

IAEA Safety Standards

for protecting people and the environment

Prospective Radiological Environmental Impact Assessment for Facilities and Activities

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General Safety Guide

No. GSG-10



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

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

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

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

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

PROSPECTIVE RADIOLOGICAL
ENVIRONMENTAL IMPACT
ASSESSMENT FOR
FACILITIES AND ACTIVITIES



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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-10

PROSPECTIVE RADIOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT FOR FACILITIES AND ACTIVITIES

GENERAL SAFETY GUIDE

JOINTLY SPONSORED BY THE
INTERNATIONAL ATOMIC ENERGY AGENCY
AND UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2018

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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.

PREFACE

Requirements for the protection of people from harmful consequences of exposure to ionizing radiation, for the safety of radiation sources and for protection of the environment are established in the IAEA Safety Requirements for Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (IAEA Safety Standards Series No. GSR Part 3). GSR Part 3 is jointly sponsored by the European Commission, the Food and Agriculture Organization of the United Nations, the IAEA, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization, the United Nations Environment Programme and the World Health Organization.

Three related Safety Guides were prepared to provide generic guidance on meeting the requirements of GSR Part 3 for protection of the public and protection of the environment, as follows:

- IAEA Safety Standards Series No. GSG-8, Radiation Protection of the Public and the Environment, which provides guidance on the framework for protection of the public and the environment;
- IAEA Safety Standards Series No. GSG-9, Regulatory Control of Radioactive Discharges to the Environment, which provides guidance on application of the principles of radiation protection and the safety objectives associated with the control of discharges and on the process for authorization of discharges;
- IAEA Safety Standards Series No. GSG-10, Prospective Radiological Environmental Impact Assessment for Facilities and Activities, which describes a framework and methodologies for prospective radiological environmental impact assessment.

These three Safety Guides are jointly sponsored by the IAEA and UN Environment, the leading global environmental authority, which sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment. The recommendations provided in these three Safety Guides, together with the requirements of GSR Part 3, provide a basis for including environmental considerations in the assessment and management of radioactive releases. In this context, UN Environment encourages the application of these recommendations in all its Member States, and their use as a foundation for the development of national regulations on protection of the environment from harmful effects of ionizing radiation.

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.

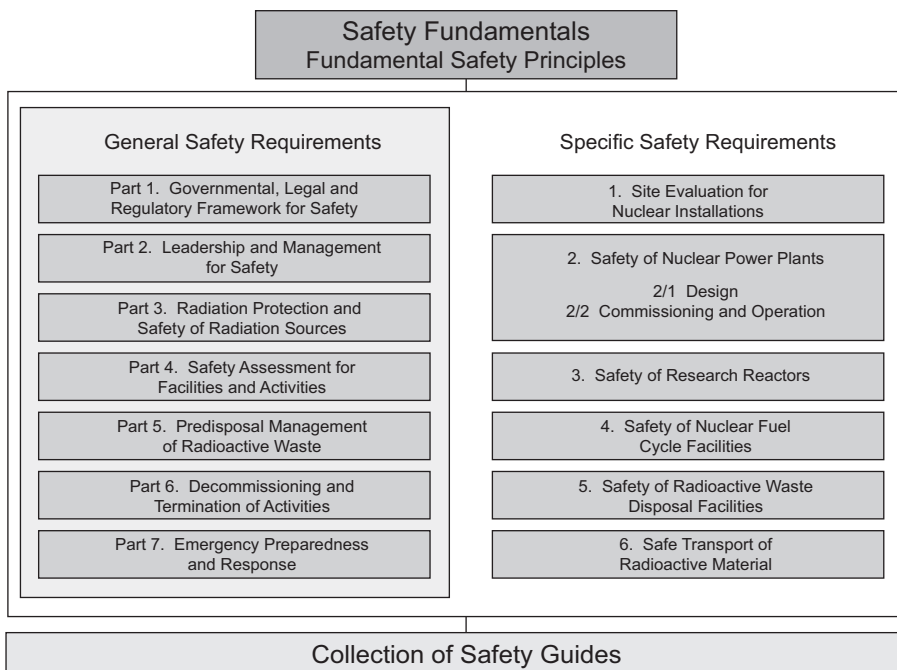


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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

