

IAEA Safety Standards

for protecting people and the environment

Near Surface Disposal Facilities for Radioactive Waste

Specific Safety Guide

No. SSG-29



IAEA

International Atomic Energy Agency



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IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

The publications by means of which the IAEA establishes standards are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety. The publication categories in the series are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides**.

Information on the IAEA's safety standards programme is available on the IAEA Internet site

<http://www-ns.iaea.org/standards/>

The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at: Vienna International Centre, PO Box 100, 1400 Vienna, Austria.

All users of IAEA safety standards are invited to inform the IAEA of experience in their use (e.g. as a basis for national regulations, for safety reviews and for training courses) for the purpose of ensuring that they continue to meet users' needs. Information may be provided via the IAEA Internet site or by post, as above, or by email to Official.Mail@iaea.org.

RELATED PUBLICATIONS

The IAEA provides for the application of the standards and, under the terms of Articles III and VIII.C of its Statute, makes available and fosters the exchange of information relating to peaceful nuclear activities and serves as an intermediary among its Member States for this purpose.

Reports on safety in nuclear activities are issued as **Safety Reports**, which provide practical examples and detailed methods that can be used in support of the safety standards.

Other safety related IAEA publications are issued as **Emergency Preparedness and Response** publications, **Radiological Assessment Reports**, the International Nuclear Safety Group's **INSAG Reports**, **Technical Reports** and **TECDOCs**. The IAEA also issues reports on radiological accidents, training manuals and practical manuals, and other special safety related publications.

Security related publications are issued in the **IAEA Nuclear Security Series**.

The **IAEA Nuclear Energy Series** comprises informational publications to encourage and assist research on, and the development and practical application of, nuclear energy for peaceful purposes. It includes reports and guides on the status of and advances in technology, and on experience, good practices and practical examples in the areas of nuclear power, the nuclear fuel cycle, radioactive waste management and decommissioning.

NEAR SURFACE
DISPOSAL FACILITIES FOR
RADIOACTIVE WASTE



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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

IAEA SAFETY STANDARDS SERIES No. SSG-29

NEAR SURFACE DISPOSAL FACILITIES FOR RADIOACTIVE WASTE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2014

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FOREWORD

by Yukiya Amano
Director General

The IAEA's Statute authorizes the Agency to “establish or adopt... standards of safety for protection of health and minimization of danger to life and property” — standards that the IAEA must use in its own operations, and which States can apply by means of their regulatory provisions for nuclear and radiation safety. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned. A comprehensive set of high quality standards under regular review is a key element of a stable and sustainable global safety regime, as is the IAEA's assistance in their application.

The IAEA commenced its safety standards programme in 1958. The emphasis placed on quality, fitness for purpose and continuous improvement has led to the widespread use of the IAEA standards throughout the world. The Safety Standards Series now includes unified Fundamental Safety Principles, which represent an international consensus on what must constitute a high level of protection and safety. With the strong support of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its standards.

Standards are only effective if they are properly applied in practice. The IAEA's safety services encompass design, siting and engineering safety, operational safety, radiation safety, safe transport of radioactive material and safe management of radioactive waste, as well as governmental organization, regulatory matters and safety culture in organizations. These safety services assist Member States in the application of the standards and enable valuable experience and insights to be shared.

Regulating safety is a national responsibility, and many States have decided to adopt the IAEA's standards for use in their national regulations. For parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by regulatory bodies and operators around the world to enhance safety in nuclear power generation and in nuclear applications in medicine, industry, agriculture and research.

Safety is not an end in itself but a prerequisite for the purpose of the protection of people in all States and of the environment — now and in the future. The risks associated with ionizing radiation must be assessed and controlled without unduly limiting the contribution of nuclear energy to equitable and sustainable development. Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used beneficially, safely and ethically. The IAEA safety standards are designed to facilitate this, and I encourage all Member States to make use of them.

NOTE BY THE SECRETARIAT

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. The process of developing, reviewing and establishing the IAEA standards involves the IAEA Secretariat and all Member States, many of which are represented on the four IAEA safety standards committees and the IAEA Commission on Safety Standards.

The IAEA standards, as a key element of the global safety regime, are kept under regular review by the Secretariat, the safety standards committees and the Commission on Safety Standards. The Secretariat gathers information on experience in the application of the IAEA standards and information gained from the follow-up of events for the purpose of ensuring that the standards continue to meet users' needs. The present publication reflects feedback and experience accumulated until 2010 and it has been subject to the rigorous review process for standards.

Lessons that may be learned from studying the accident at the Fukushima Daiichi nuclear power plant in Japan following the disastrous earthquake and tsunami of 11 March 2011 will be reflected in this IAEA safety standard as revised and issued in the future.

THE IAEA SAFETY STANDARDS

BACKGROUND

Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in medicine, industry and agriculture. The radiation risks to workers and the public and to the environment that may arise from these applications have to be assessed and, if necessary, controlled.

Activities such as the medical uses of radiation, the operation of nuclear installations, the production, transport and use of radioactive material, and the management of radioactive waste must therefore be subject to standards of safety.

Regulating safety is a national responsibility. However, radiation risks may transcend national borders, and international cooperation serves to promote and enhance safety globally by exchanging experience and by improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate any harmful consequences.

States have an obligation of diligence and duty of care, and are expected to fulfil their national and international undertakings and obligations.

International safety standards provide support for States in meeting their obligations under general principles of international law, such as those relating to environmental protection. International safety standards also promote and assure confidence in safety and facilitate international commerce and trade.

A global nuclear safety regime is in place and is being continuously improved. IAEA safety standards, which support the implementation of binding international instruments and national safety infrastructures, are a cornerstone of this global regime. The IAEA safety standards constitute a useful tool for contracting parties to assess their performance under these international conventions.

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property, and to provide for their application.

With a view to ensuring the protection of people and the environment from harmful effects of ionizing radiation, the IAEA safety standards establish fundamental safety principles, requirements and measures to control the radiation exposure of people and the release of radioactive material to the environment, to restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation, and to mitigate the consequences of such events if they were to occur. The standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

Safety measures and security measures¹ have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. They are issued in the IAEA Safety Standards Series, which has three categories (see Fig. 1).

Safety Fundamentals

Safety Fundamentals present the fundamental safety objective and principles of protection and safety, and provide the basis for the safety requirements.

Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered ‘overarching’ requirements, are expressed as ‘shall’ statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

¹ See also publications issued in the IAEA Nuclear Security Series.

