

IAEA Safety Standards

for protecting people and the environment

Construction for Nuclear Installations

Specific Safety Guide

No. SSG-38



IAEA

International Atomic Energy Agency



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IAEA SAFETY STANDARDS AND RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

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

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

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

<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.

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

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

CONSTRUCTION FOR NUCLEAR INSTALLATIONS



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

IAEA SAFETY STANDARDS SERIES No. SSG-38

CONSTRUCTION FOR NUCLEAR INSTALLATIONS

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2015

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FOREWORD

by Yukiya Amano
Director General

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

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

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

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

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

THE IAEA SAFETY STANDARDS

BACKGROUND

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

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

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

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

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

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

THE IAEA SAFETY STANDARDS

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

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

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

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

Safety Fundamentals

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

Safety Requirements

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

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

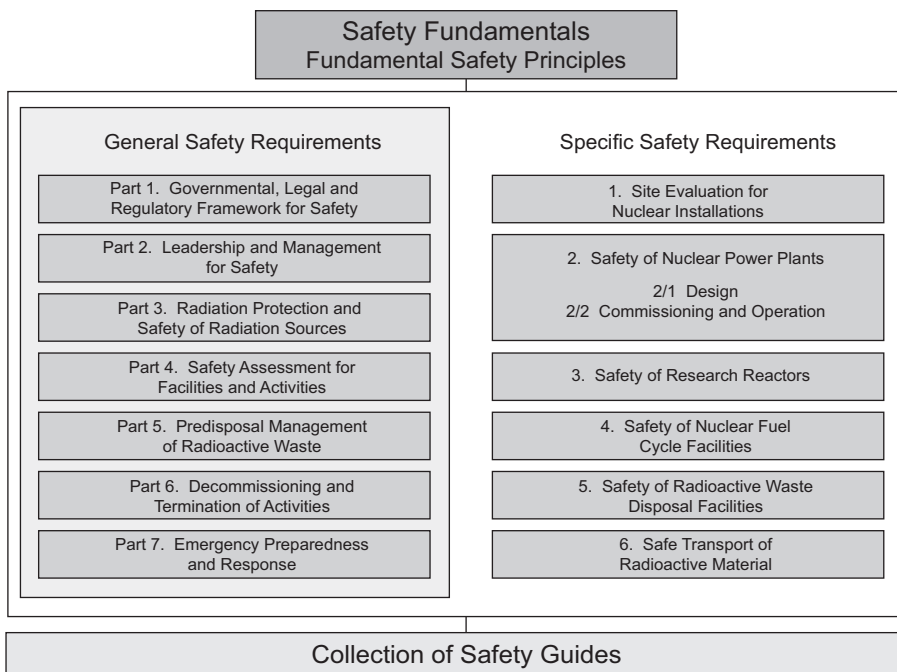


FIG. 1. The long term structure of the IAEA Safety Standards Series.

Safety Guides

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

APPLICATION OF THE IAEA SAFETY STANDARDS

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

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

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

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

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

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

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

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

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

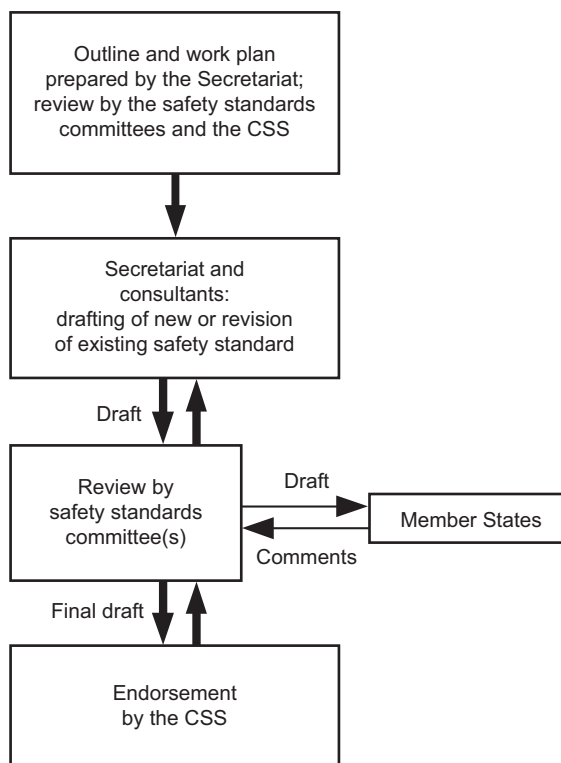


FIG. 2. The process for developing a new safety standard or revising an existing standard.

includes senior governmental officials having responsibility for establishing national standards.

