

IAEA Safety Standards

for protecting people and the environment

Predisposal Management of Radioactive Waste from Nuclear Fuel Cycle Facilities

Specific Safety Guide

No. SSG-41



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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.

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PREDISPOSAL MANAGEMENT
OF RADIOACTIVE WASTE
FROM NUCLEAR FUEL
CYCLE FACILITIES



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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-41

PREDISPOSAL MANAGEMENT OF RADIOACTIVE WASTE FROM NUCLEAR FUEL CYCLE FACILITIES

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2016

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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.

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.

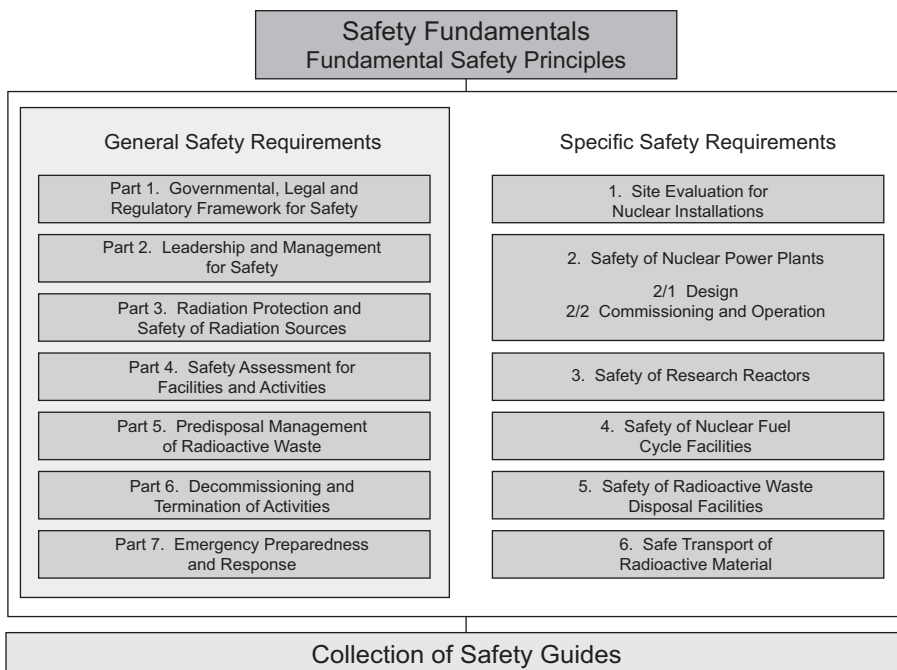


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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 five safety standards committees, for emergency preparedness and response (EPReSC) (as of 2016), 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

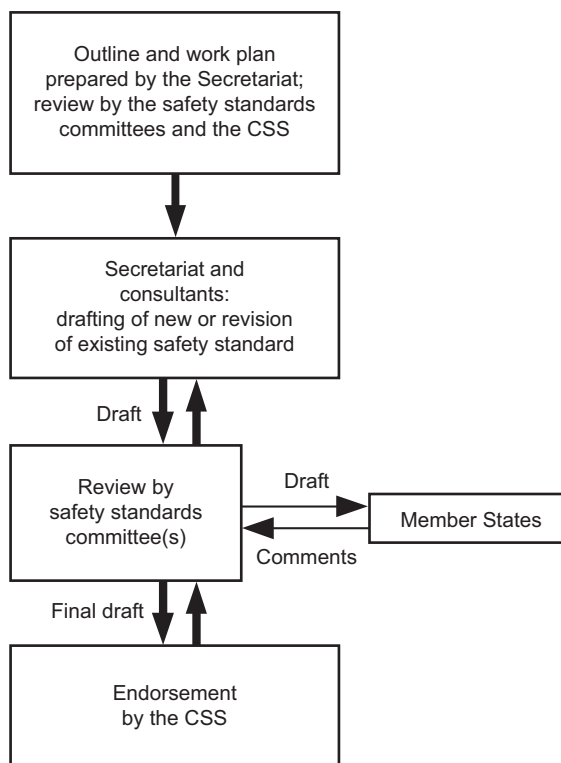


FIG. 2. The process for developing a new safety standard or revising an existing standard.

the Commission on Safety Standards is appointed by the Director General and 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 (radioactive material for which no further use is foreseen, and with characteristics that make it unsuitable for authorized discharge, authorized use or clearance from regulatory control) arises from a number of activities involving the use of radioactive material. The nuclear fuel cycle produces a wide range of radioactive waste, including: high level waste (e.g. vitrified waste from spent fuel reprocessing), intermediate level waste that typically contains longer lived radionuclides, and low level waste that typically contains short lived radionuclides and limited quantities of long lived radionuclides. The approach to treating liquid and gaseous waste streams influences the amount of effluent generated for discharge, and the approach to clearance from regulatory control and recycling influences the amount of waste for storage and disposal; therefore, optimization of the overall radioactive waste management process (predisposal waste management and disposal) is very important. Thus, a key feature of the predisposal management of radioactive waste from nuclear fuel cycle facilities is the interdependence between the steps in the processes of predisposal management and disposal within a national framework for waste management.