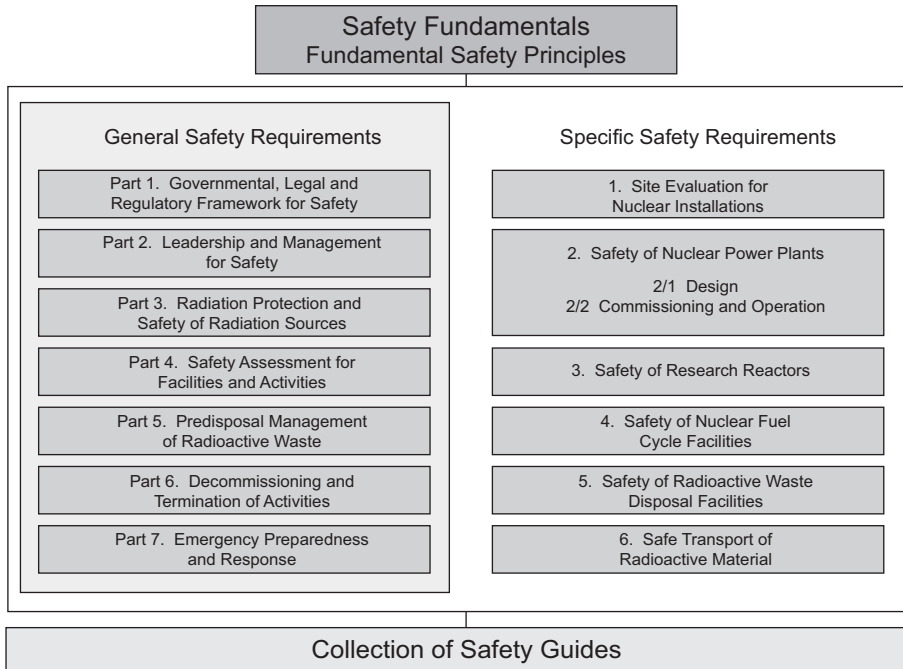


FIG. 1. The long term structure of the IAEA Safety Standards Series.

Safety Guides

Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as ‘should’ statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

The principal users of safety standards in IAEA Member States are regulatory bodies and other relevant national authorities. The IAEA safety standards are also used by co-sponsoring organizations and by many organizations that design, construct and operate nuclear facilities, as well as organizations involved in the use of radiation and radioactive sources.

The IAEA safety standards are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes and to protective actions to reduce existing radiation risks. They can be used by States as a reference for their national regulations in respect of facilities and activities.

The IAEA's Statute makes the safety standards binding on the IAEA in relation to its own operations and also on States in relation to IAEA assisted operations.

The IAEA safety standards also form the basis for the IAEA's safety review services, and they are used by the IAEA in support of competence building, including the development of educational curricula and training courses.

International conventions contain requirements similar to those in the IAEA safety standards and make them binding on contracting parties. The IAEA safety standards, supplemented by international conventions, industry standards and detailed national requirements, establish a consistent basis for protecting people and the environment. There will also be some special aspects of safety that need to be assessed at the national level. For example, many of the IAEA safety standards, in particular those addressing aspects of safety in planning or design, are intended to apply primarily to new facilities and activities. The requirements established in the IAEA safety standards might not be fully met at some existing facilities that were built to earlier standards. The way in which IAEA safety standards are to be applied to such facilities is a decision for individual States.

The scientific considerations underlying the IAEA safety standards provide an objective basis for decisions concerning safety; however, decision makers must also make informed judgements and must determine how best to balance the benefits of an action or an activity against the associated radiation risks and any other detrimental impacts to which it gives rise.

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

The preparation and review of the safety standards involves the IAEA Secretariat and four safety standards committees, for nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), and a Commission on Safety Standards (CSS) which oversees the IAEA safety standards programme (see Fig. 2).

All IAEA Member States may nominate experts for the safety standards committees and may provide comments on draft standards. The membership of the Commission on Safety Standards is appointed by the Director General and

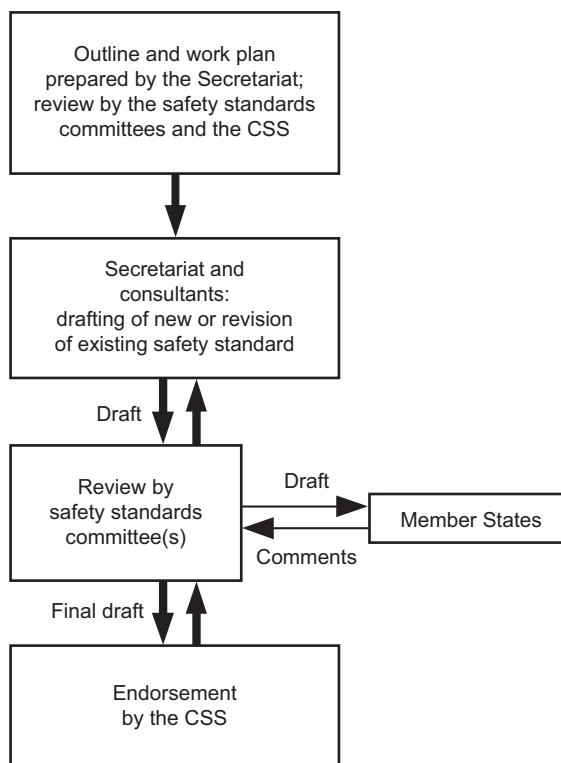


FIG. 2. The process for developing a new safety standard or revising an existing standard.

includes senior governmental officials having responsibility for establishing national standards.

A management system has been established for the processes of planning, developing, reviewing, revising and establishing the IAEA safety standards. It articulates the mandate of the IAEA, the vision for the future application of the safety standards, policies and strategies, and corresponding functions and responsibilities.

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

The findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the recommendations of international expert bodies, notably the International Commission on Radiological Protection (ICRP), are taken into account in developing the IAEA safety standards. Some

safety standards are developed in cooperation with other bodies in the United Nations system or other specialized agencies, including the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization and the World Health Organization.

INTERPRETATION OF THE TEXT

Safety related terms are to be understood as defined in the IAEA Safety Glossary (see <http://www-ns.iaea.org/standards/safety-glossary.htm>). Otherwise, words are used with the spellings and meanings assigned to them in the latest edition of The Concise Oxford Dictionary. For Safety Guides, the English version of the text is the authoritative version.

The background and context of each standard in the IAEA Safety Standards Series and its objective, scope and structure are explained in Section 1, Introduction, of each publication.

Material for which there is no appropriate place in the body text (e.g. material that is subsidiary to or separate from the body text, is included in support of statements in the body text, or describes methods of calculation, procedures or limits and conditions) may be presented in appendices or annexes.

An appendix, if included, is considered to form an integral part of the safety standard. Material in an appendix has the same status as the body text, and the IAEA assumes authorship of it. Annexes and footnotes to the main text, if included, are used to provide practical examples or additional information or explanation. Annexes and footnotes are not integral parts of the main text. Annex material published by the IAEA is not necessarily issued under its authorship; material under other authorship may be presented in annexes to the safety standards. Extraneous material presented in annexes is excerpted and adapted as necessary to be generally useful.

