

IAEA Safety Standards

for protecting people and the environment

Leadership, Management and Culture for Safety in Radioactive Waste Management

General Safety Guide

No. GSG-16



IAEA

International Atomic Energy Agency



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IAEA SAFETY STANDARDS AND RELATED PUBLICATIONS

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

<https://www.iaea.org/resources/safety-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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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.

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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.

LEADERSHIP, MANAGEMENT
AND CULTURE FOR SAFETY
IN RADIOACTIVE WASTE
MANAGEMENT

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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. GSG-16

LEADERSHIP, MANAGEMENT AND CULTURE FOR SAFETY IN RADIOACTIVE WASTE MANAGEMENT

GENERAL SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2022

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FOREWORD

by Rafael Mariano Grossi
Director General

The IAEA's Statute authorizes it to "establish...standards of safety for protection of health and minimization of danger to life and property". These are standards that the IAEA must apply to its own operations, and that States can apply through their national regulations.

The IAEA started its safety standards programme in 1958 and there have been many developments since. As Director General, I am committed to ensuring that the IAEA maintains and improves upon this integrated, comprehensive and consistent set of up to date, user friendly and fit for purpose safety standards of high quality. Their proper application in the use of nuclear science and technology should offer a high level of protection for people and the environment across the world and provide the confidence necessary to allow for the ongoing use of nuclear technology for the benefit of all.

Safety is a national responsibility underpinned by a number of international conventions. The IAEA safety standards form a basis for these legal instruments and serve as a global reference to help parties meet their obligations. While safety standards are not legally binding on Member States, they are widely applied. They have become an indispensable reference point and a common denominator for the vast majority of Member States that have adopted these standards for use in national regulations to enhance safety in nuclear power generation, research reactors and fuel cycle facilities as well as in nuclear applications in medicine, industry, agriculture and research.

The IAEA safety standards are based on the practical experience of its Member States and produced through international consensus. The involvement of the members of the Safety Standards Committees, the Nuclear Security Guidance Committee and the Commission on Safety Standards is particularly important, and I am grateful to all those who contribute their knowledge and expertise to this endeavour.

The IAEA also uses these safety standards when it assists Member States through its review missions and advisory services. This helps Member States in the application of the standards and enables valuable experience and insight to be shared. Feedback from these missions and services, and lessons identified from events and experience in the use and application of the safety standards, are taken into account during their periodic revision.

I believe the IAEA safety standards and their application make an invaluable contribution to ensuring a high level of safety in the use of nuclear technology. I encourage all Member States to promote and apply these standards, and to work with the IAEA to uphold their quality now and 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.

Safety Guides

Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it

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

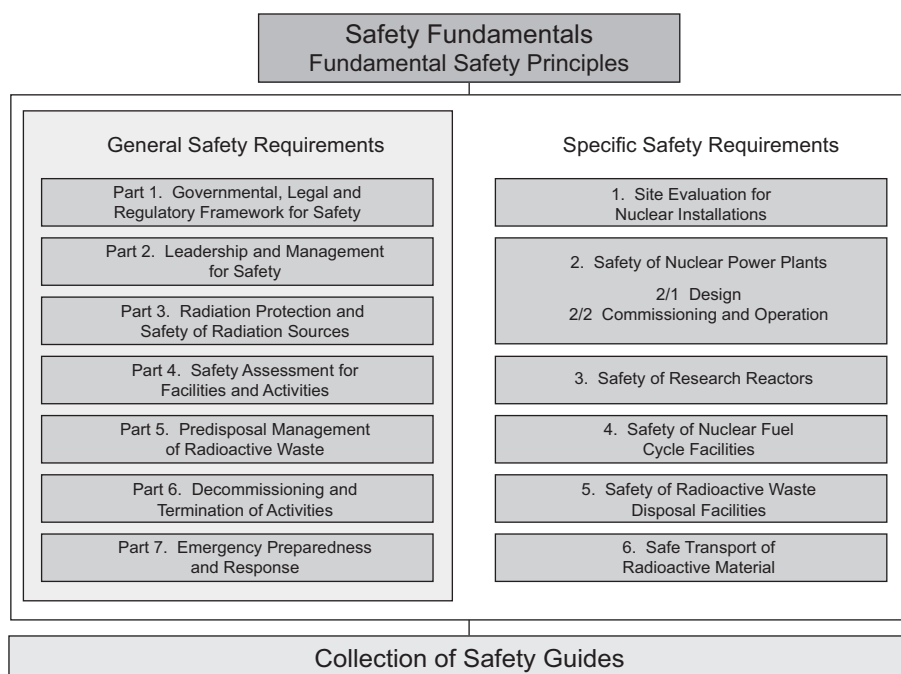


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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 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.