1.2. The principles that govern the safety of the management of radioactive waste are presented in IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1], and the requirements to be met are established in the following IAEA Safety Requirements publications: IAEA Safety Standards Series Nos GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [2], GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [3] and GSR Part 5, Predisposal Management of Radioactive Waste [4]. Similar safety aspects and expectations for good practice have been set down in international legal instruments, such as the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) [5].

1.3. GSR Part 5 [4] and IAEA Safety Standards Series No. NS-R-5 (Rev. 1), Safety of Nuclear Fuel Cycle Facilities [6], require that measures to prevent or restrict the generation of radioactive waste are considered in the design of nuclear facilities and in the planning of activities that have the potential to generate radioactive waste. This recognizes that the proper management of the materials and processes that result in radioactive waste is key to avoiding or minimizing

the quantities of waste generated, thereby minimizing the overall environmental impact.

1.4. Predisposal management of radioactive waste, as the term is used in GSR Part 5 [4], covers all steps in the management of radioactive waste from its generation up to (but not including) its disposal, including waste processing (pretreatment, treatment and conditioning), storage and transport. While the generation of radioactive waste at nuclear fuel cycle facilities is considered part of normal operations, it is important to address the interdependences between the operational demands of each of the various steps in waste management.

1.5. These steps include the following:

- Pretreatment, which may include waste assay and characterization, waste collection, waste segregation, chemical adjustment and decontamination;
- Treatment, which may include volume reduction, removal of radionuclides and changing the composition of the waste;
- Conditioning, which involves those operations that transform radioactive waste into a form suitable for subsequent activities such as handling, transport, storage and disposal; conditioning may include immobilization of the waste, placing of the waste into containers and provision of additional packaging;
- Storage, which refers to the temporary placement of radioactive waste in a facility where appropriate isolation and monitoring are provided; storage is an interim activity performed with the intent to retrieve the waste at a later date for clearance from regulatory control, for authorized use (e.g. subsequent to a decay period), for processing and/or for disposal, or in the case of effluent, for authorized discharge.

1.6. The generation of radioactive waste cannot be prevented entirely but is required to be kept to the minimum practicable ('waste minimization') (Requirement 8, GSR Part 5 [4]). Waste minimization should form an essential element of a radioactive waste management strategy. Waste minimization relates to the type, volume and activity of the waste. Measures to prevent or minimize the generation of radioactive waste have to be put in place at the beginning, in the design of facilities and in the planning of activities that have the potential to generate radioactive waste [4]. This recognizes that the proper planning of the activities that generate radioactive waste is key to minimizing the quantities generated.

1.7. It may be that not all processing steps are necessary for particular categories of radioactive waste. The type of processing necessary will depend on the particular category of waste, its form and characteristics, and the overall approach to its management, including consideration of the generation of secondary waste. Where appropriate, material resulting from the pretreatment and treatment of waste may be reused or recycled, or cleared from regulatory control in accordance with national regulations. Such activities serve to reduce the eventual challenge associated with waste management. The remaining radioactive waste from all sources that is not cleared, discharged or reused needs to be managed safely over its entire lifetime. Lifetimes of certain waste streams are such that the operating organization¹ may not be capable of their management or their management may be dictated by the availability in the State of appropriate disposal facilities (e.g. a deep geological repository).

1.8. GSR Part 1 (Rev. 1) [2] requires the government to make provision for the safe management and disposal of radioactive waste arising from facilities and activities. Such provisions should be included as essential elements of governmental policy and of the corresponding strategies over the lifetime of facilities and for the duration of activities. Furthermore, the government is also required to enforce continuity of responsibility between successive authorized parties.

1.9. In some instances, the solution for predisposal management of waste has to be found by optimizing conflicting demands, e.g. balancing exposures of workers and/or those of members of the public, the short term and long term risk implications of different waste management strategies, the technological options available and the costs [4].

1.10. “To select the most appropriate type of pretreatment, treatment and conditioning for the radioactive waste when no disposal facility has been established, assumptions have to be made about the likely disposal option”, including likely waste acceptance criteria (GSR Part 5 [4], para. 1.8). In cases where waste is to be stored for extended periods, conservative assumptions should be made, for example, about the timescale within which a disposal facility will become available and, thus, about the behaviour and stability of the waste during the anticipated storage period. All assumptions made that impact the selection of options for the predisposal management of waste should be properly

¹ Operating organizations include generators of waste, organizations that carry out decommissioning activities and operators of facilities for the predisposal management of radioactive waste [4].

justified. “It is necessary to address the interdependences and the potential conflicts between the operational demands of each of the various steps in waste management, while ensuring that the waste is contained and stored in a passive, safe condition. In striking a balance between choosing an option and retaining flexibility, it is necessary to ensure that conflicts between operational demands that might compromise safety are avoided” (GSR Part 5 [4], para. 1.8).