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1. INTRODUCTION

BACKGROUND

1.1. Radioactive waste is radioactive material in gaseous, liquid or solid form for which no further use is foreseen. It contains, or is contaminated with, radionuclides at concentrations or activities greater than the clearance levels as established by the regulatory body. Radioactive waste arises from the operation of nuclear power plants and research reactors, from nuclear fuel cycle operations and from other activities (including activities in industry, research and medicine) in which radioactive material is used. Radioactive waste presents a potential hazard to human health and the environment, and it must be managed so as to ensure that any associated risks do not exceed acceptable levels.

1.2. The safety principles to be applied in all radioactive waste management activities are established in IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1]. These principles form the technical basis for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [2]. The relevant requirements for radiation protection are set out in IAEA Safety Standards Series No. GSR Part 3 (Interim), Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (Interim Edition) [3]. The safety requirements for the disposal of radioactive waste, together with the safety objective and criteria for radiation protection in the post-closure period, are established in IAEA Safety Standards Series No. SSR-5, Disposal of Radioactive Waste [4]. The safety objective and criteria are replicated in Box 1.

1.3. As indicated in para. 1.8 of SSR-5 [4], the “term ‘disposal’ refers to the emplacement of radioactive waste into a facility or a location with no intention of retrieving the waste The term disposal implies that retrieval is not intended; it does not mean that retrieval is not possible.” A disposal facility is designed to contain the waste and to isolate it from the accessible environment to the extent demanded by the hazard of the waste. Although the radiological hazard presented by radioactive waste will reduce with time because of radioactive decay, the timescales over which the hazard remains significant can extend over many generations, depending on the radionuclides involved. The emphasis in radioactive waste disposal is therefore on the provision of long term safety through passive means.

BOX 1: RADIATION PROTECTION IN THE POST-CLOSURE PERIOD

Safety objective

The safety objective is to site, design, construct, operate and close a disposal facility so that protection after its closure is optimized, social and economic factors being taken into account. A reasonable assurance also has to be provided that doses and risks to members of the public in the long term will not exceed the dose constraints or risk constraints that were used as design criteria.

Criteria

- (a) The dose limit for members of the public for doses from all planned exposure situations is an effective dose of 1 mSv in a year.^a This and its risk equivalent are considered criteria that are not to be exceeded in the future.
- (b) To comply with this dose limit, a disposal facility (considered as a single source) is so designed that the calculated dose or risk to the representative person who might be exposed in the future as a result of possible natural processes^b affecting the disposal facility does not exceed a dose constraint of 0.3 mSv in a year or a risk constraint of the order of 10^{-5} per year^c.
- (c) In relation to the effects of inadvertent human intrusion after closure, if such intrusion is expected to lead to an annual dose of less than 1 mSv to those living around the site, then efforts to reduce the probability of intrusion or to limit its consequences are not warranted.
- (d) If human intrusion were expected to lead to a possible annual dose of more than 20 mSv (see Ref. [5], table 8) to those living around the site, then alternative options for waste disposal are to be considered, for example, disposal of the waste below the surface, or separation of the radionuclide content giving rise to the higher dose.
- (e) If annual doses in the range 1–20 mSv (see Ref. [5], table 8) are indicated, then reasonable efforts are warranted at the stage of development of the facility to reduce the probability of intrusion or to limit its consequences by means of optimization of the facility's design.
- (f) Similar considerations apply where the relevant thresholds for deterministic effects in organs may be exceeded.

Source: Paragraph 2.15 of SSR-5 [4].

^a FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

^b Natural processes include the range of conditions anticipated over the lifetime of the facility and events that could occur with a lesser likelihood. However, extremely low probability events would be outside the scope of consideration.

^c Risk due to the disposal facility in this context is to be understood as the probability of fatal cancer or serious hereditary effects.

1.4. By contrast, “the term ‘storage’ refers to the retention of radioactive waste in a facility or a location with the intention of retrieving the waste” (para. 1.9 of Ref. [4]). Storage therefore anticipates future actions, such as to provide further conditioning or packaging of the waste, to maintain the facility in which storage takes place or to construct new facilities for further storage and ultimately disposal. The storage of radioactive waste is specifically dealt with in IAEA Safety Standards Series No. GSR Part 5, Predisposal Management of Radioactive Waste [6], and IAEA Safety Standards Series No. WS-G-6.1, Storage of Radioactive Waste [7].

1.5. The choice of a disposal system (i.e. the disposal facility and the environment in which it is sited) in any given circumstance will depend on a variety of factors, including the inventory of waste to be disposed of. In particular, the approach taken to meeting safety requirements should be commensurate with the hazard associated with the waste and the longevity of the hazard (i.e. the quantity and concentration of particular radionuclides), as well as with the environmental conditions at the site at which disposal will take place. For the types of waste that may be disposed of in near surface disposal facilities, there is a range of circumstances in which disposal programmes could be developed. For example, considerable volumes of very low level waste (VLLW) may arise from the decommissioning of nuclear facilities and clean-up of the sites or from the remediation of a site following an accident. In such cases, considerations of proximity may have an important bearing on the practicable choices for the disposal of such waste. By contrast, fairly small volumes of low level waste (LLW) may be generated from a large number of sources within a State or region, which may lead to the siting and development, operation and closure of a centralized facility.

1.6. This Safety Guide provides recommendations on how to meet the safety requirements of SSR-5 [4] and is concerned with the disposal of solid radioactive waste by emplacement in designated facilities at or near the land surface. Near surface disposal is primarily suitable for waste containing mainly short lived radionuclides (radionuclides with half-lives of less than about thirty years are considered to be short lived) and only low concentrations of long lived radionuclides. It has been practised in a number of States for several decades, and the experience gained has been taken into account in the development of this Safety Guide.

1.7. This Safety Guide is intended to provide guidance on the disposal of a wide range of radioactive waste appropriate for near surface disposal [8]. The

guidance should be applied in accordance with a graded approach, consistent with the intrinsic hazard presented by the waste to be disposed of.

1.8. There is a notable difference in the approach to safety for a near surface disposal facility compared with the approach for a nuclear installation. This arises primarily because a nuclear installation, such as a fuel fabrication plant, a nuclear power plant or a reprocessing facility, is functional during its operating life and involves a production activity, such as electrical power generation. Nuclear installations rely upon operating limits and conditions for the active safety systems they employ. In contrast to a nuclear installation, the core function of a disposal facility for radioactive waste is to provide passive safety for long periods of time. However, operational limits and conditions will still be important for near surface disposal facilities to ensure operational safety and post-closure performance.

