

IAEA Safety Standards

for protecting people and the environment

Regulatory Control of Radioactive Discharges to the Environment

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General Safety Guide No. GSG-9



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IAEA SAFETY STANDARDS

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

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

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

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

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

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

RELATED PUBLICATIONS

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

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

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

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

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

REGULATORY CONTROL
OF RADIOACTIVE DISCHARGES
TO THE ENVIRONMENT



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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-9

REGULATORY CONTROL OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT

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.

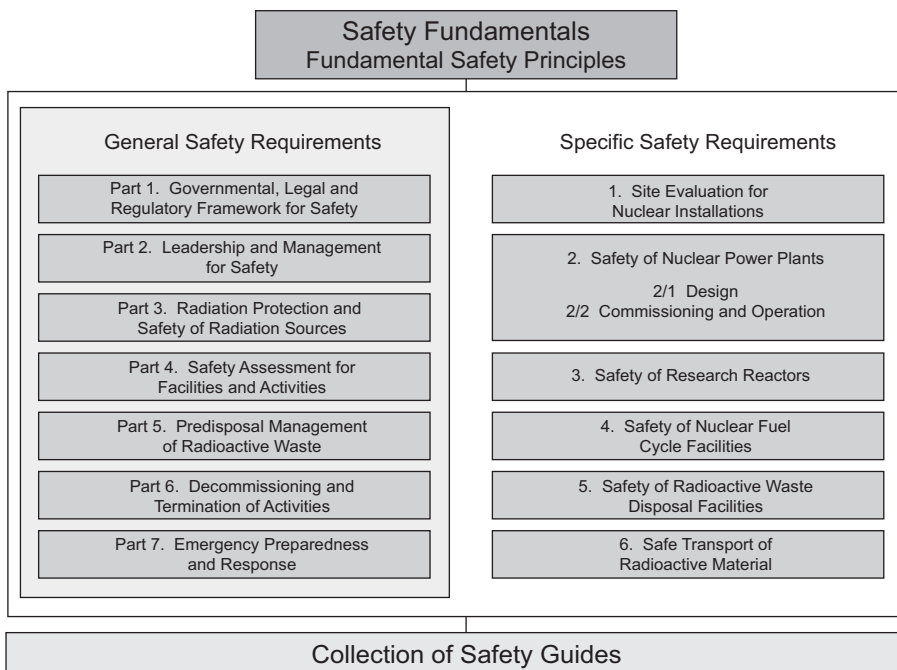


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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

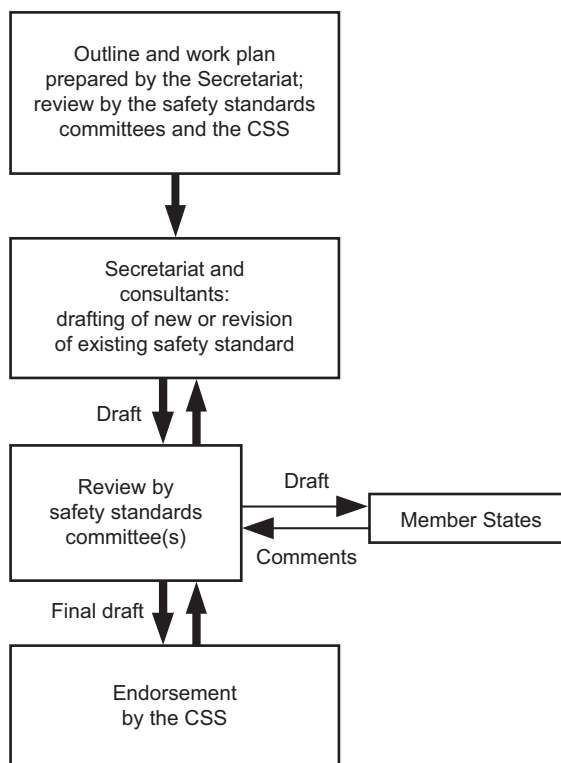


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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. Facilities and activities¹ that give rise to radiation risks are required to be designed, built, authorized, operated and maintained so as to prevent radioactive releases to the environment or to minimize the consequences of such releases and to provide adequate levels of protection of the public and the environment [3].