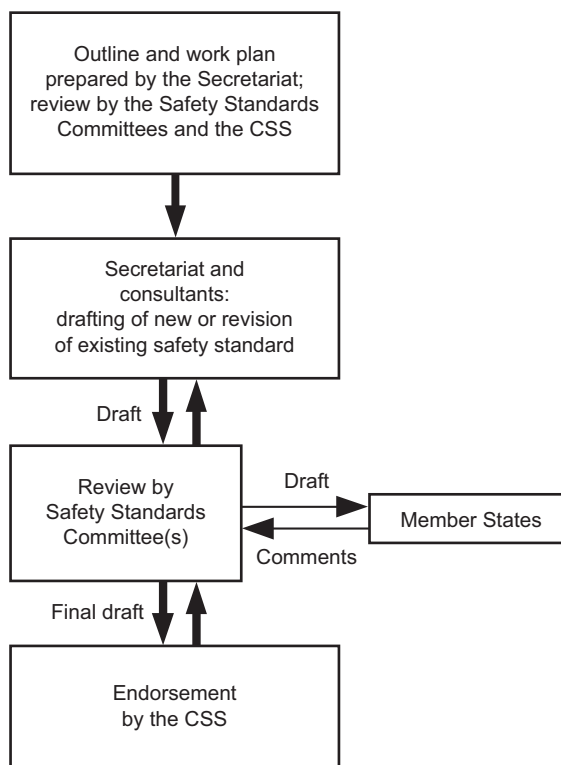


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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 <https://www.iaea.org/resources/safety-standards/safety-glossary>). 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, for legal and regulatory purposes, material for which no further use is foreseen that contains, or is contaminated with, radionuclides at activity concentrations greater than clearance levels as established by the regulatory body [1]. Radioactive waste must be managed safely and in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce radioactive waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management, in accordance with IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [2].

1.2. Requirements for the management of radioactive waste are established in IAEA Safety Standards Series Nos GSR Part 5, Predisposal Management of Radioactive Waste [3], and SSR-5, Disposal of Radioactive Waste [4]. Management systems¹ for radioactive waste management² are subject to the requirements established in IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [5].

1.3. This Safety Guide provides recommendations on meeting the requirements of GSR Part 2 [5] to provide confidence that the requirements for predisposal management of radioactive waste established in GSR Part 5 [3] and those for disposal of radioactive waste established in SSR-5 [4] will be met.

1.4. This Safety Guide supersedes IAEA Safety Standards Series Nos GS-G-3.3, The Management System for the Processing, Handling and Storage of

¹ A management system is defined as a “set of interrelated or interacting elements (*system*) for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner” [1].

² Radioactive waste management comprises all “administrative and operational activities involved in the handling, *pretreatment*, *treatment*, *conditioning*, *transport*, *storage* and *disposal* of radioactive waste” [1].

Radioactive Waste³, and GS-G-3.4, The Management System for the Disposal of Radioactive Waste⁴.

1.5. This Safety Guide identifies the need to consider nuclear security as well as safety; requirements and guidance on nuclear security are provided in the IAEA Nuclear Security Series publications.

1.6. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [6] and the supplementary Guidance on the Management of Disused Radioactive Sources issued as part of the Code of Conduct on the Safety and Security of Radioactive Sources [7] should be considered in developing management systems for the predisposal management and disposal of radioactive waste.

OBJECTIVE

1.7. The objective of this Safety Guide is to provide recommendations on developing and implementing management systems for safety during all steps of radioactive waste management — including processing (i.e. pretreatment, treatment and conditioning), storage and disposal, but excluding transport — and during related processes and activities as mentioned in para. 1.13. This Safety Guide also provides recommendations on effective leadership and culture for safety. The intention is that these recommendations will contribute to a high level of confidence that the following objectives will be achieved:

- (a) Radioactive waste management activities will be conducted in compliance with the requirements.
- (b) Radioactive waste packages will be of appropriate and consistent quality.
- (c) The characteristics of radioactive waste packages will be sufficiently known.

³ INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for the Processing, Handling and Storage of Radioactive Waste, IAEA Safety Standards Series No. GS-G-3.3, IAEA, Vienna (2008).

⁴ INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for the Disposal of Radioactive Waste, IAEA Safety Standards Series No. GS-G-3.4, IAEA, Vienna (2008).

- (d) Appropriate records will be kept that enable radioactive waste identification and decisions on whether radioactive waste packages and unpackaged waste⁵ conform to the waste acceptance criteria for radioactive waste management facilities.

1.8. This Safety Guide is intended to be used by the regulatory body and organizations with responsibilities for directing, planning or undertaking the management of radioactive waste; it is also intended to be used by the suppliers⁶ to such organizations of safety related services and products that support radioactive waste management. It will also be useful to members of the public and other interested parties.

SCOPE

1.9. This Safety Guide covers management systems for the following radioactive waste management activities:

- (a) The minimization of radioactive waste generation;
- (b) Processing, comprising pretreatment (e.g. collection, segregation, chemical adjustment, decontamination), treatment (e.g. volume reduction, removal of radionuclides from the waste, change of composition) and conditioning (e.g. immobilization, packaging, overpacking);
- (c) Storage;
- (d) Disposal (e.g. near surface disposal, geological disposal, borehole disposal).

1.10. This Safety Guide does not address the management system for the transport of radioactive waste, for which requirements are established in IAEA Safety Standards Series No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition [8], and specific recommendations are provided in IAEA Safety Standards Series No. TS-G-1.4, The Management System for the Safe Transport of Radioactive Material [9].