1.9. This Safety Guide supersedes the earlier publication Safety Series No. 111-G-3.1, Siting of Near Surface Disposal Facilities.¹

OBJECTIVE

1.10. The objective of this Safety Guide is to provide guidance and recommendations relating to the development², operation, closure and regulatory control of facilities for the near surface disposal of radioactive waste to meet the safety requirements established in SSR-5 [4]. It is primarily intended for use by those involved with policy development and with the regulatory control and use of near surface disposal.

SCOPE

1.11. The term ‘near surface disposal’ is used in this Safety Guide to refer to a range of disposal methods, including the emplacement of solid radioactive waste in earthen trenches, above ground engineered structures, engineered structures just below the ground surface and rock caverns, silos and tunnels excavated at depths of up to a few tens of metres underground. This Safety Guide provides general guidance for the development, operation and closure of facilities of this

¹ INTERNATIONAL ATOMIC ENERGY AGENCY, Siting of Near Surface Disposal Facilities, Safety Series No. 111-G-3.1, IAEA, Vienna (1994).

² The term ‘development’ covers all stages before operation of a near surface disposal facility. It includes siting, design, construction and commissioning.

type that are suitable for the disposal of VLLW and LLW [8]. This Safety Guide does not apply to intermediate level waste (ILW) that will not decay to safe levels over a period of a few hundred years or to high level waste (HLW), as both are unsuitable for near surface disposal. This Safety Guide does not cover the disposal of waste from uranium mining and milling or waste containing only naturally occurring radioactive material (NORM) or borehole disposal of radioactive waste; these topics are dealt with in Refs [9, 10].

1.12. This Safety Guide is primarily concerned with activities associated with the development, operation and closure of near surface disposal facilities after a site has been selected. It should be noted that siting encompasses a range of activities from initial conceptual design and site selection through to confirmation of the site for construction of a disposal facility. The framework within which siting is conducted, and indeed the basis for policy decisions to adopt near surface disposal as a waste management option, will be specific to the societal context and approach to decision making in which the programme for disposal is being developed [11, 12]. General recommendations regarding the technical and scientific aspects of siting are provided in Appendices I and II.

1.13. The development of radioactive waste disposal facilities that incorporate design or operational provisions to facilitate reversibility, including the possible retrievability of waste packages, has been considered in several national programmes. It is conceivable that a requirement to provide such features could emerge as a result of specific processes for the engagement of interested parties. Paragraph 1.25 of SSR-5 [4] states that:

“No relaxation of safety standards or requirements could be allowed on the grounds that waste retrieval may be possible or may be facilitated by a particular provision. It would have to be ensured that any such provision would not have an unacceptable adverse effect on safety or on the performance of the disposal system.”

This Safety Guide applies to all near surface disposal facilities, irrespective of whether or not retrievability is incorporated into the design or operational plans.

1.14. The safety of waste transport to near surface disposal facilities is addressed in IAEA Safety Standards Series No. SSR-6, Regulations for the Safe Transport of Radioactive Material (2012 Edition) [13]. Some waste transported to a near surface disposal facility may require further treatment and conditioning prior to emplacement of the waste package into the disposal facility. Guidance for the safety of waste treatment and conditioning facilities that may be collocated with

a near surface disposal facility is not provided in this Safety Guide. IAEA safety standards for fuel cycle facilities and for the predisposal management of waste apply for this type of facility [6, 14].

1.15. Nuclear security aspects of the disposal of radioactive waste in near surface facilities are outside the scope of this publication. However, this Safety Guide does identify where security measures are relevant for safety purposes. Guidance on addressing nuclear security aspects can be found in the Nuclear Security Series publications (see Refs [15, 16] and supporting guidance).

STRUCTURE

1.16. Section 2 provides an overview of near surface disposal and its implementation, and the step by step approach to developing a near surface disposal facility. Section 3 provides guidance on legal and organizational infrastructure. Section 4 discusses the safety approach and design principles, and Section 5 provides guidance for the preparation of the safety case and safety assessment. Section 6 presents guidance for specific steps in the development, operation and closure of a near surface disposal facility. Section 7 provides guidance on assurance for safety, and Section 8 deals with existing disposal facilities. Appendices I and II provide additional information and guidance concerning the siting of near surface disposal facilities, specifically concerning data needs.

1.17. SSR-5 [4] establishes 26 safety requirements that are applicable to the near surface disposal of radioactive waste. For convenience and traceability, the text of each requirement in SSR-5 [4] is reproduced in this Safety Guide and is followed by the related recommendations.

2. OVERVIEW OF NEAR SURFACE DISPOSAL AND ITS IMPLEMENTATION

2.1. Near surface disposal refers to the emplacement of solid, or solidified, radioactive waste containing predominantly short lived radionuclides in a disposal facility located at or near the land surface. The depth chosen for disposal, and the type of facility that is developed, will depend on a number of factors including, but not limited to, the nature of the waste and the local environmental conditions

at the proposed site. An important feature of near surface disposal is the possible need to maintain institutional control over the site for a period following closure, owing to the need to prevent disturbance of the facility and its contents by human activities. However, as stated in para. 3.48 of SSR-5 [4], the “long term safety of a disposal facility for radioactive waste is required not to be dependent on active institutional control”.

2.2. Concentration and containment of the waste and isolation of the waste from the biosphere is the accepted management strategy for most radioactive waste [4]. Containment and isolation can be provided through a series of complementary barriers, for example the waste form itself, waste containers, other engineered features associated with the facility design, and the local environment, each of which serves in some way to prevent the release of radionuclides from the waste form and/or to restrict the migration of contaminants from the facility to the accessible environment.

2.3. The overall programme for siting, construction and operation of a near surface disposal facility is likely to last an extended period, typically of the order of a few to several decades. In the context of radiation safety, it is conventional to identify three broad periods associated with the development, operation and closure of a near surface disposal facility: the pre-operational period, the operational period and the post-closure period [4]. While such terminology is convenient, it is also appropriate to recognize that, in the context of the development of waste disposal facilities, the whole development programme (including what is conventionally referred to as operation) is in fact contributing to the assembly of the final closed disposal facility, which is then expected to perform passively (essentially with no further active management or intervention) in order to contain and to isolate the waste for as long as necessary. Indeed, in the case of a near surface disposal facility, certain key components of the engineered barrier system may not be installed until closure of the facility.

2.4. With this in mind, the following phases can be identified:

- (a) The **pre-operational period** includes the definition of concepts, site investigation and confirmation, safety assessment, design development and optimization, and construction. In the pre-operational period, site selection, detailed characterization and environmental impact assessment studies are typically conducted, together with the development of those aspects of the safety case for operational and post-closure safety that are required in order to obtain authorization to proceed with the construction of the near surface disposal facility and any commissioning activities prior to waste

emplacement. Appendices I and II provide further recommendations on siting.