OBJECTIVE

1.11. The objective of this Safety Guide is to provide operating organizations that generate and manage radioactive waste (including spent nuclear fuel declared as waste and high level radioactive waste), as well as regulatory bodies and government bodies, with recommendations on how to meet the requirements for the predisposal management of radioactive waste generated at nuclear fuel cycle facilities, excluding nuclear power plants, research reactors and facilities for the mining or processing of uranium ores or thorium ores. The waste may be managed either within larger nuclear fuel cycle facilities or at separate, dedicated waste management facilities, including centralized waste management facilities.

1.12. This Safety Guide provides recommendations and guidance on how to meet the requirements established in GSR Part 5 [4], as well as in GSR Part 1 (Rev. 1) [2] and GSR Part 3 [3], NS-R-5 (Rev. 1) [6] and IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [7].

1.13. This Safety Guide supersedes IAEA Safety Standards Series Nos WS-G-2.5, Predisposal Management of Low and Intermediate Level Radioactive Waste² and WS-G-2.6, Predisposal Management of High Level Radioactive Waste³, both of which were issued in 2003.

1.14. Guidance on the predisposal management of waste from nuclear power plants and research reactors (including subcritical assemblies and critical assemblies) is provided in IAEA Safety Standards Series No. SSG-40, Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors [8].

² INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of Low and Intermediate Level Radioactive Waste, IAEA Safety Standards Series No. WS-G-2.5, IAEA, Vienna (2003).

³ INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of High Level Radioactive Waste, IAEA Safety Standards Series No. WS-G-2.6, IAEA, Vienna (2003).

SCOPE

1.15. This Safety Guide provides guidance on the predisposal management of all types of radioactive waste (including spent nuclear fuel declared as waste and high level waste) generated at nuclear fuel cycle facilities. The waste may be managed at waste management facilities located within larger facilities or at separate, dedicated waste management facilities (including centralized waste management facilities). This Safety Guide covers all stages in the lifetime of a waste management facility, including its siting, design, construction, commissioning, operation, shutdown and decommissioning. It covers all steps carried out in the management of radioactive waste following its generation up to (but not including) disposal, including its processing (pretreatment, treatment and conditioning), storage and transport. It covers radioactive waste generated during normal operation and in accident conditions. While the recommendations of this Safety Guide are applicable to the generation and predisposal management of radioactive waste throughout the entire lifetime of the nuclear fuel cycle facility, other operational activities at nuclear fuel cycle facilities are outside the scope of this Safety Guide. A classification scheme for radioactive waste and recommendations on its application to the various types of radioactive waste are provided in IAEA Safety Standards Series No. GSG-1, Classification of Radioactive Waste [9].

1.16. While storage and transport are included in the definition of predisposal management of radioactive waste, they are not dealt with in detail in this Safety Guide. Recommendations on storage of radioactive waste and spent fuel are provided in IAEA Safety Standards Series Nos WS-G-6.1, Storage of Radioactive Waste [10] and SSG-15, Storage of Spent Nuclear Fuel [11]. Transport of radioactive waste is subject to the requirements of IAEA Safety Standards Series No. SSR-6, Regulations for the Safe Transport of Radioactive Material [12]. Spent fuel that is transferred to or destined for reprocessing facilities is not considered radioactive waste.

1.17. This Safety Guide primarily addresses the situations that are typical at facilities for the predisposal management of radioactive waste arising from the nuclear fuel cycle and from facilities that produce medical isotopes from irradiation of nuclear material. The operating organization and the regulatory body should adopt a graded approach, taking account of the hazards, the complexity and stage in the lifetime of the facilities and activities, and the characteristics of the waste (see Section 3).

1.18. Although this Safety Guide does not specifically address non-radiological hazards or conventional industrial health and safety issues, these issues also have to be considered by national authorities, both in their own right and in as much as they may affect radiological consequences [4].

1.19. This Safety Guide does not provide recommendations on the nuclear security of nuclear material, nuclear facilities or radioactive material. Fundamentals, recommendations for and guidance on nuclear security at nuclear facilities and for radioactive material are provided in Refs [13–15] and in other publications in the IAEA Nuclear Security Series.

STRUCTURE

1.20. Section 2 of this Safety Guide provides recommendations on the protection of human health and protection of the environment. Section 3 addresses the roles and responsibilities of the government, the regulatory body and the operating organization. Section 4 provides recommendations on the integrated approach to safety. Section 5 provides recommendations on development of the safety case and supporting safety assessment, while Section 6 outlines general safety considerations over the lifetime of a waste management facility. Seven appendices are included, which set out examples relevant for the predisposal management of waste from nuclear fuel cycle facilities.