⁵ In this Safety Guide, the term ‘waste’ refers to radioactive waste unless otherwise stated.

⁶ The supply chain, described as ‘suppliers’, typically includes designers, vendors, manufacturers and constructors, employers, contractors, subcontractors, and consigners and carriers who supply safety related items. The supply chain can also include other parts of the organization and parent organizations [5].

1.11. This Safety Guide covers management systems for the activities involved in managing all types of radioactive waste as described in IAEA Safety Standards Series No. GSG-1, Classification of Radioactive Waste [10], including the following:

- (a) Activities that generate waste containing naturally occurring radionuclides;
- (b) Activities in hospitals, laboratories and research and development facilities, and in industry;
- (c) Decontamination of facilities or parts thereof;
- (d) Decommissioning of facilities or parts thereof;
- (e) Remediation (e.g. of areas affected by past activities);
- (f) Activities to manage waste generated from incidents, including accidents, and from emergencies;
- (g) Activities to manage legacy waste.

1.12. This Safety Guide provides guidance on the management system for the management of radioactive waste arising from remediation and from decommissioning, but not on any other aspect of decommissioning. Recommendations on the management system for decommissioning activities other than for the management of radioactive waste arising from decommissioning are provided in IAEA Safety Standards Series Nos. SSG-47, Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities [11], and SSG-49, Decommissioning of Medical, Industrial and Research Facilities [12].

1.13. This Safety Guide also covers management systems for the following related processes and activities:

- (a) Radioactive waste minimization;
- (b) Radioactive waste characterization (e.g. to determine the radiological and physicochemical properties of waste);
- (c) Clearance;
- (d) Design and manufacture of radioactive waste containers and waste packages;
- (e) Siting, design and construction of radioactive waste management facilities;
- (f) Safety case development and safety assessment of radioactive waste management facilities;
- (g) Authorization (e.g. licensing);
- (h) Commissioning of radioactive waste management facilities;
- (i) Operation of facilities for the predisposal management of radioactive waste;
- (j) Operation of radioactive waste disposal facilities (e.g. activities, which can extend over several decades, involving receipt of radioactive waste, waste

- emplacement in the disposal facility, backfilling and sealing, and any other operations in the period prior to closure);
- (k) Closure of radioactive waste disposal facilities;
 - (l) Institutional control of radioactive waste disposal facilities, covering both active control (e.g. nuclear security, surveillance, monitoring) and passive control (e.g. preservation of records, restricted land use).

STRUCTURE

1.14. This Safety Guide addresses all the relevant requirements of GSR Part 2 [5], GSR Part 5 [3] and SSR-5 [4]. Section 2 identifies characteristics of radioactive waste management that influence leadership, management and culture for safety. Section 3 provides recommendations on responsibility for safety. Section 4 provides recommendations on leadership for safety. Section 5 provides recommendations on management for safety. Section 6 provides recommendations on culture for safety. Section 7 provides recommendations on the measurement, assessment and improvement of the management system. The Appendix identifies elements of the management system for radioactive waste management or its regulation.

2. CHARACTERISTICS OF RADIOACTIVE WASTE MANAGEMENT

2.1. Radioactive waste management has specific characteristics that affect leadership, management and culture for safety within organizations that have responsibilities for directing, planning, undertaking or regulating the management of radioactive waste, as well as within suppliers of safety related services and products within the supply chain. The following paragraphs identify such specific characteristics as a basis for the more detailed sections that follow.

2.2. Radioactive waste management is directed and undertaken by dedicated personnel in a range of organizations whose leadership needs to be able to foster the development of a strong culture for safety and establish and apply an effective management system. GSR Part 2 [5] emphasizes that leadership for safety, management for safety, a management system and a systemic approach (i.e. an approach relating to the system as a whole, in which the interactions between technical, human and organizational factors are duly considered) are essential

to the establishment and implementation of adequate safety measures and the fostering of a strong culture for safety.

2.3. As stated in para. 1.5(b) of GSR Part 2 [5], management for safety includes the following:

“establishing and applying an effective management system. This management system has to integrate all elements of management so that requirements for safety are established and applied coherently with other requirements, including those for human performance, quality and security; and so that safety is not compromised by the need to meet other requirements or demands.”

2.4. Radioactive waste management involves a wide range of activities, from simple, small scale, low hazard, repetitive tasks to complex, large scale, highly hazardous tasks at the limits of engineering capabilities. Because of the wide range of activities, it is important that the management system be developed and applied to a specific facility or activity using a graded approach (see Requirement 7 of GSR Part 2 [5]).