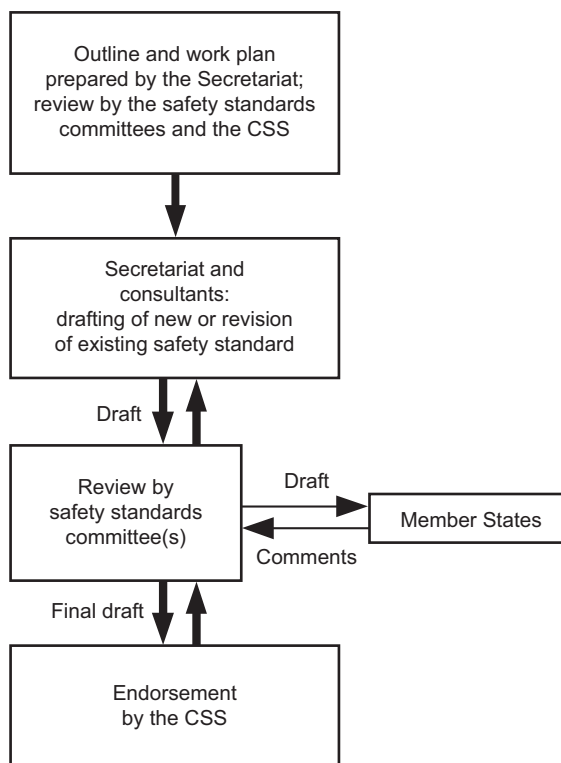


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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. In 2014, the IAEA published IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [1]. GSR Part 3 [1] is based on IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [2], and the recommendations of the International Commission on Radiological Protection (ICRP) [3]. The system of radiation protection and safety set out in GSR Part 3 [1] aims to assess, manage and control exposure to radiation so that radiation risks, including risks of health effects and risks to the environment, are reduced to the extent reasonably achievable. Protection of the public is based on the principles of justification, optimization and dose limitation, which were specified by the ICRP [3] and are incorporated in the IAEA safety standards (see Refs [1, 2]).

1.2. GSR Part 3 [1] establishes a requirement for a prospective assessment to be conducted of the radiological environmental impacts due to releases of radionuclides from facilities and activities¹. This Safety Guide provides guidance on meeting the requirements in GSR Part 3 [1] for performing such assessments for certain facilities and activities if required by the regulatory body and, in particular, for meeting the requirement established in para. 3.9(e) of GSR Part 3 [1], which states that:

“Any person or organization applying for authorization: ... Shall, as required by the regulatory body, have an appropriate prospective assessment made for radiological environmental impacts, commensurate with the radiation risks associated with the facility or activity.”

1.3. The aim of a prospective radiological environmental impact assessment is to determine whether the planned facility or activity complies with current legislative and regulatory requirements on the protection of the public and the environment under all reasonably foreseeable circumstances. Such a prospective assessment includes the consideration of exposures expected to occur in normal operation and potential exposures due to accidents that are identified and

¹ The term ‘facilities and activities’ is defined in SF-1 [2] and in the IAEA Safety Glossary [4]. It is a general term encompassing all nuclear facilities and uses of all sources of ionizing radiation. The recommendations of this Safety Guide apply to certain facilities and activities, as described in paras 1.10–1.24.

characterized by means of a safety analysis. The radiological environmental impact assessment should be as simple as possible, but as complex as necessary to achieve this aim.