- (b) The **operational period** begins when waste is first received at the facility. From this time, radiation exposures may occur as a result of waste management activities, and these are subject to control in accordance with the requirements for radiation protection and safety. Experience has shown that the operational period is likely to run in parallel with the ongoing construction of the waste emplacement system and with data acquisition programmes. This provides flexibility, for example enabling the design of the facility to be modified in the light of experience or in accordance with regulatory processes. Monitoring and testing programmes, intended to provide evidence to support an eventual decision to close the disposal facility, can be expected to continue, and the safety case for the period of operation and for the period after closure will be further updated and developed. If considered necessary, the operational period may include extended performance monitoring and waste retrieval prior to closure. The operational period is completed following emplacement of the last waste package and the final closure of the facility.
- (c) The **post-closure period** begins at the time when waste acceptance, handling and emplacement operations are concluded, any cap over the facility has been constructed and — in the case of disposal in rock caverns, silos and tunnels — the galleries and access routes from the surface have been sealed. After closure, the safety of the disposal facility is provided for by passive means inherent in the characteristics of the site and of the facility, although institutional control such as controls over access to, or use of, the site may be put in place or continue for a certain period. The higher the concentrations and total quantities of longer lived radionuclides in the waste, and the greater the vulnerability of the site to disruptive events, the longer such a period of control may need to be. However, for the purposes of the safety assessment, it is usually assumed that the period of active institutional control during which human intrusion is prevented lasts only for a limited time (typically a few hundred years) in order that, as soon as reasonably possible, safety will be provided by passive means.

2.5. The development, operation and closure of a near surface disposal facility is likely to last over many years. Given such timescales, and the large volume and diversity of information necessary to support the process (e.g. through the acquisition of data on waste and from engineering activities, site characterization and other activities that will support the safety case), it is appropriate to subdivide the programme into a series of steps involving formal stages at which the programme is reviewed and evaluations of safety are undertaken

before decisions are made to progress [4]. Such a step by step approach allows confidence in safety to be increased in an iterative manner and helps to ensure that all key decisions are well founded. As a general rule, regulatory reviews at each key decision point also provide opportunities for independent technical review and involvement of interested parties. Figure 1 illustrates typical steps as the disposal facility progresses from the early decision making stage through to the post-closure period.

2.6. After site selection, consistent with the phases described above, a number of activities grouped in broad areas should be undertaken — namely, detailed site characterization and site confirmation that the site meets the selection criteria, design of the disposal facility, construction of the disposal facility, operation of the disposal facility (i.e. receipt and emplacement of waste) and closure of the disposal facility. The last three of these correspond to three important steps in the regulatory approval of a near surface disposal facility (see Fig. 1). Site characterization and design activities, as well as associated record keeping, may be expected to continue, at some level, up to facility closure. Key information on the disposal facility should also be placed in appropriate archives.

2.7. A step by step process also provides flexibility so that the programme can be adapted in response to new technical information. The step by step process facilitates the consideration of reversibility in the development, operation and closure of a disposal facility and, at each step, enables a decision to be made on proceeding to the next step, to wait for additional information before making a decision, or to reverse a decision.

3. LEGAL AND ORGANIZATIONAL INFRASTRUCTURE

3.1. Development, operation and closure of a near surface disposal facility requires the assignment of responsibilities among three types of organization: the national government, the appointed regulatory body (or bodies) and the operator of the facility. Recommendations on the responsibilities of each of these are provided in this section.

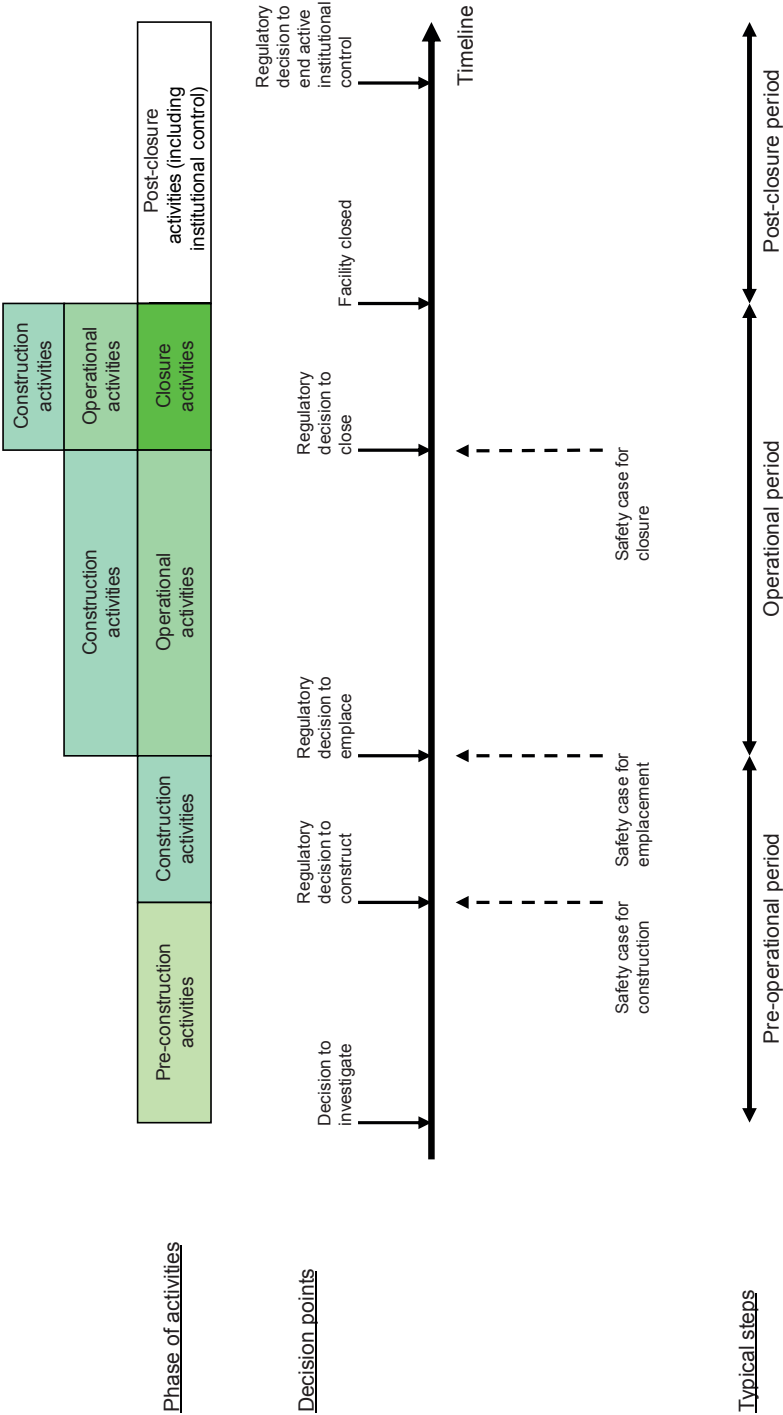


FIG. 1. Timeline to illustrate the development, operation and closure of a near-surface disposal facility.