1.2. Some facilities and activities, during normal operation, generate gaseous and liquid effluents that contain small amounts of radionuclides that may expose the public and the environment to low levels of radiation. In many cases, the complete prevention of the release of such effluents is technically difficult or extremely costly to achieve. In all cases, the resulting doses to any member of the public must be below established limits.

1.3. In accordance with the requirements for optimization of radiation protection, it can be concluded that, if releases are controlled such that “the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure [are] ‘as low as reasonably achievable, economic and social factors being taken into account’ (ALARA)” [3], then such releases may be acceptable in terms of protection and safety, considering the very low radiological significance of the releases and the possibly high costs that may be associated with reducing them further.

1.4. Facilities and activities that generate controllable radioactive releases are regulated in different ways through a graded approach. In many cases, the regulation of facilities and activities generating radioactive releases during normal operation that result in very low doses to the public and for which there is no risk of an unexpected accidental release can be managed through the application of the concept of exemption or by means of notification [3]. However, some releases may result in doses with a higher level of radiological significance or the facility or activity may present potentially higher radiation risks. In such cases, it may be appropriate for the regulation of the releases from such facilities or activities to

¹ The term ‘facilities and activities’ is defined in IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1], and the IAEA Safety Glossary [2]. 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 para. 1.13.

be managed by means of an authorization (registration or licensing, as relevant) that establishes stringent technical and regulatory conditions, including for the adequate management and control of these effluents and their radiological consequences. For a practice that is justified, the decision to authorize such releases should take into account the radiation protection principles of optimization and dose limitation, and other relevant safety principles.

1.5. Dose limits and dose constraints are established for the doses received by the public due to the authorized releases of effluents [3]. In accordance with IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1], and the requirements established in IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [3], effluents are required to be properly managed by the licensee in order to ensure the optimized protection of the public and the environment.

1.6. A ‘discharge’ is a planned and controlled release of gaseous, aerosol or liquid radioactive substances to the environment and, as such, the term does not include releases to the environment in an accident. Strictly, the term ‘discharge’ refers to the act or process of releasing material to the environment, but it is also used in this Safety Guide to describe the material being released or to be released [2].

1.7. This Safety Guide provides recommendations on the application of the safety requirements established in GSR Part 3 [3] to the regulatory control of discharges and takes account of the recommendations provided in a number of relevant Safety Guides [4–10] and the experience of Member States. This Safety Guide supersedes IAEA Safety Standards Series No. WS-G-2.3, Regulatory Control of Radioactive Discharges to the Environment².

OBJECTIVE

1.8. The objective of this Safety Guide is to provide governments, regulatory bodies, applicants and operating organizations with a structured approach to controlling radiation exposures of the public resulting from discharges from normal operations of facilities and activities, and for the optimization of

² INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Control of Radioactive Discharges to the Environment, IAEA Safety Standards Series No. WS-G-2.3, IAEA, Vienna (2000).

protection and safety. Guidance is provided on authorizations for discharges, demonstrating compliance with the authorization and enforcing the authorization.

1.9. This Safety Guide is for use by those applying for an authorization for discharges to the environment and by those reviewing applications and authorizing discharges as part of an authorization process [3]. It may also be relevant for other interested parties.

SCOPE

1.10. The scope of this Safety Guide is limited to discharges to the atmosphere of airborne effluents and to surface aquatic media of liquid effluents from facilities and activities during normal operation in planned exposure situations [3]. The disposal of solid radioactive waste, releases of radioactive substances in the post-closure period of a waste disposal facility, the migration of liquids containing radionuclides into underground water and releases to the environment due to accidents are not addressed in this Safety Guide; relevant guidance is provided in other Safety Guides [11–14].

1.11. This Safety Guide provides guidance on the regulatory control of discharges in connection with an authorization process.³ More specifically, this Safety Guide addresses authorizations for discharges from new and modified facilities and activities, and the review of established authorizations for discharges.