1.4. In the framework of international legal instruments or national laws and regulations, States may also require that, for some facilities and activities, a governmental decision making process², including a comprehensive initial assessment of possible significant effects on the environment, be carried out at an early stage in the development of the facility or activity. In this case, the radiological environmental impact assessment is generally part of a broader impact assessment, which is generally referred to as an ‘environmental impact assessment’ or by its common abbreviation EIA. An environmental impact assessment prospectively evaluates biophysical impacts (including radiological impacts) and also covers social, economic and other relevant impacts of a proposed activity or facility prior to major decisions being taken. Within such a framework, the results of the radiological environmental impact assessment, as described within this Safety Guide, may be used for making informed judgements on the acceptability of the risk from the radiation protection perspective.

1.5. This Safety Guide is related to other publications in the IAEA Safety Standards Series, namely IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), Safety Assessment for Facilities and Activities [5]; IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency [6]; IAEA Safety Standards Series No. GSG-8, Radiation Protection of the Public and the Environment [7]; IAEA Safety Standards Series No. GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency [8]; and IAEA Safety Standards Series No. GSG-9, Regulatory Control of Radioactive Discharges to the Environment [9]. This Safety Guide should be used in conjunction with these other safety standards.³

1.6. This Safety Guide provides a general framework that is consistent with, and that can be applied as a complement to, the guidance provided in other Safety

² An explanation of the term ‘governmental decision making process’ is provided in para. 2.3.

³ The IAEA has also issued a Safety Report on methods and models that can be used to assess the impact of releases of radioactive material to the environment [10] and Technical Reports relevant to environmental transfer parameters [11, 12]. A revision of Safety Reports Series No. 19 [10] is in preparation and will cover screening assessments of public exposure, generic models and parameters for use in assessing the impact of radioactive discharges, and generic models and parameters for assessing exposures of flora and fauna due to radioactive discharges from facilities and activities.

Guides that set out frameworks for safety assessment for facilities and activities and include the concept of radiological environmental impact assessment (as part of the safety assessment) but in less detail than it is described in this Safety Guide. Examples include IAEA Safety Standards Series No. GSG-3, The Safety Case and Safety Assessment for the Predisposal Management of Radioactive Waste [13], and IAEA Safety Standards Series No. WS-G-5.2, Safety Assessment for the Decommissioning of Facilities Using Radioactive Material [14].

OBJECTIVE

1.7. This Safety Guide provides recommendations and guidance on a general framework for performing prospective radiological impact assessments for facilities and activities, to estimate and control the radiological effects on the public and on the environment. This radiological impact assessment is intended for planned exposure situations as part of the authorization process and, when applicable, as part of a governmental decision making process (see para. 2.3) for facilities and activities. The situations covered include both exposures expected to occur in normal operation and potential exposures (see para. 2.2).

1.8. This Safety Guide provides general guidance and recommendations about the content of a prospective radiological environmental impact assessment, its use and the procedures for its implementation, as an aid to national regulatory bodies, to persons or organizations responsible for facilities and activities and to other interested parties⁴, including but not restricted to those persons or organizations applying for an authorization for or responsible for the operation of facilities and the conduct of activities. It is recognized in this Safety Guide that different States use different approaches to perform some aspects of the radiological environmental impact assessment. This is because of the complexity and diversity of the options for the management of environmental issues, which depends on the characteristics of the facilities and activities themselves, the specific environmental conditions and the national regulations and circumstances.

⁴ GSR Part 3 [1] uses the term ‘interested party’ to mean, in a broad sense, a person or group having an interest in the performance of an organization. Interested parties have typically included customers, owners, operators, employees, suppliers, partners and trade unions; the regulated industry or professionals; scientific bodies; and governmental agencies or regulatory bodies. The term could also include other States (e.g. neighbouring States concerned with possible transboundary impacts).

1.9. Figures 1–3 (in Sections 4 and 5) and I–1 and I–2 (in Annex I) illustrate elements of the prospective radiological environmental impact assessment and facilitate their logical description but do not represent detailed procedures. Other important aspects that should be considered when performing those assessments, such as the selection of computer codes, uncertainty analysis, verification, quality assurance and quality control, are not described in this Safety Guide.