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

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

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

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

INTERPRETATION OF THE TEXT

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

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

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

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

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1. INTRODUCTION

BACKGROUND

1.1. The goal of construction is to build correctly an approved design. This Safety Guide sets out an appropriate management process that focuses on the implementation of various aspects of construction activities. It provides specific guidance and recommendations to meet the requirements established in The Management System for Facilities and Activities (GS-R-3) [1], and supplements the recommendations provided in Application of the Management System for Facilities and Activities (GS-G-3.1) [2] and The Management System for Nuclear Installations (GS-G-3.5) [3]. Appendix V of GS-G-3.5 [3] provides some guidance on the specific processes to be covered in the management system for the construction of a nuclear installation.

1.2. This Safety Guide is broadly applicable to nuclear installations and is intended for application in the construction of new nuclear installations and in carrying out major design modifications¹ and refurbishments of existing nuclear installations. Nuclear installations differ greatly in type, size, radiation risks, utilization and other characteristics, so that judgement has to be exercised as to the degree of applicability of this Safety Guide to specific installations and sites.

1.3. To ensure that newly constructed structures, systems and components or nuclear installations can be commissioned and operated safely, it is necessary to meet the relevant safety requirements established in Safety of Nuclear Power Plants: Design (SSR-2/1) [5], Safety of Nuclear Power Plants: Commissioning and Operation (SSR-2/2) [6], Safety of Research Reactors (NS-R-4) [7], Safety of Nuclear Fuel Cycle Facilities (NS-R-5) [8] and Predisposal Management of Radioactive Waste (GSR Part 5) [9]. For example, Requirement 11 of SSR-2/1 [5], on provision for construction, states that “Items important to safety for a nuclear power plant shall be designed so that they can be manufactured, constructed, assembled, installed and erected in accordance with established processes that ensure the achievement of the design specifications and the

¹ Modifications to Nuclear Power Plants (NS-G-2.3) [4] provides guidance on the control of activities relating to modifications at nuclear power plants and deals with the intended modification of structures, systems and components, operational limits and conditions, procedures and software, and the management systems and tools for the operation of a nuclear power plant.

required level of safety.” This Safety Guide provides recommendations on how the objective of “achievement of the design specifications and required level of safety” can be met in practice. In addition, the regulatory authorization described in Governmental, Legal and Regulatory Framework for Safety (GSR Part 1) [10] is granted for specific installations in accordance with each State’s regulatory framework.

1.4. It is recognized that even if the design and commissioning are fully compliant with all safety requirements, a high level of safety can only be achieved when the construction is carried out with high quality and care, since commissioning cannot test all aspects of the design. Therefore, all construction activities have a potential impact on safety, even though there may be no nuclear material present during the construction.

OBJECTIVE

1.5. The objective of this Safety Guide is to provide recommendations and guidance based on international good practices in the construction of nuclear installations, as currently followed in Member States, which will enable construction to be of high quality, consistent with the design requirements, and as agreed by the regulatory body in issuing the authorization for construction.

SCOPE

1.6. This Safety Guide is applicable to the construction stage of a new nuclear installation and to major modifications and refurbishments of an existing nuclear installation, including the processes of manufacturing and assembling of components, carrying out of architectural and civil works, installation and maintenance of structures, systems and components, and performance of the associated tests to demonstrate their acceptability. Neither the design stage nor the commissioning stage is addressed in this Safety Guide, although these stages may overlap with the construction stage. The specific definition of each stage may vary for each organization or State.

1.7. This Safety Guide identifies and explains safety significant construction management activities that should be considered, checked and reviewed to ensure the quality and safety of a new or modified nuclear installation.

1.8. This Safety Guide may be applied to nuclear installations in the following ways:

- To support the development, implementation and assessment of construction methods and procedures and the identification of good practices for ensuring the quality of the construction to meet the design intent and ensure safety;
- To assist the regulatory body in its oversight and evaluation of the construction activities performed;
- To assist the licensee in providing specifications to a contractor, via contractual documentation;
- To assist the licensee in understanding the management aspects that should be considered when assessing contractors' qualifications and performance;
- To assist the licensee in its oversight of the whole supply chain and its verification of the compliance of contractors with the licensee's quality and safety requirements;
- To assist interested parties in understanding the roles and responsibilities of different types of contractors.