1.12. This Safety Guide addresses the derivation of operational limits and conditions for discharges, the demonstration of compliance with the authorization and the need for a radiation monitoring programme. An important initial input into the process of controlling discharges is the prospective assessment of the protection of the public and the environment from harmful effects of ionizing radiation. A separate Safety Guide provides recommendations on such prospective radiological impact assessments for protection of both the public and the environment [7]. Only limited reference is made in this Safety Guide to the

³ Requirements for the authorization process for facilities and activities, as it relates to the system of protection and safety, are established in GSR Part 3 [3].

methodology used in dose assessments and the models and data that may be used in the derivation of authorized limits, such as those described in Ref. [15].⁴

1.13. This Safety Guide applies to different types of facilities and activities that discharge liquid and gaseous effluents containing radionuclides that may give rise to radiation risks to the public. Such facilities and activities range from nuclear installations⁵ to applications of radioisotopes in industry, medicine and research. This Safety Guide also covers the controllable releases during normal operation to the atmosphere and to surface waters that may result from the mining and processing of ores for the extraction of uranium or thorium as part of the nuclear fuel cycle. Consideration is also given to discharges of naturally occurring radioactive material⁶ in non-nuclear industries.

1.14. This Safety Guide focuses on setting discharge limits for the protection of the public; the radiation protection of workers is considered only as part of the optimization of protection and safety, especially in connection with the on-site management of radioactive waste and effluents. Recommendations on the assessment and control of occupational exposures are provided in IAEA Safety Standards Series No. GSG-7, Occupational Radiation Protection [16].

STRUCTURE

1.15. Section 2 sets out the principles of radiation protection applicable to the control of discharges. Section 3 presents the safety objectives, requirements and concepts relevant to the control of discharges, including the general responsibilities of the government, the regulatory body, the operating organization and other relevant parties. Section 4 provides guidance on the decision making process for establishing the need for an authorization for discharges. Section 5 provides

⁴ A revision of Safety Reports Series No. 19 [15] 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.

⁵ The term ‘nuclear installation’ includes nuclear power plants, research reactors (including subcritical and critical assemblies) and any adjoining radioisotope production facilities, spent fuel storage facilities, facilities for the enrichment of uranium, nuclear fuel fabrication facilities, conversion facilities, facilities for the reprocessing of spent fuel, facilities for the predisposal management of radioactive waste arising from nuclear fuel cycle facilities, and nuclear fuel cycle related research and development facilities [2].

⁶ ‘Naturally occurring radioactive material’ is radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides [2].

recommendations on the process for authorization for discharges, including the development of an authorization for discharges and the setting of discharge limits, the establishment and use of dose constraints, the characterization of discharges and the exposure scenarios used in specifying discharge limits, the consideration of optimization of protection and safety, the assessment of doses to the public, the operational limits and conditions associated with the authorization, the demonstration of compliance, inspection and enforcement, and the involvement of interested parties. Section 6 covers discharges of naturally occurring radionuclides. In Section 7, the aspects relating to the control of discharges during decommissioning are presented. Finally, Section 8 provides recommendations on the regulation of discharges from previously unregulated practices. The Annex provides practical considerations that can be taken into account when setting authorizations for discharges.

2. THE PRINCIPLES OF RADIATION PROTECTION FOR CONTROL OF DISCHARGES

2.1. The radiation protection and safety principles established in the IAEA safety standards (see Refs [1, 3]), on the basis of the recommendations of the International Commission on Radiological Protection [17], relevant for the control of radioactive discharges to the environment from a facility or activity in planned exposure situations are the principles of justification, optimization and dose limitation.

JUSTIFICATION OF FACILITIES AND ACTIVITIES

2.2. For a facility or activity to be authorized, it is required to be demonstrated that the introduction of that practice will produce a positive net benefit (i.e. the expected benefits to individuals and to society from the practice outweigh the harm, including radiation detriment) [3]. Decisions regarding justification should be taken at a sufficiently high governmental level to enable all the considerations that may be related to the benefits and detriments to be taken into account [6]. Any decision on justification should always involve consideration of the radiation doses expected either to be incurred or to be averted or reduced, according to the circumstances. The radiation dose to the public is only one of the factors involved in the justification process. Many other factors, well beyond radiation

protection considerations, will need to be considered in determining whether a practice is justified.

2.3. Justification applies to the overall practice and not to individual aspects of the practice, such as discharges, which can be authorized or exempted from the requirement for an authorization only if the practice as a whole is already regarded as justified.