SCOPE

1.10. This Safety Guide applies to those facilities and activities for which, according to their characteristics and according to national or internationally applicable regulations, a radiological environmental impact assessment is mandatory. Guidance on how to determine the need for and complexity of a radiological environmental impact assessment is provided in Section 4.

1.11. This Safety Guide provides guidance on how to prospectively evaluate radiation exposures and radiation risks due to radioactive releases to the environment from new or existing facilities and activities from which the public and the environment might be exposed to radiation.⁵ For certain facilities and activities, radiation exposure of and radiation risk to the public due to direct external irradiation is considered. This Safety Guide describes a radiological environmental impact assessment using generic data and models; site specific data and models; and a combination of both, as relevant.

1.12. The radiation exposures considered include exposures that are expected to occur as a result of normal operation (i.e. due to authorized discharges or direct external irradiation) and exposures that might occur but are not certain to occur,

⁵ Facilities and activities needing a radiological environmental impact assessment are those in which radioactive material is produced, processed, used, handled or stored in such a form and on such a scale that consideration of the possible impact on the public and the environment is required. Examples of such facilities include nuclear installations (including nuclear power plants, research reactors, radioisotope production facilities, source production facilities, spent fuel storage facilities, reprocessing facilities, facilities for the enrichment of uranium, nuclear fuel fabrication facilities, predisposal radioactive waste management facilities, disposal facilities during the operational period, and nuclear fuel cycle related research and development facilities); some mining and raw material processing facilities, such as open pit uranium mines; and facilities for the milling or processing of uranium ores. Examples of activities include the use of unsealed radiation sources for industrial, research and medical purposes, and the decommissioning of certain facilities.

as determined by means of a safety analysis⁶ of events and accidents⁷, as defined in GSR Part 3 [1] (i.e. potential exposures).

1.13. This Safety Guide does not provide guidance on equivalent prospective assessments of ‘delayed’ exposures that may occur in the post-closure period of a waste disposal facility [15], of exposures from the transport of radioactive material and of exposures from the use of mobile radioactive sources. Specific guidance on the assessment of exposures for disposal and for transport is provided in, respectively, IAEA Safety Standards Series No. SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste [16], and IAEA Safety Standards Series No. TS-G-1.3, Radiation Protection Programmes for the Transport of Radioactive Material [17].

1.14. A radiological environmental impact assessment, as described within this Safety Guide, is intended to be prospective in nature. For example, it can be conducted prior to siting, as part of the application for an authorization during construction and prior to operation, or prior to decommissioning. A radiological environmental impact assessment can serve multiple purposes, including establishing the initial basis for authorization with respect to the protection of the public and the environment, and as an important input into the process of authorizing controlled discharges. The process for authorizing discharge limits for optimizing the protection of workers and the public and safety is covered in GSG-9 [9].

1.15. A radiological environmental impact assessment can also be conducted for existing facilities for which changes in their operational processes are planned, before the implementation of any significant change affecting the level of discharges or potential releases to the environment; if deemed necessary, a radiological environmental impact assessment can also be conducted in the framework of a periodic safety review.

1.16. The radiological environmental impact assessment described in this Safety Guide is not intended to assess retrospectively the radiological impact from discharges during operation or the consequences of an actual accident. Nevertheless, the prospective assessment of potential exposures could provide

⁶ ‘Safety analysis’ is part of the safety assessment for facilities and activities [5].

⁷ The IAEA Safety Glossary defines an ‘accident’ as “Any unintended *event*, including operating errors, equipment *failures* and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of *protection and safety*” (*italic* denotes a term with an entry in the Safety Glossary) [4].

preliminary information to be used in assessing the hazards and the related consequences for the purpose of establishing an adequate level of emergency preparedness and response [6].

