protection of human health and the environment described in section 3.1 above are met.

Consistent with Part 1 of Schedule 3 of the ARPANS Regulations, an application for a licence to authorise the preparation of a site for a radioactive waste store needs to include the *General Information* described in section 1.3 and:

- a detailed site evaluation establishing the suitability of the site
- information describing the characteristics of the site, including the extent to which the site may be affected by natural and man-made events.

The applicant needs to take the site characteristics into account in the safety assessment and the design of the store. As more is learnt about the site, this needs to be taken into account in the development of the safety assessment.

The following site evaluation criteria should be addressed in the application:

Earthquakes and surface faulting

The seismological and geological conditions in the region and the engineering geological aspects and geotechnical aspects of the proposed site area should be evaluated. Information on prehistorical, historical and instrumentally recorded earthquakes in the region should be collected and documented.

Hazards due to earthquake induced ground motion should be assessed for the site with account taken of the seismotectonic characteristics of the region and specific site

conditions. A thorough uncertainty analysis should be performed as part of the evaluation of seismic hazards.

The potential for surface faulting (i.e. the fault capability) should be assessed for the site. If reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the store, an alternative site should be considered.

Extreme meteorological events and flooding

The potential for extreme wind events such as tropical cyclones should be evaluated along with extreme levels of temperature and precipitation.

The likelihood of flooding affecting the store during its design life should be evaluated and should be extremely low.

Geotechnical hazards

The site and its vicinity should be evaluated to determine the potential for slope instability that could affect the safety of the store over a period greater than its designed life.

Any potential for collapse, subsidence or uplift of the site surface should be evaluated. There should not be any significant potential for such occurrences during the designed life of the store.

The potential for liquefaction of the subsurface materials of the proposed site should be evaluated by using parameters and values for the site specific ground motion. The geotechnical characteristics of the subsurface materials, including the uncertainties in them, shall be investigated and a soil profile for the site in a form suitable for design purposes shall be determined.

The stability of the foundation material under static and seismic loading should be assessed. The groundwater regime and the chemical properties of the groundwater shall be studied.

Aircraft crashes

The potential for aircraft crashes on the site should be assessed with account taken, to the extent practicable, of characteristics of future air traffic and aircraft. If the assessment shows that there is a potential for an aircraft crash on the site that could affect the safety of the store, then an assessment of the hazards should be made. The hazards associated with an aircraft crash to be considered should include impact, fire and explosions.

Installations that may give rise to missiles of any type that could affect the safety of the store should be evaluated.

Chemical explosions

Activities in the region that involve the handling, processing, transport and storage of chemicals having a potential for explosions or for the production of gas clouds capable of deflagration or detonation should be identified. Hazards associated with chemical explosions should be expressed in terms of overpressure and toxicity (if applicable), with account taken of the effect of distance.