2.5. The following aspects warrant particular consideration in developing a management system for radioactive waste management:

- (a) The provision of adequate human, financial and other resources for the safe management of radioactive waste. In accordance with the ‘polluter pays’ principle, an organization that generates radioactive waste is responsible for ensuring that funds are available for the waste to be managed properly.
- (b) Ownership of and responsibility for radioactive waste. The responsibility for radioactive waste can change during its management. There should be clarity at all times regarding both ownership of the waste and responsibility for safety. In some jurisdictions, ownership of and responsibility for radioactive waste is transferred when the waste moves from one organization to another; in others, ownership of and responsibility for radioactive waste always remains with the original generator of the waste. While the owner should retain overall responsibility for the waste, the licensee of the facility where the waste resides is responsible for its safety.
- (c) The possibility that national authorities or State organizations might need to take responsibility for radioactive waste because this responsibility cannot be discharged by the generator of the waste.
- (d) The timescales involved in radioactive waste management can span many human generations (see para. 3.7 of SF-1 [2]); this raises issues for the

provision of resources, particularly the provision of financial and human resources, not only for technical and safety related aspects but also for knowledge management and for culture for safety.

- (e) The need to ensure that radioactive waste generation is minimized (see para. 3.29 of SF-1 [2]) and that waste packages and unpackaged waste conform to the waste acceptance criteria of the receiving organization (see Requirement 12 of GSR Part 5 [3]).
- (f) The views of interested parties on decisions on the management of radioactive waste.
- (g) The selection of permanent options (i.e. discharge, clearance or disposal) for the release of radioactive waste from regulatory control.
- (h) The need to ensure that, wherever possible, radioactive waste is in a passively safe condition.
- (i) International best⁷ practices and lessons from industry experience.

2.6. Radioactive waste is typically managed by a series of organizations (which might be privately or publicly owned) that carry out the sequence of required predisposal management and disposal steps. For example, radioactive waste generated by one organization may be transferred to another for processing (i.e. pretreatment, treatment and conditioning), to another for storage and to yet another for disposal (see Fig. 1). Figure 1 illustrates the systemic control of radioactive waste management by operating organizations at different facilities working under a series of management systems and under the governmental, legal and regulatory framework. Waste package specifications⁸ and waste acceptance criteria facilitate the safe transfer of waste across the boundaries between management systems.

2.7. Processing, storage and disposal of radioactive waste may extend over a very long time (e.g. processing facilities and storage facilities for radioactive waste often operate for years or a few decades, and disposal facility operation may potentially last more than a hundred years). A radioactive waste management facility may therefore need to be managed over a long time period, potentially involving a series of different organizations with different leadership, cultures

⁷ 'Best' as used here means the most effective in achieving a high general level of protection of people and the environment as a whole; further guidance on the meaning of best is included in IAEA Safety Standards Series No. GSG-9, Regulatory Control of Radioactive Discharges to the Environment [13].

⁸ Waste package specifications comprise defined characteristics and properties of waste packages to provide for their acceptance at subsequent radioactive waste management facilities.

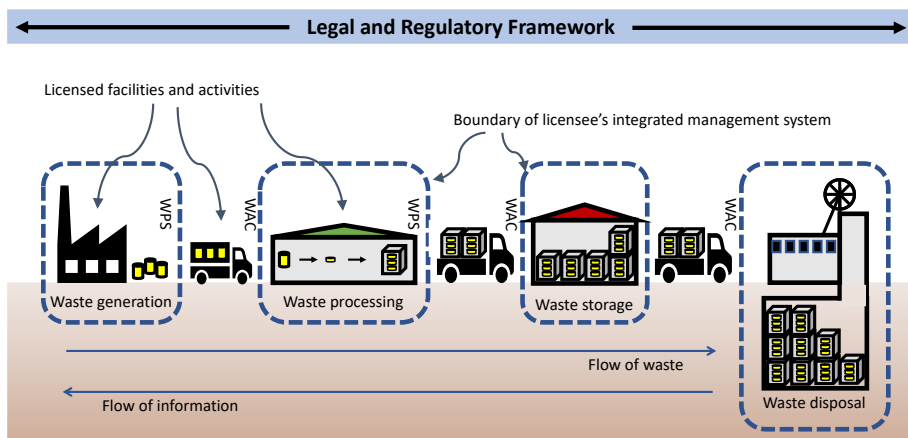


FIG. 1 Illustration of the systemic control of radioactive waste management by operating organizations at different facilities working under a series of management systems. WPS: waste package specifications; WAC: waste acceptance criteria.

and management systems, operating under successive authorities and national and international structures. The long duration of radioactive waste management has further implications, including the need to provide resources and to manage interdependencies between organizations and facilities over long time periods.

2.8. The long term nature of radioactive waste management, and particularly of radioactive waste disposal, also means that particular attention should be paid to the following:

- (a) Maintaining the confidence of interested parties, including the public, that management supervision will be continuous over the period necessary;
- (b) Establishing confidence that the long term performance of a radioactive waste disposal facility will meet regulatory requirements;
- (c) Estimating costs and establishing the funding arrangements that will be necessary to continue to monitor and control the radioactive waste using the management system until active institutional control ceases;
- (d) Ensuring continuity of understanding, knowledge, resources and safety culture over long time periods.

2.9. To gain the acceptance of the public and other interested parties for waste management operations, decision makers and leaders of the relevant organizations should place emphasis on the societal and ethical responsibilities to achieve safety now and in the future [14].