1.17. The prospective assessment of potential exposures for facilities and activities, as described in this Safety Guide, may necessitate that accidents with very low probabilities of occurrence leading to radiological consequences for the public and the environment be considered and that the criteria for potential exposures be met. However, even if a facility or an activity meets these criteria, it does not preclude the need for an assessment of hazards in relation to preparedness and response for a nuclear or radiological emergency, in line with requirements in GSR Part 7 [6]. Other aspects of the consequences of large accidental releases to the environment, such as societal and economic effects and non-radiological effects on the environment and on ecosystems, are outside the scope of this Safety Guide.

1.18. This Safety Guide does not describe in detail the specifications and characteristics of the events and accidents to be considered in the assessment of potential exposure of the public, nor the methodology for their selection and analysis; such specification and characterization, which should be determined by a systematic analysis, should be done in the framework of a safety assessment for a facility or activity, as described in GSR Part 4 (Rev. 1) [5].

1.19. This Safety Guide defines a general framework and describes the general aspects of the methodology for performing a prospective radiological environmental impact assessment; this Safety Guide does not describe in detail the models to be used or the collection and use of data from radiological environmental monitoring programmes, which are normally undertaken at the pre-operational stage and the operational stage⁸ of a facility or activity. For the purposes of this Safety Guide, it is assumed that environmental and source monitoring is carried out as relevant at the pre-operational stage and at the operational stage and that it provides the necessary information for adequate dose estimates and for verifying that the models and assumptions used in the prospective assessment are appropriate. The prospective assessment as described

⁸ Monitoring programmes at the pre-operational stage are defined, for instance, to establish 'baseline' activity concentrations in environmental media and to provide information and data for dose assessment purposes [18]. During the operation of the facility or the conduct of the activity, monitoring programmes are put in place to verify compliance with discharge limits, to check the conditions of operation, to provide warning of unusual or unforeseen conditions and to check the predictions of environmental models [18].

in this Safety Guide can also be used to underpin the establishment or upgrade of a site specific environmental monitoring programme. Guidance for environmental and source monitoring programmes is provided in IAEA Safety Standards Series No. RS-G-1.8, Environmental and Source Monitoring for Purposes of Radiation Protection [18], and further information is provided in Ref. [19]. The need for and general characteristics of environmental monitoring programmes for the demonstration of compliance with authorized discharge limits are addressed in GSG-9 [9].

1.20. This Safety Guide does not cover occupational exposures or medical exposures. Recommendations on these categories of exposure and their inclusion in the authorization process are provided in IAEA Safety Standards Series No. GSG-7, Occupational Radiation Protection [20], and IAEA Safety Standards Series No. SSG-46, Radiation Protection and Safety in Medical Uses of Ionizing Radiation [21].

1.21. This Safety Guide covers primarily the assessment of the risk of radiological impacts to the health of individual members of the public due to radiation exposure during normal operation and due to potential exposure, as required by GSR Part 3 [1]. In many instances, it can be concluded, on the basis of evidence such as experience or simplified analysis, that specific consideration of effects in the environment is not necessary. This may not be the case in all situations, and the explicit consideration of the protection of the environment may be required by the regulatory body. In other cases, explicit consideration of the protection of the environment is captured in national legislation. A methodology for the explicit assessment of the radiation impacts on flora and fauna, which can be used in accordance with national or international regulatory frameworks for the protection of the environment, is presented as an example in Annex I.

1.22. This Safety Guide does not address the process of ‘iteration and design optimization’, which is normally conducted within the framework of a safety assessment for the predisposal management of radioactive waste [13]; however, a radiological environmental impact assessment as described in this Safety Guide can serve as an input for that process.

1.23. Optimization of protection and safety is required in GSR Part 3 [1]; the optimization process includes not only consideration of the protection of the public but also consideration of the protection of workers and all the safety features of the facility or activity, such as those related to the on-site management of radioactive waste. This Safety Guide covers the assessment of the exposure of the public only. The wider aspects of optimization of protection and safety

are covered in other IAEA Safety Standards, for example in GSG-3 [13] on the predisposal management of radioactive waste. Optimization of the protection of the public in connection with the establishment of radioactive discharge limits for facilities and activities is described in GSG-9 [9]. The result of a radiological environmental impact assessment, as described in this Safety Guide, is a necessary input into the optimization process to be used for establishing discharge limits.