2. PROTECTION OF HUMAN HEALTH AND PROTECTION OF THE ENVIRONMENT

RADIOACTIVE WASTE MANAGEMENT

2.1. The safety objective and the fundamental safety principles established in SF-1 [1] apply to all facilities and activities in which radioactive waste is generated, processed or stored, for the entire lifetime of facilities, including their planning, siting, design, construction, commissioning, operation, shutdown and decommissioning. This includes the associated transport of radioactive waste.

2.2. GSR Part 1 (Rev. 1) [2], GSR Part 5 [4], NS-R-5 (Rev. 1) [6] and GSR Part 2 [7] establish requirements for a management system that integrates, among other things, all elements of management including safety, health,

environmental, nuclear security, quality and economic elements, so that the implications of all actions are considered with regard to safety as a whole and safety is not compromised. A key component of such a system in an organization is a robust safety culture.

2.3. In nuclear fuel cycle facilities, the control of events initiated by chemical hazards can have a significant bearing on achieving the fundamental safety objective. Events initiated by chemical hazards are required to be considered in the design, commissioning, operation and decommissioning of such facilities. Activities at nuclear fuel cycle facilities may also include industrial processes that pose additional hazards to site personnel and to the environment.

2.4. In controlling the radiological and non-radiological hazards associated with radioactive waste, the following aspects are also required to be considered: conventional health and safety issues, environmental impacts, radiation risks that may transcend national borders, and potential impacts and burdens on future generations [1].

RADIATION PROTECTION

2.5. The three general principles of radiation protection, which concern justification, optimization of protection and application of dose limits, are expressed in safety principles 4, 5, 6 and 10 of SF-1 [1], and related requirements are established in GSR Part 3 [3].

2.6. Requirements for radiation protection have to be established at the national level, with due regard to GSR Part 3 [3]. In particular, GSR Part 3 [3] requires radiation protection to be optimized for any persons who are exposed as a result of activities, with due regard to dose constraints, and requires the exposures of individuals to be kept within specified dose limits.

2.7. National regulations will prescribe dose limits for the exposure of workers and members of the public under normal conditions. Internationally accepted values for these limits are contained in schedule III of GSR Part 3 [3]. In addition to the provision for protection against the exposures that will arise from normal operations, provision has to be made for preventing and limiting the likelihood and magnitude of exposures in anticipated operational occurrences and accident conditions. Requirements for preventing and limiting the likelihood and magnitude of exposures in anticipated operational occurrences and accident conditions are also established in GSR Part 3 [3]. They include management

requirements and technical requirements for preventing the occurrence of accidents and provisions for mitigating their consequences if they do occur.

2.8. In choosing options for the predisposal management of radioactive waste, consideration has to be given to both the short term and the long term radiological impacts on workers and the public [1, 16, 17].

2.9. Doses and risks associated with the transport of radioactive waste have to be managed in accordance with the requirements established in SSR-6 [12].

PROTECTION OF THE ENVIRONMENT

2.10. Requirements for protection of the environment that are associated with the predisposal management of radioactive waste have to be established by the relevant national regulatory bodies, with all potential environmental impacts that could reasonably be expected taken into consideration [1, 3].

2.11. In accordance with para. 2.1 of SF-1 [1], to achieve the fundamental safety objective of protecting people and the environment from harmful effects of ionizing radiation,

“measures have to be taken:

- (a) To control the radiation exposure of people and the release of radioactive material to the environment;
- (b) To restrict the likelihood of events that might lead to a loss of control over...source[s] of radiation;
- (c) To mitigate the consequences of such events if they were to occur.”

2.12. NS-R-5 (Rev. 1) [6] states that the operating organization is required to take measures to avoid or to optimize the generation of radioactive waste, including consideration of requirements related to disposal, with the aim of minimizing the overall environmental impact. This includes ensuring that gaseous and liquid radioactive releases to the environment are in compliance with authorized limits and reducing doses to the public and effects on the environment to levels that are as low as reasonably achievable (optimization of protection).

2.13. Clearance (the removal of radioactive material within authorized practices from any further regulatory control) and the control of discharges (planned and controlled releases of gaseous or liquid radioactive material to the environment)

are addressed in IAEA Safety Standards Series Nos RS-G-1.7, Application of the Concepts of Exclusion, Exemption and Clearance [18] and WS-G-2.3, Regulatory Control of Radioactive Discharges to the Environment [19], respectively.

3. ROLES AND RESPONSIBILITIES

LEGAL AND ORGANIZATIONAL FRAMEWORK

Requirement 1 of GSR Part 5 [4]: Legal and regulatory framework

“The government shall provide for an appropriate national legal and regulatory framework within which radioactive waste management activities can be planned and safely carried out. This shall include the clear and unequivocal allocation of responsibilities, the securing of financial and other resources, and the provision of independent regulatory functions. Protection shall also be provided beyond national borders as appropriate and necessary for neighbouring States that may be affected.”