2.10. Without effective leadership, radioactive waste management programmes⁹ have limited possibilities to succeed. Political leadership should create circumstances in which operating organizations can succeed safely. Examples in some States show that if political decisions are made at the right time, significant progress can be made in radioactive waste management. There should be good communication between and among decision makers and leaders of the relevant organizations involved in radioactive waste management, and a coordinated approach should be taken, particularly towards radioactive waste disposal (see e.g. Ref. [15]). Implementing disposal involves balancing several technical and sociopolitical requirements. Thus, it is important that all key actors — the government (at all levels), operating organizations and the regulatory body, plus supporting technical experts — be aware of the issues involved and facilitate the achievement of policy aims.

2.11. Leadership for safety in radioactive waste management, particularly in programmes for the disposal of radioactive waste, depends on senior management¹⁰ possessing the following:

- (a) Awareness and judgement;
- (b) A clear view of long term policies and strategies for radioactive waste management, and the ability to communicate these effectively;
- (c) The ability to distinguish strategically important issues;
- (d) An understanding of which aspects are important to the safety of radioactive waste management;
- (e) An understanding of the hazards and risks associated with the facilities and activities in their charge, and how these compare to other hazards and risks, so that they can oversee the development and application of the management system for radioactive waste management according to a graded approach;
- (f) An understanding of which aspects of radioactive waste management are important to the public and other interested parties;
- (g) The ability to explain and communicate the importance of safety and culture for safety in radioactive waste management.

⁹ In a radioactive waste management programme, a group of related waste management projects is managed in a coordinated way and with a particular long term aim in order to obtain benefits and control not available from managing the projects individually.

¹⁰ Senior management is defined as “The person or persons who direct, control and assess an organization at the highest level” [1].

3. RESPONSIBILITY FOR SAFETY

3.1. Requirement 1 of GSR Part 2 [5] states:

“The registrant or licensee — starting with the senior management — shall ensure that the fundamental safety objective of protecting people and the environment from harmful effects of ionizing radiation is achieved.”

3.2. The prime responsibility for properly executing a particular radioactive waste management task (e.g. processing, storage or disposal, or a related activity such as the characterization of radioactive waste, clearance, or the design, construction, commissioning, operation and decommissioning or closure, as applicable, of a facility for predisposal management of radioactive waste or a radioactive waste disposal facility) rests with the operating organization¹¹ of the facility at which the waste management task is undertaken. The responsibilities of the regulatory body are defined in Requirement 3 of GSR Part 5 [3] and Requirement 2 of SSR-5 [4].

3.3. Paragraph 4.2 of GSR Part 2 [5] states that “Senior management shall be responsible for establishing safety policy.” Senior management should define and implement an organization’s safety policy based on the national policy and strategy for safety. The senior management of an organization responsible for a radioactive waste management facility or activity should be accountable for managing and demonstrating the safety of the facility or activity, consistent with the national policy and strategy for radioactive waste management and in compliance with regulatory requirements.

3.4. The senior management of an operating organization is responsible for developing goals, strategies, plans and objectives (see Requirement 4 of GSR Part 2 [5]), and for coordinating activities to achieve the fundamental

¹¹ The operating organization is defined as “Any organization or person applying for *authorization* or authorized to operate an *authorized facility* or to conduct an *authorized activity* and responsible for its *safety*....This includes, inter alia, private individuals, governmental bodies, *consignors* or *carriers*, *licensees*, hospitals and self-employed persons” [1]. Operating organization is synonymous with ‘operator’. The licensee is defined as “The holder of a current *licence*. The *licensee* is the *person or organization* having overall responsibility for a *facility* or *activity*” [1]. The operating organization might not be the holder of the licence (e.g. the operator could be a supply chain organization). In practice, for an authorized facility, the operating organization is normally also the registrant or licensee. However, the separate terms are retained to refer to the two different capacities [1].

safety objective without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks. Safety should be considered in all business decisions, activities and associated management system documentation, and protection must be optimized to provide the highest level of safety that can reasonably be achieved (see Principle 5 of SF-1 [2]). Paragraph 4.5 of GSR Part 2 [5] states that “Senior management shall ensure that goals, strategies and plans are periodically reviewed against the safety objectives, and that actions are taken where necessary to address any deviations”.

3.5. Senior management should ensure that each step of radioactive waste management has consistent goals and objectives in order not to compromise the safety of the subsequent steps in the waste management process.

3.6. Senior management should prepare plans to ensure that essential functions can operate safely for a sustained period with significant employee absence (e.g. due to an influenza outbreak). The regulatory body should regularly review those plans.

3.7. Demonstrating safety involves the development of a safety case. Recommendations on the development of the safety case are provided in IAEA Safety Standards Series Nos GSG-3, The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste [16], and SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste [17].

3.8. The senior management of an organization that manages radioactive waste is required to provide adequate resources to ensure that the organization manages the radioactive waste safely (see Requirement 9 of GSR Part 2 [5]). The senior management of such an organization should include in the management system provisions to deal with funding challenges, such as cost increases over time, cost uncertainties and risks, the availability of public and private funds, and unplanned events.

3.9. The clear allocation of accountabilities and responsibilities is essential to ensure safety throughout the management of radioactive waste. Senior management should ensure that it is clear within the management system when, how and by whom decisions are to be made and that appropriate records of decisions are documented (see para. 5.64).