1.24. The possible non-radiological impacts of facilities and activities, which are generally included in an environmental impact assessment within a governmental decision making process, such as the impacts on people and the environment from releases of other hazardous substances (i.e. chemicals and heated water), the impacts from the construction of a facility, the impacts on places of societal significance (i.e. historical monuments and cultural places), the impacts on endangered species, and the impacts on the landscape, as well as other societal and economic factors, are not considered in this Safety Guide but should be considered by States according to national and internationally applicable regulations at the time of making relevant decisions.

STRUCTURE

1.25. Section 2 provides explanations of the main concepts and terms used in the Safety Guide. Section 3 presents the safety requirements for the government, the regulatory body and licensees relating to prospective radiological environmental impact assessment. Section 4 describes the framework in which such assessments are done. Section 5 describes the methodology needed to carry out a prospective radiological environmental impact assessment for the protection of the public for normal operation and for potential exposures, and addresses the protection of the environment. Section 6 presents considerations of variability and uncertainty in radiological environmental impact assessments. The Appendix presents risk criteria established by relevant international organizations, which could be used as the basis for defining national criteria for the consideration of potential exposures. Annex I presents an example of a methodology for assessing and controlling the exposures of flora and fauna. Annex II presents considerations relating to the risk of health effects and the assessment of potential exposure of the public.

2. EXPLANATION OF CONCEPTS AND TERMS

2.1. This section provides an explanation of some of the concepts and terms used in this Safety Guide. Unless otherwise mentioned, concepts or terms are to be understood as defined in GSR Part 3 [1] or in the IAEA Safety Glossary [4].

PLANNED EXPOSURE SITUATIONS: EXPOSURES EXPECTED TO OCCUR IN NORMAL OPERATION AND POTENTIAL EXPOSURES

2.2. Paragraph 1.20(a) of GSR Part 3 [1] defines a ‘planned exposure situation’ as:

“a situation of exposure that arises from the planned operation of a source or from a planned activity that results in an exposure due to a source.... In planned exposure situations, exposure at some level can be expected to occur. If exposure is not expected to occur with certainty, but could result from an accident or from an event or a sequence of events that may occur but is not certain to occur, this is referred to as ‘potential exposure’.”

The magnitude and extent of these exposures can usually be predicted. Exposures expected to occur and potential exposures can and should be taken into account at the planning or design stage [7].

GOVERNMENTAL DECISION MAKING PROCESS

2.3. In the context of this Safety Guide, the term ‘governmental decision making process’ refers to the procedures carried out at all planning, pre-operational, operational and decommissioning stages by the government or governmental agencies, including the regulatory body, in deciding whether a project for a facility or an activity may be undertaken, continued, changed or stopped. The term could also apply to areas of national policy, such as whether to embark on a nuclear power programme [22].

2.4. A governmental decision making process⁹ is normally conducted at the early stages of a programme of development and, mainly, for facilities and activities

⁹ The term ‘governmental decision making process’ encompasses or is related to different terms used in some States with similar or equivalent meanings, such as ‘decision in principle’, ‘environmental impact statement’, and, in some cases, ‘justification’.

for which it is foreseen that a thorough assessment of their possible impact on the environment is necessary. For some nuclear installations and facilities, this decision making process is described in national or international regulations by the term ‘environmental impact assessment’ (see paras 2.7–2.9).

AUTHORIZATION PROCESS

2.5. ‘Authorization’ is defined in GSR Part 3 [1] as “The granting by a regulatory body or other governmental body of written permission for a person or organization (the operator) to conduct specified activities.”