Requirement 2 of GSR Part 5 [4]: National policy and strategy on radioactive waste management

“To ensure the effective management and control of radioactive waste, the government shall ensure that a national policy and a strategy for radioactive waste management are established. The policy and strategy shall be appropriate for the nature and the amount of the radioactive waste in the State, shall indicate the regulatory control required, and shall consider relevant societal factors. The policy and strategy shall be compatible with the fundamental safety principles and with international instruments, conventions and codes that have been ratified by the State. The national policy and strategy shall form the basis for decision making with respect to the management of radioactive waste.”

3.1. The government is responsible for ensuring that a national policy and strategy are established for the management of radioactive waste [1, 2]. The policy and strategy, and the legal framework, should cover all types and volumes of radioactive waste generated in the State, all waste processing and storage

facilities located in the State, and all waste imported into it or exported from it, with due account taken of the interdependences between the various steps of radioactive waste management, the time periods involved and the long term management (including disposal) options available.

3.2. The management of radioactive waste should be undertaken within an appropriate national legal and regulatory framework that provides for a clear allocation of duties and responsibilities, and that ensures the effective regulatory control of the facilities and activities concerned [1, 2]. Measures should be established within the legal framework to ensure compliance with other relevant international legal instruments, such as the Joint Convention [5], the Convention on Nuclear Safety [20], the Code of Conduct on the Safety and Security of Radioactive Sources [21], the Convention on Assistance in the Case of a Nuclear Accident [22], and the Convention on Early Notification of a Nuclear Accident or Radiological Emergency [23].

3.3. If more than one governmental body is charged with implementation of the national policy and strategy, effective arrangements should be put in place to ensure that the responsibilities and functions of each body are clearly defined and coordinated, in order to avoid any omissions or unnecessary duplication. This should be organized in such a way as to achieve consistency and to enable the necessary feedback and exchange of information.

3.4. In relation to the predisposal management of radioactive waste, where nuclear safety, environmental protection, industrial safety and occupational health aspects are separately regulated, the regulatory framework should recognize that safety as a whole is affected by the interdependences between radiological, industrial, chemical and toxic hazards. This should be taken into account in the regulatory framework, so that it delivers effective control.

3.5. It should be ensured within the legal framework that the construction of facilities for the predisposal management of radioactive waste adjacent to an existing facility that could affect the safety of either facility is monitored and controlled by means of planning requirements or other legal instruments.

3.6. The management of radioactive waste may entail the transfer of the waste from one operating organization to another, or from one State to another. Such transfers create interdependences in legal responsibilities as well as physical interdependences in the various steps in the management of radioactive waste. The legal framework should include provisions to ensure a clear allocation of responsibility for safety throughout the entire waste management process

(including provisions for regulatory control and authorization), in particular with respect to the long term storage of radioactive waste and with respect to its transfer between operating organizations.

3.7. The government is responsible for establishing a regulatory body independent from the owner of the radioactive waste and the operating organization managing the radioactive waste, with adequate authority, power, staffing and financial resources to discharge its assigned responsibilities [2, 4].

3.8. Responsibility for safety should be ensured by means of a system of authorization established by the regulatory body. For transfers of radioactive waste between one State and another, authorizations from the relevant national regulatory bodies of both States are required [2, 4].

3.9. A mechanism for providing adequate financial resources is required to be established to cover future costs, in particular, the costs associated with the decommissioning of the nuclear fuel cycle facility and its associated waste management facilities, and also the costs of long term management of radioactive waste (including its storage and disposal) [4, 24]. The organizational and financial arrangements are required to be updated at each stage of licensing. Consideration is also required to be given to the use of these financial resources in the event of a sudden shutdown of the predisposal radioactive waste management facility or early dispatch of the waste to a disposal facility.

3.10. In order to facilitate the establishment of a national policy and strategy, the government should establish a national inventory of the radioactive waste (both current waste and anticipated waste, including waste expected to be generated during the decommissioning and dismantling of nuclear fuel cycle facilities and associated waste management facilities) and should update it at regular time intervals. This inventory should address the various waste classes as defined in GSG-1 [9] or in the national waste classification scheme. In establishing the national policy and strategy, account should be taken of the long term management of the waste including its disposal, both from a technical point of view and from the point of view of ensuring adequate human resources and financial resources.

3.11. There should be sufficient capacity to process all waste generated, and storage capacity should be sufficient to take account of uncertainties in the availability of facilities for the processing and disposal of waste. In judging the sufficiency of capacity, account should be taken of uncertainties in processes, reliability and availability of systems and the possible need for redundancy.