GOVERNMENT RESPONSIBILITIES

Requirement 1 of SSR-5 [4]: Government responsibilities

“The government is required to establish and maintain an appropriate governmental, legal and regulatory framework for safety within which responsibilities shall be clearly allocated for disposal facilities for radioactive waste to be sited, designed, constructed, operated and closed. This shall include: confirmation at a national level of the need for disposal facilities of different types; specification of the steps in development and licensing of facilities of different types; and clear allocation of responsibilities, securing of financial and other resources, and provision of independent regulatory functions relating to a planned disposal facility.”

3.2. As stated in para. 3.7 of SSR-5 [4], the national legal and organizational framework for near surface disposal has to include the following:

- (a) Defining the national policy and strategy for the long term management of radioactive waste of different types;
- (b) Setting clearly defined legal, technical and financial responsibilities for organizations that are to be involved in the development, operation and closure of near surface disposal facilities;
- (c) Ensuring the adequacy and security of financial provisions, for example by requiring the owners of the waste to establish segregated funds;
- (d) Defining the overall process for the development (siting, design and construction), operation and closure of near surface disposal facilities, including the legal and regulatory requirements at each step, and the processes for decision making and the involvement of interested parties;
- (e) Ensuring that the necessary scientific and technical expertise is available to support site and facility development, operation and closure, independent regulatory review and other national review functions;
- (f) Defining legal, technical and financial responsibilities and, if necessary, providing for any institutional arrangements that are envisaged after closure, including monitoring and arrangements that may be required for ensuring the security of the disposed of waste.

3.3. The government should ensure that the regulatory body is independent of the generator of the waste and the operator of the disposal facility. The regulatory body should possess the expertise to provide proper oversight and objectivity in evaluating waste management and disposal activities. Individuals working within the regulatory body should be sufficiently independent of influence from waste generators and from the operator of the disposal facility. The government should perform periodic reviews to evaluate the effectiveness of the regulatory body and its ability to fulfil its mission.

3.4. In accordance with national laws and preferences, the government should ensure that interested parties that are directly or indirectly affected by the outcome of the project are involved in making decisions at appropriate stages throughout the project. A clear, formal process identifying interested parties and decision makers should be established to facilitate a meaningful exchange of information and viewpoints. The ways in which interested parties are involved in decision making processes concerning the near surface disposal of radioactive waste will vary according to national laws, regulations and preferences. The involvement of interested parties in the development of frameworks for decision making can encourage public confidence in government actions, make the regulatory body more effective and improve the safety performance of operators [12].

RESPONSIBILITIES OF THE REGULATORY BODY

3.5. These recommendations refer to a single regulatory body, but it is recognized that, in practice, the regulation on safety of near surface disposal facilities could involve the participation of multiple regulatory bodies to address the concurrent activities of nuclear safety, industrial safety, environmental protection and radiological protection. The specific roles and responsibilities of the regulatory body in relation to waste management are established in IAEA Safety Standards Series No. GSR Part 1, Governmental, Legal and Regulatory Framework for Safety [17] and include the following:

- Carrying out licensing, inspection and enforcement of regulations;
- Providing independent advice to the government in the formulation of objectives in the national policy;
- Issuing and updating rules, guidance and other regulatory criteria specific to near surface disposal facilities.

Requirement 2 of SSR-5 [4]: Responsibilities of the regulatory body

“The regulatory body shall establish regulatory requirements for the development of different types of disposal facility for radioactive waste and shall set out the procedures for meeting the requirements for the various stages of the licensing process. It shall also set conditions for the development, operation and closure of each individual disposal facility and shall carry out such activities as are necessary to ensure that the conditions are met.”

3.6. The regulatory body should provide guidance on the interpretation of the national legislation and regulatory requirements, including in particular the types of waste that can and should be disposed of in specific disposal facilities. Guidance should be provided on the expectations on the operator regarding the development, operation and closure, and licensing of each individual facility and, specifically, on the interaction between the regulatory body and the operator before the formal licensing process commences. The regulatory body should engage in dialogue with waste generators, the operator of the disposal facility and other interested parties to ensure that the regulatory requirements are appropriate and practicable and are clearly understood by the various parties.

3.7. The regulatory body should maintain competent staff and an appropriate management system, and should have access to independent assessment capabilities and participate in international co-operation as necessary to fulfil its regulatory functions.

3.8. In developing regulations, guidance and other regulatory criteria specific to near surface disposal facilities, the regulatory body should ensure consistency with the national policy and give due regard to the objectives and criteria set out in SSR-5 [4]. The regulations and guidance may include:

- Radiation protection criteria and environmental protection criteria for operational and post-closure safety;
- Requirements for the content of the safety case for a disposal facility, including the safety assessment and the management system;
- Criteria and requirements for the siting, design, construction, operation and closure of disposal facilities;
- Criteria and requirements for the waste, waste form, packaging, any backfill and sealing material and other components of the facility;
- Requirements for the involvement of interested parties.

3.9. The regulatory body has to establish and to document the procedures for evaluating the safety of a near surface disposal facility and the procedures that operators are expected to follow in the licensing process and in demonstrating compliance with the safety requirements [4]. The procedures established by the regulatory body should cover the following:

- Specification of the information to be supplied by the operator;
- Review of the required submissions and assessment of the compliance with regulatory requirements;
- Issuance of approvals and licences and setting of conditions in conformity with legislation and regulations;
- Guidance on the conditions of authorization;
- Inspection and audit of the operator's data gathering, safety assessment, activities in construction and operation to ensure quality, and compliance with regulations and the terms of approvals and licences;
- Periodic reviews of approvals, licences and inspection procedures to determine their continued suitability or need for amendments;
- Involvement of interested parties;
- Requirements for termination of regulatory control.

3.10. The regulatory body should establish its own independent capability for reviewing safety cases and supporting safety assessments. This should be composed of qualified and competent individuals with the essential knowledge, skills and abilities to review and to evaluate critically the required submissions for applicants and licensees. The regulatory body should be capable of conducting, or arranging, independent research and assessments, if necessary with the involvement of technical support organizations, as required for the approval of licences for the development, operation and closure of near surface disposal facilities. The regulatory body should participate in international cooperation as necessary to fulfil its regulatory functions. Independent review capabilities can be established and maintained through formal agreements with academic institutions and national laboratories (where available) and through special commercial contracting agreements, where conflicts of interest may arise. It should also periodically review the adequacy of its regulations and guidance. It may not be necessary to undertake independent research if the regulatory body is satisfied that the organization is undertaking appropriate research, that this research is of sufficient quality and that it is subject to independent expert review.