OPTIMIZATION OF PROTECTION

2.4. The principle of optimization of protection and safety should be applied when setting discharge limits. Optimization of protection and safety is defined in GSR Part 3 [3] as:

“The process of determining what level of protection and safety would result in the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure being ‘as low as reasonably achievable, economic and social factors being taken into account’ (ALARA).”

2.5. The protection and safety measures should provide the highest level of safety that can reasonably be achieved throughout the lifetime of the facility or activity without unduly limiting the operation of the facility or activity. The optimization of protection and safety involves the balancing of all costs, not just financial costs, associated with achieving a particular level of protection and safety, against the benefit in terms of reduction in dose. Further guidance on the optimization process relating to the control of discharges is provided in Section 5, and additional information is provided in the Annex to this Safety Guide.

APPLICATION OF DOSE LIMITS

2.6. For planned exposure situations, exposures and risks are subject to control to ensure that the specified dose limits are not exceeded and that optimization is applied to attain the desired level of protection and safety [3].

2.7. The dose limits that are relevant for members of the public in connection with discharges during normal operation are [3]:

- (a) An effective dose of 1 mSv in a year;
- (b) In special circumstances⁷, a higher value of effective dose in a single year could apply, provided that the average effective dose over five consecutive years does not exceed 1 mSv per year.

These dose limits represent the maximum acceptable dose to any member of the public from all authorized radiation sources to which he or she is exposed in planned exposure situations.⁸ The use of dose limits to set discharge limits for a specific source is described in Section 5 and the Annex.

3. SAFETY OBJECTIVES AND REQUIREMENTS RELEVANT TO THE CONTROL OF RADIOACTIVE DISCHARGES

GENERAL

3.1. SF-1 [1] establishes principles to be applied to achieve the fundamental safety objective of protecting the public and the environment, now and in the future, from harmful effects of ionizing radiation. This safety objective has to be achieved without unduly limiting the operation of facilities and the conduct of activities that give rise to radiation risks.

3.2. The requirements for a governmental, legal and regulatory framework for safety are established in IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [18].

3.3. GSR Part 3 [3] describes the concepts and establishes requirements for the protection of people and the environment from harmful effects of ionizing radiation and for the safety of radiation sources. GSR Part 3 also establishes requirements relevant to the various interested parties (e.g. the government, the regulatory body, the operating organization) for the control of discharges.

⁷ For example, in authorized, justified and planned operating conditions that lead to transitory increases in exposures.

⁸ GSR Part 3 [3] also establishes dose limits for the public for the equivalent dose to the lens of the eye and to the skin. Because of the conditions in which such exposures would typically occur, these dose limits are not relevant for discharges to the environment during normal operation.

3.4. Paragraph 1.6 of GSR Part 3 [3] specifies that the system of protection and safety 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.” For planned exposure situations, para. 1.17 of GSR Part 3 [3] states that “exposures and risks are subject to control to ensure that the specified dose limits...for public exposure are not exceeded, and optimization is applied to attain the desired level of protection and safety.”

3.5. Although the system of protection and safety required by the IAEA safety standards is founded primarily on considerations of the radiation protection of humans, it also aims to provide for appropriate protection of the environment from harmful effects of ionizing radiation [3].

3.6. The establishment of discharge limits for facilities and activities, as described in this Safety Guide, is primarily for optimization of the protection of members of the public (i.e. the objective of the assessment to determine discharge limits is control of the effective dose to the representative person⁹, with appropriate consideration given to the radiation protection of workers at the discharging facility). This approach is based on the conclusion that the environment is protected by means of the conditions under which the practice is authorized.¹⁰

⁹ The representative person is defined for the purposes of radiation protection as “An individual receiving a *dose* that is representative of the *doses* to the more highly exposed individuals in the population” (*italic denotes a term in the IAEA Safety Glossary*) [2]. The representative person will generally be a hypothetical construct and not an actual member of the population. The representative person can be considered to be the same concept as the critical group, and similar methods can be used for assessing doses to the representative person as have been used previously for assessing doses to the critical group [15].

¹⁰ Some States consider that, in addition to the optimization of the protection of the public, there may be a need to assess and verify more explicitly the protection of the environment, including, for instance, estimating the impact of radiation exposure on populations of flora and fauna. IAEA Safety Standards Series No. GSG-10, Prospective Radiological Environmental Impact Assessment for Facilities and Activities [7], provides guidance on prospective radiological environmental impact assessment that includes, as an example in an annex, a methodology for assessing exposures of flora and fauna and the relevant criteria. Usually, explicit consideration of the exposure of flora and fauna will not influence the setting of discharge limits.