3.12. The government should consult interested parties (i.e. those who are involved in or are affected by radioactive waste management activities) on matters relating to the development of national policies and strategies that affect the management of radioactive waste, and should take due account of the concerns of the public in decision making [2].

RESPONSIBILITIES OF THE REGULATORY BODY

Requirement 3 of GSR Part 5 [4]: Responsibilities of the regulatory body

“The regulatory body shall establish the requirements for the development of radioactive waste management facilities and activities and shall set out procedures for meeting the requirements for the various stages of the licensing process. The regulatory body shall review and assess the safety case³ and the environmental impact assessment for radioactive waste management facilities and activities, as prepared by the operator both prior to authorization and periodically during operation. The regulatory body shall provide for the issuing, amending, suspension or revoking of licences, subject to any necessary conditions. The regulatory body shall carry out activities to verify that the operator meets these conditions. Enforcement actions shall be taken as necessary by the regulatory body in the event of deviations from, or noncompliance with, requirements and conditions.”

³ “The safety case is a collection of arguments and evidence in support of the safety of a facility or activity. The safety case will normally include the findings of a safety assessment, and will typically include information (including supporting evidence and reasoning) on the robustness and reliability of the safety assessment and the assumptions made therein.”

3.13. The main responsibilities of the regulatory body relating to the safe management of radioactive waste include the development of regulatory requirements, of procedures for licensing, compliance verification and enforcement, and of guidance to be followed by licensees. Responsibilities of the regulatory body may also include contributing to the technical basis and inputs for the establishment of policies, safety principles and associated criteria, and establishing requirements or conditions to serve as the basis for regulatory decisions. The regulatory body should also provide specific guidance on how to meet requirements for the safe management of radioactive waste.

3.14. The scope and level of detail of the regulatory review of the licensing documentation (safety case⁴) for the predisposal management of radioactive waste from nuclear fuel cycle facilities should follow a graded approach commensurate with the safety significance, complexity, and maturity of the facility or activity, as well as the characteristics of the waste, with consideration given to the stage in the lifetime of the nuclear fuel cycle facility or predisposal radioactive waste management facility. The safety case and supporting safety assessment should be reviewed and updated periodically as necessary by the operating organization and subsequently reviewed by the regulatory body.

3.15. General recommendations for regulatory inspection and enforcement actions relating to radioactive waste management facilities are provided in IAEA Safety Standards Series No. GS-G-1.3, Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body [25]. The regulatory body should periodically verify that the operation of the radioactive waste management facility meets national requirements and the facility's licence conditions, including requirements relating to the keeping of records on inventories and material transfers; requirements for processing, storage, maintenance, inspection, testing and surveillance; operational limits and conditions; requirements for modifications to the facility; and requirements relating to emergency preparedness and response. Such verification may be carried out, for example, by means of routine inspections of the radioactive waste management facility and audits of the operating organization. The regulatory body should verify that the necessary records are prepared and that they are maintained for an appropriate period of time. A suggested list of records is included in IAEA Safety Standards Series No. GS-G-1.4, Documentation for Use in Regulating Nuclear Facilities [26].

3.16. The regulatory body should establish a process for informing interested parties about the safety aspects (including health and environmental aspects) of the radioactive waste management facility and about regulatory processes, and should consult these parties, as appropriate, in an open and inclusive manner. The need for confidentiality, for example for purposes of nuclear security, should be respected.

⁴ The safety case may be known by different names (such as safety report, safety dossier, safety file) in different States and may be presented in a single document or a series of documents (see Section 5).

3.17. The regulatory body should establish and clarify to the operator the licensing strategy to be adopted for each waste management facility (in accordance with the national legal and governmental framework), for example:

- (a) A licence issued for an indefinite period of time (e.g. the entire lifetime of the predisposal waste management facility), covering the generation and processing of waste and/or the storage system, and encompassing the entire anticipated operating period of the nuclear fuel cycle facility generating the waste, including periodic review of the safety case and safety assessments (see Section 5); or
- (b) A licence issued for a specified time period, or for a specific stage of the lifetime of the predisposal waste management facility, with the possibility of its renewal on or prior to expiration; or
- (c) A licence issued for a specific activity or condition, e.g. long term storage of radioactive waste after the nuclear fuel cycle facility has been permanently shut down and decommissioned.

3.18. If the regulatory body consists of more than one authority, effective arrangements are required to be put in place through the establishment of clear communication and operational protocols to ensure that regulatory responsibilities and functions are clearly defined, agreed and effectively coordinated. Communication and operational protocols should clearly identify the responsibilities and functions of each authority, should spell out the objectives and actions or agreements, and should be periodically reviewed in order to avoid any omissions or unnecessary duplication and to prevent conflicting requirements being placed on the operating organization (Requirement 7, GSR Part 1 (Rev. 1) [2]).