2.6. The authorization for a facility or an activity, in the form of a registration or licence [1], could be granted for the design, siting, construction and operation of the facility or activity; for decommissioning activities; or for modifications in the conditions of operation of the facility or the conduct of the activity.

ENVIRONMENTAL IMPACT ASSESSMENT

2.7. The term ‘environmental impact assessment’ (or equivalent) is included in many international instruments and national legislation and regulations [23–30]. In the context of this Safety Guide, ‘environmental impact assessment’ refers to a procedure within a governmental decision making process for identifying, describing and assessing prospectively the effects and the risk of effects of a particular proposed activity or facility on aspects of environmental significance.¹⁰

2.8. The effects relating to radioactive releases from facilities and activities to the environment likely to be considered in an environmental impact assessment generally include radiological effects on human health and, where required by States, radiological effects on flora and fauna. Non-radiological impacts included in an environmental impact assessment are not considered in this Safety Guide but are subject to national and internationally applicable regulations.

2.9. In general, an environmental impact assessment requires the involvement of the applicant of the proposed facility or activity, relevant governmental agencies, the regulatory body and a number of interested parties, including, in some States, the public [22–30].

¹⁰ Reference [31] provides information on environmental impact assessments in the framework of the development of a new nuclear power programme.

ENVIRONMENT AND PROTECTION OF THE ENVIRONMENT

2.10. GSR Part 3 [1] defines the environment as “The conditions under which people, animals and plants live or develop and which sustain all life and development; especially such conditions as affected by human activities.” Usually, the environment includes ecosystems that comprise biotic and abiotic components.

2.11. GSR Part 3 [1] further states in the definition of the environment that:

“Protection of the environment includes protection and conservation of: non-human species, both animal and plant, and their biodiversity; environmental goods and services, such as the production of food and feed; resources used in agriculture, forestry, fisheries and tourism; amenities used in spiritual, cultural and recreational activities; media, such as soil, water and air; and natural processes, such as carbon, nitrogen and water cycles.”

2.12. Furthermore, para. 1.35 of GSR Part 3 [1] notes that:

“the protection of the environment [is identified] as an issue necessitating assessment, while allowing for flexibility in incorporating into decision making processes the results of environmental assessments that are commensurate with the radiation risks.”

RADIOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

2.13. For the purpose of this Safety Guide, a radiological environmental impact assessment is a prospective assessment of the expected and analytically conceivable radiological impacts, which is quantified in terms of effective dose to members of the public and which is conducted as part of the authorization process. The results of a radiological environmental impact assessment are compared with predefined radiological criteria defined in GSR Part 3 [1]. A radiological environmental impact assessment may be seen as one component of an environmental impact assessment (as described in paras 2.7–2.9) in the context of planning for a particular facility or activity.

MEMBERS OF THE PUBLIC

2.14. GSR Part 3 [1] defines a member of the public as “in a general sense, any individual in the population except when subject to occupational exposure or medical exposure.” Paragraph 3.27 of SF-1 (Principle 7: Protection of present and future generations) [2] states that “Safety standards apply not only to local populations but also to populations remote from facilities and activities” and that “Where effects could span generations, subsequent generations have to be adequately protected without any need for them to take significant protective actions.”

3. SAFETY REQUIREMENTS RELEVANT TO PROSPECTIVE RADIOLOGICAL ENVIRONMENTAL IMPACT ASSESSMENT

3.1. This section contains extracts from SF-1 [2], GSR Part 3 [1] and GSR Part 4 (Rev. 1) [5] setting out the relevant safety requirements for the protection of the public and the environment that are required to be considered in the conduct of prospective radiological environmental assessments for planned exposure situations. Recommendations on how to meet these requirements are provided in Sections 4 and 5 and in the Appendix to this Safety Guide.