3.10. Paragraph 3.3 of GSR Part 5 [3] states:

“It is possible that the predisposal management of radioactive waste will involve the transfer of radioactive waste from one operator to another, or that radioactive waste may even be processed in another State. In such situations, continuity of responsibility for safety is necessary throughout.”

3.11. Appropriate management arrangements should be put in place for the transfer of waste to ensure that it is clear where responsibility lies and the exact point at which the transfer of responsibility takes place. These management arrangements should also include provision for the transfer of appropriate records and knowledge. The responsible body at any given time is required to have an adequate management system that meets Requirements 6–8 of GSR Part 2 [5] to ensure that safety is not compromised.

3.12. If an authorization for a radioactive waste management facility or activity is terminated at any time, the government should ensure that it is clear which parties are responsible for the safety of both the facility and the waste. As stated in footnote 5 of SF-1 [2], “Not having an authorization would not exonerate the person or organization responsible for the facility or activity from the responsibility for safety.” If management and control of a site is necessary following termination of an authorization, the government should ensure that the necessary management and control is provided. For example, management arrangements may be necessary for monitoring purposes and for ensuring safety and security.

3.13. In some instances — for example, following closure of a disposal facility or the end of active institutional control of such a facility — responsibility might be transferred to the government. In such instances, the government should take over responsibility for record keeping, knowledge management and other passive institutional control measures, such as restricted land use.

3.14. There may be occasions on which there is radioactive waste for which no owner can be identified (e.g. if an orphan source is discovered and it is declared radioactive waste). In such cases, the government has to provide for the control of such waste (see para. 3.9 of SF-1 [2]). The government should arrange for the necessary resources and should assign clear responsibilities to appropriate organizations (e.g. the regulatory body) for the safe management of such waste. Organizations assigned responsibility for radioactive waste management should provide strong and effective leadership.

3.15. The senior management of a licensee that generates radioactive waste should liaise with the regulatory body and the operating organizations of relevant radioactive waste management facilities (including suitably qualified and experienced contractors, where relevant) with the aim of defining and optimizing arrangements for transfers of radioactive waste. Recommendations on the management of the supply chain to ensure that the waste can be safely managed through all steps of radioactive waste management are provided in Section 5.

3.16. The regulatory body is required to have legal authority to require the operating organization to provide the regulatory body with all necessary safety related information (see para. 2.13 of IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [18]). The operating organization should initiate interactions with the regulatory body concerning the supply of necessary safety related information as soon as possible and before the processing of waste.

3.17. Senior management should direct and oversee the development, implementation, review and revision of emergency plans in accordance with para. 3.13 of GSR Part 5 [3]. Training, drills and exercises are also required to be provided for personnel relevant for emergency response, in accordance with Requirement 25 of IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency [19].

3.18. Requirement 4 of GSR Part 7 [19] states that **“The government shall ensure that a hazard assessment is performed to provide a basis for a graded approach in preparedness and response for a nuclear or radiological emergency.”** The hazard assessment should take into account the characteristics of the waste, of the waste management facility, and of the site and its vicinity at each stage in the lifetime of the facility. Recommendations relevant to the management of large volumes of radioactive waste generated during a nuclear or radiological emergency are provided in IAEA Safety Standards Series No. GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency [20], and further information is provided in Ref. [21].

4. LEADERSHIP FOR SAFETY

4.1. Requirement 2 of GSR Part 2 [5] states that **“Managers shall demonstrate leadership for safety and commitment to safety.”**

4.2. Senior management should recognize that the attitude of individuals and the culture for safety within an organization are influenced through leadership. To improve the culture for safety and help individuals to develop professionally, managers at all levels are required to demonstrate their commitment to safety as an overriding priority in resource allocation, in business planning, in documentation and in all waste management activities (see paras 3.1 and 3.2 of GSR Part 2 [5]).

4.3. Senior management should demonstrate a proactive and long term approach to safety issues in decision making in radioactive waste management.

4.4. Senior management should ensure that processes and procedures are incorporated in the management system to identify and manage human, technological and organizational factors affecting safety. This is particularly important for radioactive waste management programmes that involve numerous organizations in implementing technological solutions and carrying out radioactive waste management activities.

4.5. Senior management should promote and exercise open and effective communication on safety at all levels in the organization. Senior management should frequently and consistently share information concerning radioactive waste management with relevant personnel. Information with a bearing on safety, and on societal and economic elements, should be communicated, as appropriate, to personnel and other relevant interested parties, including the regulatory body. This is particularly important for radioactive waste management programmes in which various other parties and operating organizations are involved in the radioactive waste management process. Senior management should regularly seek feedback on how effective the leadership is in ensuring safety and improving the management system, and should ensure that necessary corrective actions are taken.

4.6. Where radioactive waste management is likely to occur over long periods, senior management should take particular care to ensure effective knowledge transfer (e.g. recording and archiving of information) and succession planning for continuing good leadership.