RESPONSIBILITIES OF THE OPERATING ORGANIZATION

Requirement 4 of GSR Part 5 [4]: Responsibilities of the operator

“Operators shall be responsible for the safety of predisposal radioactive waste management facilities or activities. The operator shall carry out safety assessments and shall develop a safety case, and shall ensure that the necessary activities for siting, design, construction, commissioning, operation, shutdown and decommissioning are carried out in compliance with legal and regulatory requirements.”

3.19. The operating organization is responsible for the safety of all activities undertaken at its facilities associated with the management of radioactive waste (including activities undertaken by contractors) in compliance with the principles contained in SF-1 [1]. The operating organization is responsible for the demonstration of safety by means of a safety case and periodic safety reviews, and is responsible for ensuring that activities are carried out in compliance with the safety case and with national legal and regulatory requirements. The operating organization is responsible for the establishment and implementation of a management system, including the related programmes and procedures necessary to ensure safety. The operating organization is required to maintain a strong safety culture, to take measures to review and assess its safety culture periodically, and to adopt and apply the necessary principles and processes in order to strengthen the safety culture [7].

3.20. In some instances the operating organization may be the owner of the radioactive waste, while in other cases the owner may be a separate organization or operating unit. If the owner and the operating organization are separate, the interface between responsibilities of the owner and those of the operating organization should be clearly defined, agreed on and documented. Ownership of the waste should be clearly specified; in cases of centralized reprocessing facilities that collect and mix waste streams arising from multiple sources, ownership of the conditioned waste should be clearly identified. Information on any change in ownership of the radioactive waste or in the relationship between the owner and the operating organization of the waste management facility should be provided to the regulatory body and, as required, to governmental bodies.

3.21. The responsibilities of the operating organization of a radioactive waste management facility typically include the following:

- (a) Application to the regulatory body, including submission of an acceptable safety case, to obtain regulatory approval for the radioactive waste management facility or activity.
- (b) The conduct of appropriate radiological impact assessments and non-radiological environmental impact assessments in support of the application for a licence, and the conduct of periodic safety reviews.
- (c) The development of operational limits and conditions and controls, including waste acceptance criteria of the waste management facility consistent with the safety case, for approval by the regulatory body.
- (d) The conduct of all activities in accordance with the requirements of the safety case, the licence conditions and the applicable regulations.

- (e) The development and application of procedures for the receipt, storage and processing of radioactive waste.
- (f) Planning for the possible long term storage of radioactive waste after the nuclear fuel cycle facility has been decommissioned.
- (g) Ensuring that the information recorded at a particular step in the waste management process is sufficient to demonstrate compliance with the downstream waste acceptance criteria (e.g. the safety case for disposal of the waste).
- (h) Management of the information required either to support the later disposition or storage of the radioactive waste or to support the decommissioning of that waste management facility, especially where such decommissioning may take place many decades after operations have ceased.
- (i) The provision of periodic reports as required by the regulatory body (e.g. information on the actual inventory of radioactive waste, on any transfers of radioactive waste into and out of the facility, including material cleared from regulatory control, and on any events that occur at the facility and which have to be reported to the regulatory body) and communication with relevant interested parties and the public.
- (j) The development and implementation of measures that will control the generation of radioactive waste, in terms of its volume and activity content, to the minimum practicable.
- (k) Ensuring that radioactive waste is processed in a manner that complies with the acceptance criteria for storage and disposal as well as with transport requirements. In situations where acceptance criteria for disposal are not yet available, ensuring that the management of radioactive waste is based on reasonable assumptions for the anticipated disposal option, including provisions for waste characterization in order to supply data for future decisions with respect to disposal, and making provisions for relocating the radioactive waste for storage and/or disposal.
- (l) Ensuring that spent nuclear fuel declared as waste is managed appropriately with account taken of its high activity, heat generation and potential for criticality [27]. Appendix I provides a listing of the typical properties and characteristics that should be considered for waste packages and spent nuclear fuel declared as waste.
- (m) Due consideration and decision making in the following cases:
 - (i) The management of waste if no disposal option is available;
 - (ii) The management of waste that would need to be stored over long periods of time prior to its disposal;

- (iii) The management of waste in the case of storage for radioactive decay with the objective of clearance of the waste from regulatory control or reclassification of the waste.

3.22. The operating organization is responsible for establishing an overall waste management strategy consistent with the national waste management policy. The operating organization should develop a waste management programme that is consistent with the overall waste management strategy, that is facility specific, and that is consistent with other relevant programmes on the site (e.g. on multi-facility sites). The waste management programme:

- (a) Should implement the national waste management policy and strategy, as far as applicable;
- (b) Should take into account the connections between the sources of radioactive waste and the eventual discharge, disposal or onward disposition of the waste from that facility;
- (c) Should take into account the following hierarchy of strategic options for the predisposal management of radioactive waste:
 - (1) Keeping the generation of radioactive waste to the minimum practicable, in terms of its type, activity and volume, by using suitable technologies;
 - (2) Reuse and recycling of materials;
 - (3) Processing of radioactive waste to ensure its safe storage and disposal.