Contractors may be construction organizations, technical support organizations or consultants responsible for independent review and assessment, and organizations responsible for performing third party inspections.

1.9. In this Safety Guide, it is considered that all relevant safety requirements have to be met in accordance with a graded approach.

1.10. While this Safety Guide focuses on achieving high quality during construction, which is a prerequisite for the safe and reliable operation of a nuclear installation, nuclear security aspects should also be considered and evaluated during construction. Publications in the IAEA Nuclear Security Series provide guidance on nuclear security issues and should be taken into consideration throughout the lifetime of the installation, including during site selection, design and construction [11–16].

STRUCTURE

1.11. Section 2 sets out general considerations including explanations of terms used and prerequisites for the start of construction. Section 3 provides guidance on the regulatory oversight of construction activities. Section 4 provides recommendations on the management system for construction. Section 5 provides

recommendations for the management of construction activities, focusing on construction works on the site and at off-site locations.

2. GENERAL CONSIDERATIONS

USE OF TERMS

Construction

2.1. Construction is the process of manufacturing and assembling the components of a facility, the carrying out of civil works, the installation of components and equipment and the performance of associated tests [17]. The associated tests are those carried out to ensure that the structures, systems and components have been constructed, manufactured and installed in accordance with design specifications. Guidance on such tests can be found in the annex of SSG-28 [18] entitled Listing of Typical Commissioning Tests. Owing to differences in the construction schedule for each item, the commissioning and construction stages for the installation may take place concurrently. Hence, it is difficult to define a precise ‘end of construction’, but the licensee should ensure that items have been installed, inspected and tested and should obtain an authorization from the regulatory body before carrying out significant steps in the commissioning process [19].

Construction organization

2.2. The construction organization is the entity managing the construction activities, such as civil and architectural works and manufacturing, assembly, installation and testing of items important to safety at the installation itself. The construction organization may be part of the licensee or may be a separate, contracted organization (see Fig. 1). If the licensee appoints a contractor or contractors to carry out specific functions for construction of part or all of the installation, the responsibilities of the contractor(s) should be clearly specified and the work of the contractor should be controlled by the licensee. The licensee retains the prime responsibility for safety and this responsibility cannot be delegated through the use of contractors [20]. The licensee, in order to meet this responsibility, should put in place an oversight process that covers the management of activities by the contractor or any subcontractors, and the activities themselves.

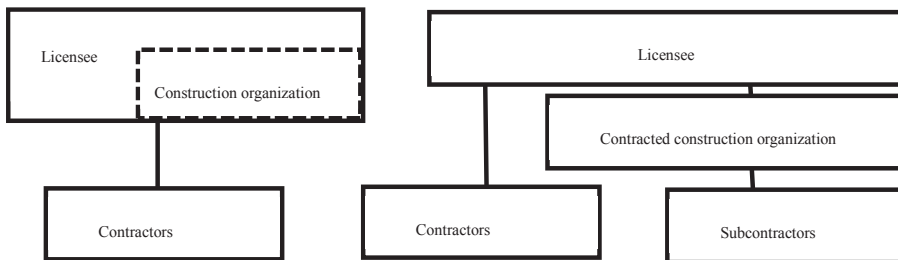


FIG. 1. Possible organizational structures for a construction organization.

Contractor

2.3. A contractor is any individual or organization that provides items or renders services in accordance with a contract or a procurement document. Contractors may include designers, architects, engineers, manufacturers, assemblers, installers, distributors, importers, suppliers, technical support organizations and other consultants and their subcontractors or subsidiaries.

Design organization

2.4. The design organization is the organization responsible for preparation of the detailed design of the installation to be built.

PREREQUISITES FOR THE CONSTRUCTION OF A NUCLEAR INSTALLATION

2.5. To ensure the highest level of safety in the construction of a nuclear installation, the following are necessary:

- An appropriate legal and governmental infrastructure, including an independent regulatory body with well-defined responsibilities, authority and functions;
- An established regulatory framework, including necessary regulations and guides, to ensure competent regulation during construction;
- A well-resourced and technically competent licensee;
- Well-established safety culture in all involved parties;
- Suitably qualified and experienced contractors;
- A technical support infrastructure for the regulatory body and the licensee, as necessary.