RESPONSIBILITIES OF THE OPERATOR

Requirement 3 of SSR-5 [4]: Responsibilities of the operator

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

3.11. In developing the design of a safe near surface disposal facility, the operator should establish a safety strategy that will clearly set out how the facility is to comply with all the safety requirements. The strategy should indicate how the safety principles will be applied and should take into consideration the characteristics and quantities of the radioactive waste to be disposed of, the characteristics of the available site or sites, the available engineering techniques, and the national legal infrastructure and regulatory requirements. The safety strategy should also indicate how the management system will provide assurance of the necessary quality of work to be carried out and, among other things, it should establish the necessary frameworks for organization of the work (e.g. interaction between designers, assessors, site investigators and researchers). The safety strategy should be presented in the safety case for the facility, which the operator should develop in accordance with the detailed guidance provided in IAEA Safety Standards Series No. SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste [18].

3.12. In conducting the research necessary to support the understanding of the processes on which the safety of the near surface disposal facility depends, the operator has to carry out all the necessary investigations of the site and materials used in construction and operation (including packaging and other engineered barriers). The operator has to assess the suitability of materials for a given application and has to ensure the availability of other data required for the safety assessment [4].

3.13. The operator has to establish technical specifications to ensure that the disposal facility is constructed, operated and closed in accordance with the regulatory requirements and the safety case. This has to include the development and use of waste acceptance criteria and other controls and limits to be applied during construction, operation and closure [4].

3.14. The operator should identify and seek to prevent potential conflicts between efforts to address long term safety objectives and operational objectives: for example, operational expediency should not jeopardize long term safety functions, nor should site workers be subjected to undue risks in the interests of long term safety.

3.15. The operator should supply all information relevant to the safety case and the supporting safety assessment to the regulatory body, together with any other documents necessary to demonstrate safety and, through a process of iteration, demonstrate compliance with regulatory requirements and with the technical specification of the facility. Such information and records have to be retained by the operator until they are transferred to another organization that assumes this responsibility, such as at closure [4]. The need to preserve records for long time periods during operation and after closure should be taken into account in selecting the location, format and materials to be used for such records.

4. SAFETY APPROACH

4.1. The safety approach includes all the ways in which protection of people and protection of the environment are ensured throughout the lifetime of a near surface disposal facility. As the long term safety of a disposal facility for radioactive waste is required not to be dependent on active institutional control [4], the safety of a near surface disposal facility largely rests on the quality of the selected site and the capability of the design of the facility to contain and to isolate the waste. This emphasizes the importance that should be given to all steps in the development of a near surface disposal facility that precede the actual construction and operation of the facility.

4.2. Within the framework set by the national policy for near surface disposal of radioactive waste, the operator, in consultation with the regulatory body, should set out elements of the national policy in a formal safety strategy document that is produced as early as possible in the disposal programme and is updated periodically. The safety strategy is the high level integrated approach adopted for achieving safe disposal. It should include strategies to select a site and to design, construct, operate and close a disposal facility. In addition, it should include recommendations for the preparation and maintenance of the safety case for use in decision making and procedures for regulatory approval for the assumed duration of the period of institutional control (see Section 5). Throughout the

whole process, safety should be the central and main consideration in all decisions taken in the development and operation of a near surface disposal facility.

4.3. The development and definition of a safety strategy should be the responsibility of the operator, which should develop and apply its safety strategy in line with the national policy for disposal. The operator should take into account the national regulatory framework, international standards and legal instruments and all relevant constraints posed by societal and economic factors. The regulatory body should review the operator's safety strategy for the near surface disposal facility at the early stage of its development and well in advance of the formal licensing steps.

4.4. The requirements in IAEA Safety Standards Series No. GSR Part 3 (Interim) [3] and the recommendations provided in the 1990 Recommendations of the International Commission on Radiological Protection [19] assume that, subject to the appropriate definition of exposed groups, the protection of people against the radiological hazards associated with a near surface disposal facility will also protect the environment against such hazards. The issues associated with the protection of the environment from harmful effects of ionizing radiation and the possible development of standards for this purpose are discussed in Refs [20, 21].

IMPORTANCE OF SAFETY IN THE DEVELOPMENT PROCESS

Requirement 4 of SSR-5 [4]: Importance of safety in the process of development and operation of a disposal facility

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

4.5. As established in para. 2.15 of SSR-5 [4] (see Box 1):

“The safety objective is to site, design, construct, operate and close a disposal facility so that protection after its closure is optimized, social and economic factors being taken into account. A reasonable assurance also has to be provided that doses and risks to members of the public in the long

term will not exceed the dose constraints or risk constraints that were used as design criteria.”

4.6. SSR-5 [4], when applied to near surface disposal facilities, requires that long term safety is to be ensured by:

- (a) The capability of the features of the disposal facility to contain the waste and isolate it from the accessible biosphere;
- (b) The capability of the features of the site to contribute to the containment and isolation of the waste;
- (c) The limitations placed on the radiological inventory, mainly with regard to long lived radionuclides, that can be disposed of in the facility;
- (d) The measures for surveillance and control of the disposal facility and its immediate surroundings that are applied to prevent or restrict any human activities that could disturb the facility barriers and lead to increased exposures.

4.7. Consequently, near surface disposal is an appropriate disposal option only for VLLW and LLW, while ILW and HLW, which contain larger quantities of long lived radionuclides, have to be disposed of in deeper geological disposal facilities. Whereas well sited and well designed geological disposal facilities aim at ensuring containment and isolation of radioactive waste over very long periods of time (tens to hundreds of thousands of years), the location of a near surface disposal facility at or near the surface makes it susceptible to processes and events that will degrade its containment and isolation capacity over much shorter periods of time (up to several hundreds of years). In near surface disposal, the facility is located in the biosphere where most human activities take place, and the possibility of human intrusion into a near surface disposal facility after the period of institutional control is considerably greater than in the case of geological disposal. Therefore, human intrusion after the period of institutional control has to be taken into account, and the adequacy of the limitations placed on the radioactive inventory should be assessed and confirmed, principally in terms of allowable quantities of long lived radionuclides in the waste packages.

4.8. The development, operation and closure of a near surface disposal facility involves an iterative process of site characterization and design and evolution of the safety case and supporting safety assessment to provide an optimized level of operational and post-closure safety (see the appendix to SSR-5 [4]). Throughout this process, all relevant characteristics of the waste to be disposed of should be identified and taken into account in the design of the facility and in the safety assessment. This iterative process may take several years, and key

decisions, such as those on the choice of design concept, siting, detailed design, allowable inventory and construction of the facility, should be made in a step by step process as the project develops. In this process, optimization of the disposal facility and its safety performance through the evaluation and comparison of options should generally progress from more strategic considerations to detailed choices for design and operation. Optimization of the long term safety of a near surface disposal facility should mainly be achieved by means of decisions on the site and the design of the facility, and by a cautious approach followed in safety assessment to set adequate limitations on the inventory. Societal and economic factors, such as public acceptance of the disposal facility, and natural factors, such as surface geology, can constrain the available options for siting the facility. However, optimization of the design of the facility should take due account of all the favourable and unfavourable site characteristics and should be based on best practices.