4.7. Senior management is required to establish expectations for behaviour with regard to safety (see para. 3.1(c) of GSR Part 2 [5]). Senior management should communicate to all personnel the expectations for the performance of safety related tasks by individuals and by teams. Managers should be familiar with the special characteristics of radioactive waste management, such as the need to manage interdependencies, and should communicate these characteristics to personnel.

4.8. Managers should, through their own actions, promote safe ways of working, be visibly involved in safety related activities and reinforce good practices. Contributing to the development and use of international safety standards is an example of a safety related activity that should promote safe ways of working. Managers are required to promote the values of the organization and encourage open, transparent and questioning behaviours (see para. 3.2 of GSR Part 2 [5]). Managers should also be able to recognize deteriorations in safety performance or safety related attitudes and should take immediate actions to respond to the situation.

4.9. Managers should promote ways for all personnel involved in radioactive waste management to participate in the development, implementation and continuous improvement of the management system (see Section 7), with the aims of optimizing protection and safety, and achieving the organization's safety goals. Where relevant, and taking account of the need to apply a graded approach, it should be possible for other parties affected by the waste management facility or activities (e.g. the public, waste generators, organizations involved in other parts of the waste management process, sub-contractors) to contribute to improvements to the management system. Participation in activities such as peer reviews and international research and development programmes on radioactive waste management can help personnel involved in radioactive waste management to gain a better understanding of the adequacy of the management system. Managers should motivate staff to share their perceptions on the adequacy of the management system, so that the organization can enhance safety performance.

4.10. Managers at all levels in the organization should actively promote the adoption of effective measures to respond to events (including near misses) and to learn lessons from operating experiences and from identifying good practices (see para. 6.7 of GSR Part 2 [5]).

4.11. Managers should also have administrative, communication and interpersonal skills. Managers should develop their skills and support their colleagues and staff, both internally and in other organizations involved in radioactive waste management, to systematically develop their skills, solve problems and resolve conflicts.

4.12. Paragraph 3.3 of GSR Part 2 [5] states:

“Managers at all levels in the organization:

- (a) Shall encourage and support all individuals in achieving safety goals and performing their tasks safely;

- (b) Shall engage all individuals in enhancing safety performance;
- (c) Shall communicate clearly the basis for decisions relevant to safety.”

4.13. Managers should communicate routinely and often with individuals working in the organization. Managers should check that individuals understand their safety goals and how they are expected to perform their tasks safely. Managers should observe individuals’ work, monitor safety performance and provide feedback on the performance of safety related tasks. Good performance should be recognized and, as appropriate, praised and rewarded. Managers should motivate individuals and assist them in maintaining and increasing their self-esteem and pride in work performed; this is particularly relevant for radioactive waste management tasks, which need to be performed to produce consistent, high quality waste products, sometimes over long timescales. Managers should engage with all the individuals working in the organization to identify areas of weaker performance and devise appropriate solutions for enhancing safety performance. The implementation of improvements and enhancements should be facilitated and encouraged. Training and coaching in radioactive waste management tasks should be provided as appropriate. Managers are required to make clear the basis for safety related decisions; this involves providing rational explanations for decisions, including information on their understanding of what is important to the safety of the radioactive waste management facilities and activities, and on other relevant factors, supported by appropriate data and evidence.

5. MANAGEMENT FOR SAFETY

RESPONSIBILITY FOR THE INTEGRATION OF SAFETY INTO THE MANAGEMENT SYSTEM

Responsibility of senior management for the management system

5.1. Requirement 3 of GSR Part 2 [5] states that “**Senior management shall be responsible for establishing, applying, sustaining and continuously improving a management system to ensure safety.**” Senior management remains responsible for the management system even when an external organization is involved in its development or improvement.

5.2. The development of a management system for an organization should take into account, as appropriate, the following:

- (a) International standards such as ISO 9001:2015 for quality management systems [22], ISO 14001:2015 for environmental management systems [23] and ISO 45001:2018 for occupational health and safety management systems [24];
- (b) The national legal framework, and regulatory requirements and guidance;
- (c) Best practices in the nuclear and radioactive waste management industries;
- (d) The organization's responsibilities, short term and long term objectives, and strategic plans.

5.3. Irrespective of the codes, standards and requirements used in developing the management system, the design of the management system should incorporate processes and procedures both to comply with these codes, standards and requirements and to demonstrate compliance.

5.4. Senior management should ensure that all radioactive waste management activities are undertaken in compliance with the management system. Senior management should ensure that the management system continues to be properly implemented, assessed and improved, especially during periods of change, and that relevant personnel are informed of any changes and the reason for their introduction and are trained in the new processes and procedures.

5.5. Senior management should put in place arrangements to ensure that managers at all levels demonstrate commitment to the establishment, implementation, assessment and continuous improvement of the management system. Senior management should ensure that, where appropriate, the management system is capable of dealing with long term aspects, such as changes in responsibilities, as well as any interdependencies among waste generators, predisposal management facilities and activities, and waste disposal facilities and activities.