More detailed guidance on facility specific waste management programmes is provided in Appendix II.

3.23. At the design stage, the operating organization is required to prepare an initial decommissioning plan, and to update it as necessary and as required [24]. The final decommissioning plan is required to consider the possible long term storage and disposal of radioactive waste after permanent shutdown of the facility⁵. For new facilities, features that will facilitate decommissioning are required to be included in the design; such features should be included in the initial decommissioning plan, together with information on arrangements for how the availability of the necessary financial resources will be ensured.

⁵ The term 'permanent shutdown', as used in this Safety Guide, means that the nuclear fuel cycle facility has ceased operation, i.e. it will no longer be used for its intended purpose. Permanent shutdown differs from a planned shutdown (e.g. due to maintenance, inspection or modification) or an unplanned shutdown (e.g. due to an incident or accident).

3.24. For existing facilities without a decommissioning plan, such a plan is required to be prepared by the operating organization as soon as possible. The decommissioning plan is reviewed and updated at each stage and periodically throughout the lifetime of the facility. Requirements on decommissioning are established in IAEA Safety Standards Series No. GSR Part 6, Decommissioning of Facilities [24], and recommendations are provided in IAEA Safety Standards Series No. WS-G-2.4, Decommissioning of Nuclear Fuel Cycle Facilities [28].

3.25. The operating organization should establish the requirements for training and qualification of its staff and contractors, including for initial training and periodic refresher training. The operating organization should ensure that all staff members concerned understand the nature of the radioactive waste being managed, the objectives of the radioactive waste management processes, the safety case, potential hazards associated with the waste and the relevant operating and safety procedures to the extent required by their responsibilities. Supervisory staff should be competent to perform their activities and should therefore be selected, trained, qualified and authorized for that purpose. Trained and qualified radiation protection officers should be appointed to oversee the application of the radiation protection requirements.

3.26. The operating organization should carry out pre-operational tests and commissioning tests to demonstrate compliance of the radioactive waste management facility and its activities with the requirements of the safety case and supporting safety assessment and with the safety requirements established by the regulatory body. A report summarizing the results of the pre-operational and commissioning tests before the introduction of radioactive material (i.e. inactive commissioning or ‘cold processing’) should be prepared and should be submitted to the regulatory body for review and acceptance.

3.27. The operating organization should ensure that the clearance of radioactive material within authorized practices from any further regulatory control and the control of discharges of radioactive material and other potentially hazardous materials to the environment are in accordance with the conditions of the licence or authorization, and should limit on-site contamination and occupational exposure, with account taken of the need for optimization of protection and safety.

3.28. Records should be maintained for discharges, the clearance of radioactive material from regulatory control, the reuse or recycling of materials, and the delivery of radioactive waste to an authorized disposal facility or its transfer to other facilities. Such records should be retained until the facility has been fully

decommissioned, or alternatively for a period of time after decommissioning as agreed with the regulatory body.

3.29. The operating organization should develop and maintain a records system on the generation, processing, storage and transfer of radioactive waste (e.g. for further processing, storage or disposal), which should cover, among other aspects, the radioactive inventory, the location and characteristics of the radioactive waste, and information on its ownership, origin and place of transfer [29]. Such records should be preserved and updated, to enable the implementation of the facility specific radioactive waste management programme. The records system should be managed by the operating organization in accordance with regulatory requirements.

3.30. The operating organization should prepare plans and implement programmes for personnel monitoring, area monitoring and environmental monitoring. Such programmes should be evaluated periodically.

3.31. The operating organization should establish a process for authorization of modifications that includes the evaluation of modifications to the radioactive waste management facility and activities, to the operational limits and conditions, and to the radioactive waste to be processed or stored. The evaluation should use a graded approach that is commensurate with the safety significance of the modifications. The evaluation of the potential consequences of such modifications should also consider potential consequences for the safety of other facilities and for the subsequent storage, further processing or disposal of radioactive waste.

3.32. As stated in GSR Part 5 [4], the operating organization is required to put in place appropriate mechanisms for ensuring that sufficient resources, including financial resources, are available to undertake all necessary tasks throughout the lifetime of the facility, including for its decommissioning, for possible long term storage of radioactive waste at the site after the facility has been permanently shut down, and for the disposal of radioactive waste (even when a disposal option is not yet available). In certain circumstances, financial resources may need to be provided by the waste owner.

3.33. The operating organization should develop on-site emergency arrangements, including an on-site emergency response plan for preparedness for and response to a nuclear or radiological emergency on the basis of the hazards associated with the facility and activities within the site and the potential consequences of an emergency [30–32]. In assessing the hazards associated with nuclear fuel cycle facility sites on which radioactive waste processing or storage facilities are also