4.9. Decisions should be made on the basis of the quantitative or qualitative information available at the time and the confidence that can be placed in that information. Therefore, a systematic identification and assessment of uncertainties that can affect the safety of the facility should be part of the development, operation and closure, and should be factored in at each major decision point that relates, directly or indirectly, to the safety of the facility. Facility development, operation and closure decisions are also influenced by external factors, such as national policy and preferences.

4.10. At each major decision point (siting, design, operation, closure and post-closure), an adequate level of confidence in safety should be developed so that the available options can be evaluated and the best protective options can be selected, with all relevant societal and economic factors taken into account. If more than one option is capable of providing the required and optimized level of safety, then factors other than safety also have to be considered. These factors could include public acceptability, cost, site ownership, existing infrastructure and transport routes [4].

4.11. Throughout the iterative process of site characterization, disposal facility design and safety assessment, the critical components for the safety of the disposal system should be identified. Different complementary approaches should be put in place to identify these critical components:

- In the design process, analysis of the safety function(s) of each component on the basis of the provision of defence in depth;

- In the iterative safety assessments, integration of all main safety relevant elements of the system and all available information (including a systematic analysis of uncertainties) regarding the performance and evolution of system components;
- Assessment of the technical feasibility of the operation of the system and its components in a manner that meets the functional requirements.

4.12. The critical components should be qualified, as appropriate and practicable, using standardized and appropriate testing methods to gain confidence in their ability to perform the required function(s) over the required timescale(s). If new techniques are employed, they should be developed and qualified in a time frame that is compatible with the project schedule. Research activities focusing on critical components should be used to improve further the understanding of system and component performance and should lead (a) to further optimization steps, even when development of the system has started, or (b) to improvement of the safety assessment to the extent that a more accurate assessment of system performance and safety can be made. A continued research programme on critical components of the disposal system is an important element of the safety strategy. However, the existence of such a programme should not be used to justify the taking of decisions early in the programme without an adequate level of confidence in the safety of the system. The balance between the level of confidence at a certain point and the prospects of additional insights from a continued research programme should be a central element in the process of interaction between the operator and the regulatory body.

4.13. Operational safety should be provided by means of active and passive control systems. Active systems could include operational controls (e.g. control of incoming waste for surface contamination or contact dose rate, and control of waste emplacement activities) and monitoring for radioactive releases, whereas passive systems could include engineered features such as shielding. Normal operating conditions, as well as anticipated operational occurrences and incident and accident conditions, should be considered in the development of operational safety systems. Both internal events (e.g. a fall of a waste package during waste handling operations) and external events (e.g. the risk of external explosion, strong winds, flooding and earthquakes) can lead to anticipated operational occurrences, incidents or accidents and should be assessed for the specific site and design of the facility. Where appropriate, the development of operational safety systems should make use of operational experience and technologies (e.g. techniques for waste handling) adopted from other types of nuclear facility. Consideration should be given to the fact that conventional risks may be more

significant than radiological risks, especially if the waste to be disposed of is conditioned waste with only a small risk of dispersion of radioactive material.

4.14. Safety mechanisms for the post-closure period are distinct from those employed in the operational period, or for other types of facility. In the post-closure period, a near surface disposal facility is required to provide the necessary degree of containment and isolation, so that the migration of radionuclides from the waste into the biosphere is reduced to an acceptably low level and so that the likelihood of, and all possible consequences of, human intrusion are sufficiently reduced. This should be achieved primarily through passive means and using multiple safety barriers, supported by surveillance and control measures, as described in the following subsections.

4.15. The concept of near surface disposal covers a wide range of facilities (e.g. disposal at the surface in engineered vaults or trenches, or disposal at varying depths — from a few metres to a few tens of metres — in facilities with various types of engineered barriers). The components of the disposal system, both engineered and natural, that contribute to the containment and isolation of the waste after the facility is closed can therefore differ to a large extent. Throughout the development, operation and closure, an adequate understanding should be developed of the performance, durability and longevity of all the components that contribute to the overall system for containment and isolation of the waste. In order to develop an adequate understanding of the behaviour of the disposal facility, a focused effort should be made to characterize and to assess the system components in terms of their initial performance and the expected or possible evolution of their performance due to degradation or disturbing events and processes. The fact that the extent to which the engineered components of the system, or the natural components, or both, contribute to the overall containment and isolation can differ widely for different types of near surface disposal facility should be taken into account.

4.16. Through the process of optimization, all decisions should be taken with the aim of selecting the best protective options, in line with policy decisions (e.g. on the type of near surface disposal facility to be developed) and with account taken of societal and economic factors (e.g. expression of local acceptance or refusal for a particular site or sites). Once the type of disposal facility has been decided and the site selected, the main effort of optimization should be on making all the design choices with respect to the engineered components of the disposal system in a manner that all relevant characteristics of the site are correctly taken into account (e.g. chemical characteristics of the site that influence or determine the lifetime and performance of the engineered components, and mechanical and

seismic characteristics of the site that can affect the stability and integrity of the engineered components). In order to design the facility in such a manner that the natural and engineered components of the disposal system are compatible and complementary, all relevant information with respect to the features of the site and the components of the facility should be used. When system specific information is lacking and generic information is used, a cautious and transparent approach to safety should be ensured.

4.17. Throughout the process of developing the disposal facility, its robustness should be evaluated in a systematic and structured manner to understand how disturbances that might be expected to occur or remaining uncertainties can affect the performance of the components and the safety of the disposal system. Both siting and design decisions should be made on the basis of an evaluation of robustness (e.g. the selection of sites that are less likely to be affected by external events such as floods or earthquakes) or the dimensioning of system components with a sufficient performance margin.

CONTAINMENT

Requirement 8 of SSR-5 [4]: Containment of radioactive waste

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

4.18. For the purposes of this Safety Guide, the final sentence of Requirement 8 of SSR-5 [4] is not relevant, as heat generating HLW is not suitable for disposal in near surface disposal facilities [8].

4.19. Containment of radioactive waste implies that the disposal facility should be sited and designed to prevent or to minimize the release of radionuclides. As near surface disposal is only suitable for classes of waste containing mainly short lived radioactive waste and potentially with limited amounts of long lived radionuclides, the time frames over which containment has to be ensured are largely determined by the objective to limit the potential for a release of