5.6. Senior management should recognize that radioactive waste management may be affected by many factors. In particular, senior management should recognize that radioactive waste disposal involves facilities built in the natural environment, which will need to perform safely over a long period. National, regional and international policies and principles for radioactive waste management, including radioactive waste disposal and industry standards for management systems, will evolve over the extended period of time for which radioactive waste management activities may continue. In addition, policy decisions (e.g. regarding the reprocessing of spent fuel) and technological

innovations and advances may lead to changes in the overall radioactive waste management strategy. Irrespective of all these factors, senior management retains responsibility for the safety of facilities and activities at all times. Senior management should, therefore, demonstrate continuous commitment to developing, implementing and improving the management system as a prerequisite to ensuring and maintaining safety.

5.7. Senior management should appoint individuals from within the organization to have specific responsibilities and authorities for the management system in the following areas¹²:

- (a) Coordinating the development and implementation of the management system and its assessment and continuous improvement;
- (b) Measuring and reporting on the performance of the management system, including its influence on safety and safety culture, and any need for improvement;
- (c) Resolving any potential conflicts between requirements on radioactive waste management and requirements on other fields of activity, such as mining safety and environmental protection (e.g. groundwater protection), and between different elements and processes of the management system.

5.8. Individuals should not be given overlapping or conflicting responsibilities and authorities.

5.9. Senior management is required to retain accountability for the management system even where other individuals are assigned responsibility for coordinating the development, application and maintenance of the management system (see para. 4.1 of GSR Part 2 [5]). Senior management should appoint an individual manager to have overall responsibility for the organization's management system that applies to the radioactive waste management programme.¹² Furthermore, senior management should ensure, when defining that person's duties, that all the waste management activities are covered in a comprehensive and coherent manner, and that these activities are covered continuously over an appropriate period of time. This is especially important for radioactive waste storage facilities and for radioactive waste disposal facilities where there could be responsibilities that extend for long periods of time.

¹² Senior management may perform some or all of these roles themselves (e.g. in small organizations).

5.10. For each process within the management system (see paras 5.87–5.117), senior management should ensure that a designated individual¹² is given the authority and responsibility for the following:

- (a) Developing and documenting the process and maintaining the necessary supporting documentation;
- (b) Ensuring that there is effective interaction between process interfaces;
- (c) Ensuring that process documentation is consistent and appropriate for the waste management facilities and activities;
- (d) Ensuring that the records necessary for demonstrating that the process results have been achieved are specified in the process documentation;
- (e) Monitoring and reporting on the performance of the process;
- (f) Promoting improvement in the process;
- (g) Ensuring that the process and any changes subsequently adopted are aligned with the goals, strategies, plans and objectives of the organization and are consistent with the organization's safety policy.

5.11. The roles and responsibilities for safety in radioactive waste management may continue for a long time and may change during this time. Responsibilities for radioactive waste may transfer between organizations and may even transfer between States (e.g. in accordance with agreements on the repatriation of waste). Management systems should be designed to ensure continuity in managing facilities and activities, and should contain provisions for managing changes, for example, in the following:

- (a) The ownership of radioactive waste and radioactive waste management facilities;
- (b) Management arrangements;
- (c) The regulatory body;
- (d) National and international legislation and standards;
- (e) Land use policies in relation to the institutional control of facilities.

5.12. When the management arrangements for radioactive waste management facilities are changed (e.g. if public organizations are privatized, if new organizations are created, if existing organizations are combined or restructured, if responsibilities are transferred between organizations, if an operating organization undergoes internal reorganization of its management structure or reallocation of resources), the possible need to adapt the management system should be assessed by senior management, while ensuring that the management system continues to be properly implemented, assessed and improved.

Goals, strategies, plans and objectives

5.13. Requirement 4 of GSR Part 2 [5] states that “**Senior management shall establish goals, strategies, plans and objectives for the organization that are consistent with the organization’s safety policy.**”

5.14. The goals, strategies, plans and objectives that are established by senior management should be derived and documented in accordance with the management system and should recognize that both short term and long term safety aspects are involved in radioactive waste management. The goals, strategies, plans and objectives should give paramount importance to safety and should seek to adhere to the waste hierarchy (see para. 3.29 of SF-1 [2] and Ref. [25]).

5.15. The goals, strategies, plans and objectives should include appropriate means of considering the concerns and expectations of interested parties in decision making (see paras 5.21–5.31), and should be communicated effectively and consulted upon, as appropriate.

5.16. Radioactive waste management strategies should be developed taking full advantage of opportunities and synergies arising from national, regional and international cooperation and experience, where appropriate. Radioactive waste management strategies should include milestones and clear time frames for the achievement of these milestones.

5.17. Senior management is also responsible for establishing the safety policy of the organization (see para. 4.2 of GSR Part 2 [5]) and should ensure that this policy is documented in the management system. Senior management should also ensure that the management system is updated if goals, strategies, plans, policies or objectives are changed. Hence, the management system documentation will consist of a dynamic collection of living documents.

5.18. The safety policy should include the following:

- (a) A statement that safety will be given overriding priority, in ensuring that other relevant requirements and provisions (e.g. for nuclear security) are also met.
- (b) A statement that the safety policy will comply with applicable national, regional and international policies, strategies and regulations on radioactive waste management.
- (c) A statement that the safety policy will take into account the views, attitudes, concerns and expectations of the public and other interested parties, in