JUSTIFICATION

3.7. Paragraph 2.8 of GSR Part 3 [3] states that “For planned exposure situations, each party with responsibilities for protection and safety shall ensure, when relevant requirements apply to that party, that no practice is undertaken unless it is justified.”

3.8. Requirement 10 of GSR Part 3 [3] states that **“The government or the regulatory body shall ensure that only justified practices are authorized.”**

OPTIMIZATION OF PROTECTION AND SAFETY

3.9. Requirement 31 of GSR Part 3 [3] on radioactive waste and discharges states that **“Relevant parties shall ensure that radioactive waste and discharges of radioactive material to the environment are managed in accordance with the authorization.”**

3.10. GSR Part 3 [3] establishes a number of requirements for the management of radioactive waste, notably including in para. 3.131(a) the requirement to ensure that “radioactive waste generated is kept to the minimum practicable in terms of both activity and volume”. The need to meet these requirements on waste management will have a direct impact on the volume of the waste generated and the radionuclides and their quantities in the waste and in the effluents resulting from the normal operation of a facility or conduct of an activity.

3.11. Paragraph 3.119 of GSR Part 3 [3] specifies that “The government or the regulatory body shall establish and enforce requirements for the optimization of protection and safety for situations in which individuals are or could be subject to public exposure.” Paragraph 3.120 of GSR Part 3 [3] 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.”

3.12. Paragraph 3.22(c) of GSR Part 3 [3] states that “The government or the regulatory body:...Shall establish or approve constraints...on dose...or shall establish or approve a process for establishing such constraints, to be used in the optimization of protection and safety.”

3.13. Requirement 11 of GSR Part 3 [3] states that **“The government or the regulatory body shall establish and enforce requirements for the**

optimization of protection and safety, and registrants and licensees shall ensure that protection and safety is optimized.”

3.14. Paragraph 3.126 of GSR Part 3 [3] specifies that in applying the principle of optimization of protection and safety in relation to public exposure:

“Registrants and licensees...shall take into account:

- (a) Possible changes in any conditions that could affect exposure of members of the public, such as changes in the characteristics and use of the source, changes in environmental dispersion conditions, changes in exposure pathways or changes in values of parameters used for the determination of the representative person;
- (b) Good practice in the operation of similar sources or the conduct of similar practices;
- (c) Possible buildup and accumulation in the environment of radioactive substances from discharges during the lifetime of the source;
- (d) Uncertainties in the assessment of doses, especially uncertainties in contributions to doses if the source and the representative person are separated in space or in time.”

AUTHORIZATION

3.15. Paragraph 3.132 of GSR Part 3 [3] establishes requirements regarding discharges that underpin the recommendations provided in this Safety Guide and 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;

- (e) Shall submit to the regulatory body the findings of (a)–(d) above as an input to the establishment by the regulatory body, in accordance with para. 3.123, of authorized limits on discharges and conditions for their implementation.”

3.16. Paragraph 3.123 of GSR Part 3 [3] establishes the following requirements relating to the control of discharges:

“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:

- (a) Shall be used by registrants and licensees as the criteria for demonstration of compliance after the commencement of operation of a source;
- (b) Shall correspond to doses below the dose limits with account taken of the results of optimization of protection and safety;
- (c) Shall reflect good practice in the operation of similar facilities or activities;
- (d) Shall allow for operational flexibility;
- (e) 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”.

DOSE LIMITATION

3.17. Requirement 12 of GSR Part 3 [3] states that **“The government or the regulatory body shall establish dose limits for...public exposure, and registrants and licensees shall apply these limits.”** Paragraph 3.26 of GSR Part 3 [3] goes on to state that “The government or the regulatory body... shall enforce compliance with the dose limits...[for] public exposures in planned exposure situations.”

TRANSBOUNDARY IMPACTS

3.18. Paragraph 3.124 of GSR Part 3 [3] establishes requirements for the assessment of radiological impacts and the control of discharges when a source within a practice could cause public exposure outside the territory or other area