LIMITATION OF DOSE AND CONSTRAINT OF DOSE AND RISK

3.2. SF-1 [2] establishes principles for ensuring the protection of the public and the environment, now and in the future, from harmful effects of ionizing radiation, and states under para. 3.25 (Principle 6: Limitation of risks to individuals) that “doses and radiation risks must be controlled within specified limits.” These principles apply to situations involving exposure to, or the potential for exposure to, ionizing radiation.¹¹

3.3. GSR Part 3 [1] states that, for planned exposure situations, exposures of and risk to members of the public are required to be subject to control (paras 2.11, 3.26, 3.27, 3.120(c) and 3.123(b)).

¹¹ The principle of dose and risk limitation is not applied to emergency exposure situations and existing exposure situations, for which reference levels are used instead.

3.4. Requirement 12 of GSR Part 3 [1] states that **“The government or the regulatory body shall establish dose limits for...public exposure, and registrants and licensees shall apply these limits.”**

3.5. Paragraph 3.120 of GSR Part 3 [1], which relates to responsibilities specific to public exposure, states that “The government or the regulatory body shall establish or approve constraints on dose and constraints on risk to be used in the optimization of protection and safety for members of the public.” Paragraph 3.123(e) of GSR Part 3 [1] states that:

“The regulatory body shall establish or approve operational limits and conditions relating to public exposure, including authorized limits for discharges. These operational limits and conditions:...Shall take into account the results of the prospective assessment for radiological environmental impacts that is undertaken in accordance with requirements of the regulatory body”.

ASSESSMENT FOR PROTECTION OF THE PUBLIC AND THE ENVIRONMENT

3.6. Principle 7 of SF-1 [2] states that **“People and the environment, present and future, must be protected against radiation risks.”**

3.7. Paragraph 3.28 of SF-1 [2] states that:

“The present system of radiation protection generally provides appropriate protection of ecosystems in the human environment against harmful effects of radiation exposure. The general intent of the measures taken for the purposes of environmental protection has been to protect ecosystems against radiation exposure that would have adverse consequences for populations of a species (as distinct from individual organisms).”

3.8. Paragraph 3.9(e) of GSR Part 3 [1] states that:

“Any person or organization applying for authorization:...Shall, as required by the regulatory body, have an appropriate prospective assessment made for radiological environmental impacts, commensurate with the radiation risks associated with the facility or activity.”

Section 4 of this Safety Guide provides guidance on the context in which an assessment is made, and Section 5 describes the methodology for assessment of the level of protection of the public and the environment.

3.9. Paragraph 3.15(d) of GSR Part 3 [1] establishes the responsibilities of registrants and licensees in planned exposure situations. It states that:

“Registrants and licensees:...Shall, for the sources for which they are authorized and for which the regulatory body requires a prospective assessment to be made for radiological environmental impacts..., conduct such an assessment and keep it up to date”.

3.10. Requirement 31 of GSR Part 3 [1] relates to radioactive waste and discharges. Paragraph 3.132 of GSR Part 3 [1] states that:

“Registrants and licensees, in cooperation with suppliers, in applying for an authorization for discharges, as appropriate:

- (a) Shall determine the characteristics and activity of the material to be discharged, and the possible points and methods of discharge;
- (b) Shall determine by an appropriate pre-operational study all significant exposure pathways by which discharged radionuclides could give rise to exposure of members of the public;
- (c) Shall assess the doses to the representative person due to the planned discharges;
- (d) Shall consider the radiological environmental impacts in an integrated manner with features of the system of protection and safety, as required by the regulatory body”.

ASSESSMENT AND CONTROL OF POTENTIAL EXPOSURE

3.11. Paragraph 3.15(e) of GSR Part 3 [1] states that “Registrants and licensees: ...Shall assess the likelihood and magnitude of potential exposures, their likely consequences and the number of individuals who may be affected by them”.

3.12. Paragraph 3.24 of GSR Part 3 [1] states that:

“registrants and licensees shall ensure that all relevant factors are taken into account in a coherent way in the optimization of protection and safety to contribute to achieving the following objectives: