IAEA Safety Standards

for protecting people and the environment

Site Evaluation for Nuclear Installations

Specific Safety Requirements

No. SSR-1

IAEA
International Atomic Energy Agency

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.

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.

SITE EVALUATION 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. SSR-1

SITE EVALUATION FOR NUCLEAR INSTALLATIONS

SPECIFIC SAFETY REQUIREMENTS

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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 measures[1] 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.

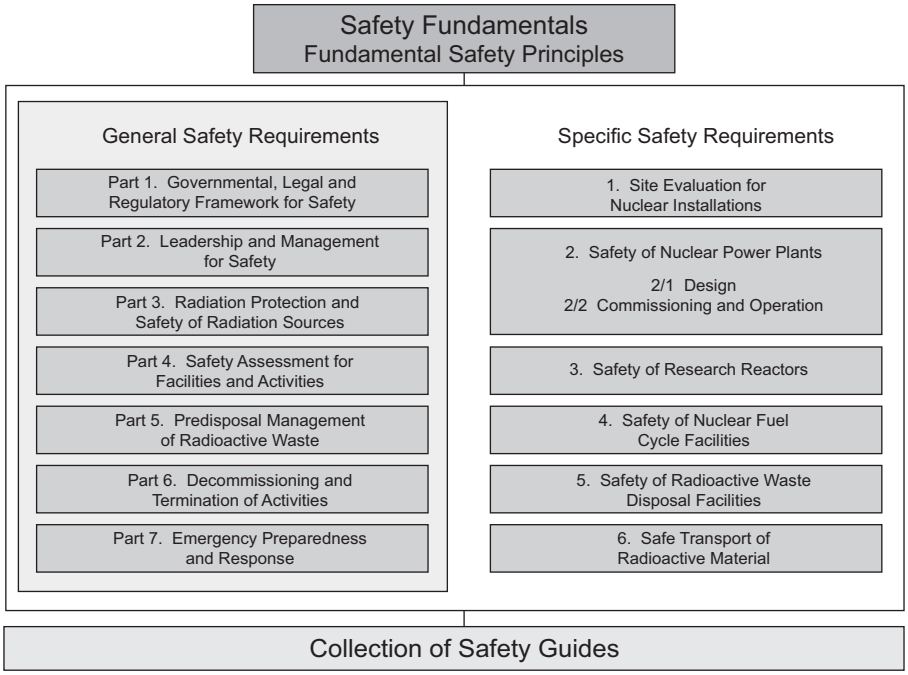

FIG. 1. The long term structure of the IAEA Safety Standards Series.

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

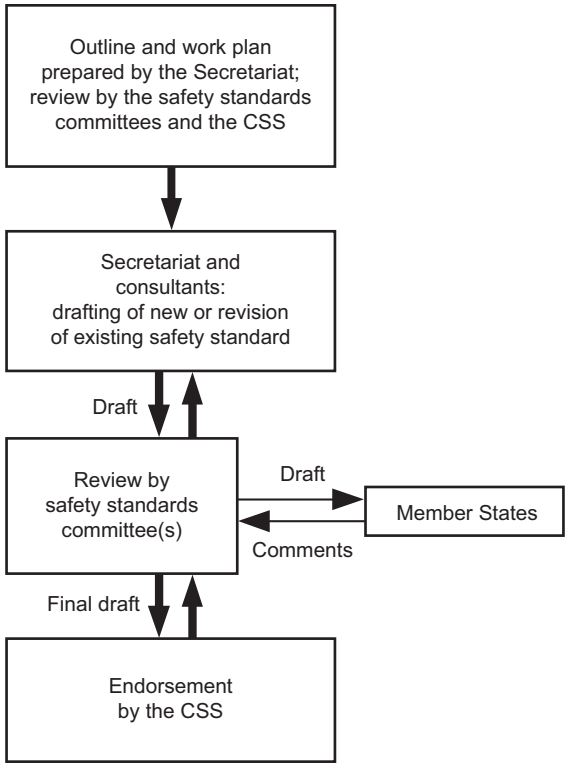

FIG. 2. The process for developing a new safety standard or revising an existing standard.

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.

CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. This Safety Requirements publication supersedes the edition of Site Evaluation for Nuclear Installations that was issued in 2016 as IAEA Safety Standards Series No. NS-R-3 (Rev. 1)[1]. NS-R-3 (Rev. 1) was a partial revision of IAEA Safety Standards Series No. NS-R-3[2] issued in 2003 and it took into account issues highlighted after the Fukushima Daiichi accident. This publication takes into account developments that have occurred since 2003 in relation to site evaluation for nuclear installations.

1.2. The requirements for site evaluation for nuclear installations established in this publication are intended to contribute to the protection of workers and the public, and to the protection of the environment, from harmful effects of ionizing radiation, in order to meet the fundamental safety objective established in IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1]. It is recognized that there are steady advances in technology and scientific knowledge in nuclear safety and corresponding advances in what is considered adequate protection. Safety requirements evolve with these advances, and this publication reflects the present consensus among States.

1.3. This Safety Requirements publication establishes requirements for site evaluation for nuclear installations, in order to meet the fundamental safety objective [1]. Several related Safety Guides (see Refs [2–8]) provide recommendations on how to meet the requirements for site evaluation for nuclear installations as contained in this publication.

OBJECTIVE

1.4. The objective of this publication is to establish requirements for:

(a) Defining the information to be used in the site evaluation process;

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3 (Rev. 1), IAEA, Vienna (2016).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3, IAEA, Vienna (2003).

(b) Evaluating a site such that the site specific hazards and the safety related site characteristics are adequately taken into account, in order to derive appropriate site specific design parameters[3];
(c) Analysing the characteristics of the population and the region surrounding the site to determine whether there would be significant difficulties in implementing emergency response actions effectively [9].

1.5. The requirements in this publication are to be applied:

(a) To identify the natural and human induced external hazards that could affect the safety of the nuclear installation;
(b) To assess the interactions between the site and nuclear installation for operational states and accident conditions, over the lifetime of the nuclear installation, including accidents that could warrant the implementation of emergency response actions.

1.6. This publication is intended for use by regulatory bodies in establishing regulatory requirements, and by operating organizations or their contractors in conducting site evaluation for nuclear installations.

SCOPE

1.7. The requirements in this publication apply to all nuclear installations [10], as follows:

— Nuclear power plants;
— Research reactors (including subcritical and critical assemblies) and any adjoining radioisotope production facilities;
— Storage facilities for spent fuel;
— 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;
— Nuclear fuel cycle related research and development facilities.

[3] Site specific design parameters are needed for the design of a nuclear installation. The design of a nuclear installation is adequate for a specific site if the actual parameters used in the design envelop the corresponding site specific design parameters.

1.8. This Safety Requirements publication covers site evaluation for both new and existing nuclear installations. For existing nuclear installations, decisions concerning the implementation of new or enhanced safety features will need to consider, as practicable, the safety significance of such features, as well as economic, social and environmental factors.

1.9. The 'site area' is the geographical area that contains an authorized facility, authorized activity or source, and within which the management of the authorized facility or authorized activity or first responders may directly initiate an emergency response [9]. The site area is typically the area within the security perimeter fence or other designated property marker.

1.10. The 'external zone' is the area immediately surrounding a proposed site area in which the population distribution and density, and land and water uses, are considered with respect to their impact on planning effective emergency response actions [9].[4]

1.11. The word 'region' is used generally in this publication to refer to the area surrounding the site and is normally intended to include more than the external zone. The size of this region will be defined for each specific external hazard (see para. 4.14). This region is also sometimes known as the 'geographical area of interest'.

1.12. The 'site vicinity' is smaller than the region and larger than the site area (typically covering a geographical area not less than 5 km in radius).

1.13. The human induced external events considered in this Safety Requirements publication are all of accidental origin. Considerations relating to the physical protection of the nuclear installation against sabotage, and to physical protection against unauthorized removal or sabotage of the nuclear material, are outside the scope of this publication, although such considerations are likely to have significant implications for site evaluation. This publication does not address the threat assessment of malicious acts. Recommendations for the establishment of the design basis threat are provided in IAEA Nuclear Security Series No. 13 [11] and in supporting publications in the IAEA Nuclear Security Series.

1.14. The interfaces between nuclear safety and nuclear security have to be considered and synergies have to be developed so that safety and nuclear

[4] The external zone is the area that would be the emergency planning zones if the installation were in place.

security complement and enhance one another. For example, site specific design parameters for the qualification of structures, systems and components important to safety against natural and human induced external hazards, as required in this publication, can also be used for the qualification of structures, systems and components important for nuclear security against relevant external hazards.

1.15. The siting process for a nuclear installation is divided into two stages:

(a) Site survey, in which candidate sites are identified after the investigation of a large region and the rejection of unsuitable sites;
(b) Site selection, in which the candidate sites are assessed by screening, evaluation, comparison and ranking on the basis of safety and other considerations to select one or more preferred candidate sites.

1.16. The suitability of the site is then confirmed in the site evaluation process. The site evaluation process starts with the second stage of the siting process (i.e. site selection), and continues throughout the entire lifetime of the nuclear installation. The detailed site evaluation (for the selected site) provides input to the preliminary safety analysis report and the final safety analysis report. Site evaluation continues throughout the operational stage of the nuclear installation, and includes monitoring, periodic safety review and other activities to confirm the site specific design parameters as well as safety re-evaluations based on the outcome of periodic safety reviews.

1.17. This publication addresses the evaluation of those site related factors that have to be taken into account to ensure that the site–installation combination does not constitute an unacceptable risk to people or the environment over the lifetime of the nuclear installation. It is recognized that there are other important factors in site evaluation, such as technology, economics, non-radiological environmental impacts and socioeconomic impacts, as well as the opinion of interested parties, including the public. Such aspects of site evaluation are not covered in this publication.

STRUCTURE

1.18. Section 2 of this publication sets out the fundamental safety objective and the safety principles applicable to site evaluation. Section 3 establishes requirements for the application of the management system for site evaluation. Section 4 establishes the general requirements that are applicable to all types of external hazard. Section 5 establishes requirements for specific technical aspects

related to the evaluation of natural and human induced external hazards. Section 6 establishes requirements for specific technical aspects related to the evaluation of the effects of the nuclear installation on the surrounding environment (including the atmosphere, the hydrosphere and the biosphere) and on the population. Section 7 establishes requirements for monitoring and periodic review of natural and human induced external hazards and site conditions throughout the lifetime of the nuclear installation.

2. SAFETY PRINCIPLES AND CONCEPTS

2.1. As stated in SF-1 [1]: "**The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation.**" Paragraph 2.1 of SF-1 [1] states:

> "This fundamental safety objective of protecting people — individually and collectively — and the environment has to be achieved without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks. To ensure that facilities are operated and activities conducted so as to achieve the highest standards of safety that can reasonably be achieved, measures have to be taken:
>
> (a) To control the radiation exposure of people and the release of radioactive material to the environment;
> (b) To restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation;
> (c) To mitigate the consequences of such events if they were to occur."

2.2. Paragraph 2.2 of SF-1 [1] states:

> "The fundamental safety objective applies for all facilities and activities, and for all stages over the lifetime of a facility or radiation source, including planning, siting, design, manufacturing, construction, commissioning and operation, as well as decommissioning and closure. This includes the associated transport of radioactive material and management of radioactive waste."

2.3. This Safety Requirements publication establishes requirements for application of the principles of SF-1 [1], in particular Principles 8 and 9:

— "**All practical efforts must be made to prevent and mitigate nuclear or radiation accidents**" (Principle 8 of SF-1 [1]).
— "The primary means of preventing and mitigating the consequences of accidents is 'defence in depth'. Defence in depth is implemented primarily through the combination of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment" (para. 3.31 of SF-1 [1]).
— "Defence in depth is provided by an appropriate combination of [inter alia] … [a]dequate site selection and the incorporation of good design and engineering features providing safety margins, diversity and redundancy" (para. 3.32 of SF-1 [1]).
— "**Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents**" (Principle 9 of SF-1 [1]).

2.4. To address Principle 8 of SF-1 [1], site evaluation for a nuclear installation shall characterize the natural and human induced external hazards that could affect the safety of the nuclear installation (see Requirement 1). The site evaluation shall provide adequate input to the design and safety assessment for demonstration of protection of people and the environment from harmful effects of ionizing radiation.

2.5. To address Principle 9 of SF-1 [1], site evaluation for a nuclear installation shall provide adequate input for demonstration of protection of people and the environment from the consequences of radioactive releases. The site evaluation shall identify the site characteristics that could affect the feasibility of planning effective emergency response actions in the external zone.

Requirement 1: Safety objective in site evaluation for nuclear installations

The safety objective in site evaluation for nuclear installations shall be to characterize the natural and human induced external hazards that might affect the safety of the nuclear installation, in order to provide adequate input for demonstration of protection of people and the environment from harmful effects of ionizing radiation.

2.6. The safety objective in site evaluation is derived from the fundamental safety objective established in SF-1 [1]. Demonstration of compliance with the safety requirements established in this publication provides the basis for demonstration of achievement of the safety objective for site evaluation.

3. APPLICATION OF THE MANAGEMENT SYSTEM FOR SITE EVALUATION

Requirement 2: Application of the management system for site evaluation

Site evaluation shall be conducted in a comprehensive, systematic, planned and documented manner in accordance with a management system.

3.1. An integrated management system that meets the requirements of IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [12] shall be established. The management system shall cover the organization, planning, work control, verification and documentation of activities and qualification and training of personnel to ensure that the required quality of the work is achieved at each stage of site evaluation. The management system shall be implemented at the earliest possible time in the conduct of site evaluation for the nuclear installation.

3.2. Site evaluation shall include, as part of the management system, proper quality assurance arrangements covering each activity that could influence safety or affect the derivation of site specific design parameters and other safety related site characteristics. The quality assurance arrangements shall be consistent with regulatory requirements and their application shall be commensurate with the importance of the activity under consideration to safety.

3.3. For each site evaluation activity, including inspection, testing, verification and validation, the acceptance criteria and the responsibilities for performing the activity shall be specified.

3.4. The results of studies and investigations conducted as part of the site evaluation shall be documented in sufficient detail to permit an independent review.

3.5. An independent review shall be made of the evaluation of the natural and human induced external hazards and the site specific design parameters, and of the evaluation of the potential radiological impact of the nuclear installation on people and the environment.

4. GENERAL REQUIREMENTS FOR SITE EVALUATION

Requirement 3: Scope of the site evaluation for nuclear installations

The scope of the site evaluation shall encompass factors relating to the site and factors relating to the interaction between the site and the installation, for all operational states and accident conditions, including accidents that could warrant emergency response actions.

4.1. The scope of the site evaluation shall cover all external hazards, monitoring activities and site specific parameters relevant for the safety of the nuclear installation. In determining the scope of the site evaluation, a graded approach shall be applied commensurate with the radiation risk posed to people and the environment.

4.2. The application of the safety requirements for site evaluation for nuclear installations shall be commensurate with the potential hazards associated with the nuclear installation.

4.3. The level of detail needed in the evaluation of a site for a nuclear installation shall be commensurate with the risk associated with the nuclear installation and the site and will differ depending on the type of nuclear installation.

4.4. The scope and level of detail of the site evaluation process necessary to support the safety demonstration for the nuclear installation shall be determined in accordance with a graded approach.

4.5. For site evaluation for nuclear installations other than nuclear power plants, the following shall be taken into consideration in the application of a graded approach:

(a) The amount, type and status of the radioactive inventory at the site (e.g. whether the radioactive material on the site is in solid, liquid and/or gaseous form, and whether the radioactive material is being processed in the nuclear installation or is being stored on the site);
(b) The intrinsic hazards associated with the physical and chemical processes that take place at the nuclear installation;
(c) For research reactors, the thermal power;
(d) The distribution and location of radioactive sources in the nuclear installation;

(e) The configuration and layout of installations designed for experiments, and how these might change in future;
(f) The need for active systems and/or operator actions for the prevention of accidents and for the mitigation of the consequences of accidents;
(g) The potential for on-site and off-site consequences in the event of an accident.

Requirement 4: Site suitability

The suitability of the site shall be assessed at an early stage of the site evaluation and shall be confirmed for the lifetime of the planned nuclear installation.

4.6. In the assessment of the suitability of a site for a nuclear installation, the following aspects shall be addressed at an early stage of the site evaluation:

(a) The effects of natural and human induced external events occurring in the region that might affect the site;
(b) The characteristics of the site and its environment that could influence the transfer of radioactive material released from the nuclear installation to people and to the environment;
(c) The population density, population distribution and other characteristics of the external zone, in so far as these could affect the feasibility of planning effective emergency response actions [9], and the need to evaluate the risk to individuals and to the population.

4.7. The site shall be deemed unsuitable for a nuclear installation if one or more of the three aspects listed in para. 4.6 indicates that the site is unacceptable and the deficiencies cannot be compensated for by means of a combination of measures for site protection, design features of the nuclear installation and administrative procedures.

4.8. Site suitability shall be assessed on the basis of relevant current data and methodologies. If relevant, conservative criteria shall be developed in relation to site specific accident scenarios, and the consistency of such criteria with the overall site suitability shall be demonstrated.

4.9. A decision regarding the suitability of the site shall be based on the characteristics of the nuclear installation, including planned operations at the site, the amount and nature of potential radioactive releases and their impact on people and the environment.

4.10. For nuclear power plants, the total nuclear capacity to be installed at the site shall be determined at the first stages of the siting process. If it is later determined or anticipated that the installed nuclear capacity (or, for other nuclear installations, the inventory of nuclear material) or its impact has increased to a level significantly greater than that previously determined to be acceptable, the site shall be re-evaluated considering the higher capacity, inventory or impact.

4.11. In the overall evaluation of site suitability, site specific attributes, such as cooling water availability or extreme environmental conditions, and their potential role in affecting the safe and continuous operation of the nuclear installation, shall also be addressed.

Requirement 5: Site and regional characteristics

The site and the region shall be investigated with regard to the characteristics that could affect the safety of the nuclear installation and the potential radiological impact of the nuclear installation on people and the environment.

4.12. Natural phenomena as well as human activities in the region with the potential to induce hazards at the site that might affect the safety of the nuclear installation shall be identified and evaluated. The extent of this evaluation shall be commensurate with the safety significance of the potential hazards at the site.

4.13. The characteristics of the natural environment in the region that could be affected by the potential radiological impact of the nuclear installation shall be investigated and assessed, for all operational states and accident conditions and for all stages of the lifetime of the nuclear installation (see Section 6).

4.14. The size of the region to be investigated shall be defined for each of the natural and human induced external hazards. Both the magnitude of the hazard and the distance from the source of the hazard to the site shall be considered in determining the size of the region to be investigated. For certain natural external events, such as tsunamis and volcanic phenomena, it shall be ensured that the size of the region that is investigated is sufficiently large to address the potential effects at the site.

4.15. The site and the region shall be studied to evaluate the present and foreseeable future characteristics that could have an impact on the safety of the nuclear installation. This includes potential changes in the severity and/or the frequency of natural external events, as well as changes in the population distribution in the region, the present and future use of land and water, the further

development of existing nuclear installations or the construction of other facilities that could affect the safety of the nuclear installation or the feasibility of planning effective emergency response actions.

Requirement 6: Identification of site specific hazards

Potential external hazards associated with natural phenomena, human induced events and human activities that could affect the region shall be identified through a screening process.

4.16. The process and associated criteria used in the screening of site specific hazards shall comply with the safety objective for site evaluation and shall be properly justified and documented.

4.17. The scope of evaluation of external events in the screening process shall cover the full ranges of severity and frequency of occurrence relevant for the design and the safety assessment of the nuclear installation, including events of high severity but low probability that could contribute to the overall risk.

4.18. An event might be screened out because it is enveloped by a set of events. However, it shall be ensured that all potential effects of the screened-out event are bounded by this set of events.

4.19. External hazards that are not excluded by the screening process shall be evaluated and then used in establishing the site specific design parameters and in the re-evaluation of the site, in accordance with the significance of these hazards to the safety of the nuclear installation.

Requirement 7: Evaluation of natural and human induced external hazards

The impact of natural and human induced external hazards on the safety of the nuclear installation shall be evaluated over the lifetime of the nuclear installation.

4.20. The site evaluation for a nuclear installation shall consider the frequency and severity of natural and human induced external events, and potential combinations of such events, that could affect the safety of the nuclear installation.

4.21. Information on the frequency and severity of external events derived from the characterization of the hazards shall be used in establishing the site specific

design parameters. Adequate account shall be taken of both aleatory uncertainties and epistemic uncertainties in the establishment of site specific design parameters.

4.22. Appropriate methods, supported by numerical models when necessary, shall be used to characterize the hazards relevant for site evaluation and the design of the nuclear installation. A thorough uncertainty analysis of the method and input data shall be performed as part of the hazard evaluation.

4.23. The decision to use deterministic and/or probabilistic methodologies in hazard evaluation shall be based on the nature of the hazard, the availability of data and the applicable requirements for safety assessment.

4.24. Special consideration shall be given to the use of applicable probabilistic methodologies and the use of probabilistic hazard curves representing external events as an input to the probabilistic safety assessment for external hazards. Such probabilistic hazard curves shall be developed with reference to the specific site conditions.

4.25. The evaluation of hazards shall address the possibility that external events can occur in combination, simultaneously or within short time frames. Interrelationships and causality between external events shall be evaluated.

4.26. The results of the evaluation of hazards shall be expressed in terms that can be used as an input for deriving the site specific design parameters; that is, appropriate parameters for describing the severity of the effects of the hazards shall be selected or developed.

4.27. The potential for explosion, chemical releases and/or thermal releases that might affect the safety of the nuclear installation or the dispersion of radioactive material shall be considered in the site evaluation process.

4.28. The potential for interactions between radioactive and non-radioactive substances, such as interactions due to heat or chemicals in radioactive liquid effluents, shall be considered.

Requirement 8: Measures for site protection

If the projected design of the nuclear installation is not able to safely withstand the impact of natural and human induced external hazards, the need for site protection measures shall be evaluated.

4.29. The need for protection of the site against the effects of specific phenomena associated with natural and human induced external hazards shall be evaluated considering adequate safety margins.

4.30. The availability of adequate engineering solutions for implementing measures for site protection shall be evaluated. If such engineering solutions are not available, the site shall be deemed unsuitable.

4.31. If measures for site protection are required to be implemented, uncertainties shall be properly taken into account in the evaluation of extreme values of parameters for describing the severity of natural and human induced external hazards. Measures for site protection shall be classified, designed, built, maintained and operated in accordance with their safety significance.

Requirement 9: Site evaluation for multiple nuclear installations on the same site or on adjacent sites

The site evaluation shall consider the potential for natural and human induced external hazards to affect multiple nuclear installations on the same site as well as on adjacent sites.

4.32. Occurrences of natural and human induced external events and their credible combinations that could affect the safety of multiple installations on the same site or installations on adjacent sites shall be considered. The potential for hazards originating from one nuclear installation to affect other nuclear installations located on the same site or on adjacent sites shall be assessed.

4.33. For identified accident scenarios, the combined effects of accidents at nuclear installations located on the same site or at adjacent and nearby sites on people and the environment shall be evaluated (see Requirement 12).

Requirement 10: Changes of hazards and site characteristics with time

The external hazards and the site characteristics shall be assessed in terms of their potential for changing over time and the potential impact of these changes shall be evaluated.

4.34. The site characteristics and the natural and human induced external hazards that can change over time and which could affect the safety of a nuclear installation shall be identified. The potential consequences of such changes shall be duly assessed for the planned lifetime of the nuclear installation.

4.35. Due account shall be taken of uncertainties in the projections of any potential changes of the external hazards and site characteristics over time by means of appropriate safety margins in the related site specific design parameters.

Requirement 11: Special considerations for the ultimate heat sink for nuclear installations that require an ultimate heat sink

The evaluation of site specific natural and human induced external hazards for nuclear installations that require an ultimate heat sink shall consider hazards that could affect the availability and reliability of the ultimate heat sink.

4.36. As appropriate for the ultimate heat sink under consideration, data for the following shall be evaluated:

(a) Air temperature and humidity;
(b) Water depth and temperature;
(c) Water quality characteristics, including turbidity, suspended solids, floating debris, and chemical and biochemical changes (both natural and human induced changes);
(d) Availability and sustainability of the water flow (for a river), minimum and maximum water level and the period of time for which safety related supplies of cooling water are at a minimum level, with account taken of the potential for failure of water control structures.

4.37. All natural and human induced external events that could cause a loss of the ultimate heat sink shall be identified and evaluated.

Requirement 12: Potential effects of the nuclear installation on people and the environment

In determining the potential radiological impact of the nuclear installation on the region for operational states and accident conditions, including accidents that could warrant emergency response actions, appropriate estimates shall be made of the potential releases of radioactive material, with account taken of the design of the nuclear installation and its safety features.

4.38. The potential effects of the nuclear installation on people and the environment shall be estimated by considering the postulated accident scenarios (including the resulting source terms) and taking into account the feasibility of planning effective emergency response actions at the site and in the external zone. These estimates shall be confirmed when the design of the nuclear installation and its safety features has been established.

4.39. The direct and indirect pathways by which radioactive releases from the nuclear installation could potentially affect the public and the environment shall be identified and evaluated. In this evaluation, specific regional and site characteristics, including the population distribution in the region, shall be taken into account, with special attention paid to the transport and accumulation of radionuclides in the biosphere.

4.40. It shall be demonstrated that the information provided to assess the potential effects on the population associated with accident conditions, including accidents that could warrant emergency response actions being taken in the external zone, is consistent with achieving the safety objective for site evaluation.

Requirement 13: Feasibility of planning effective emergency response actions

The feasibility of planning effective emergency response actions on the site and in the external zone shall be evaluated, with account taken of the characteristics of the site and the external zone as well as any external events that could hinder the establishment of complete emergency arrangements prior to operation.

4.41. Requirement 13 applies also to the infrastructure of the external zone where emergency response actions might be warranted.

4.42. An assessment shall be made of the feasibility of planning effective emergency response actions in accordance with GSR Part 7 [9].

Nuclear installations on the same site and at adjacent or nearby sites shall be considered in the assessment, with special emphasis on nuclear installations that could experience concurrent accidents.

4.43. Any causal relationships between external events and the condition of the infrastructure on the site and in the external zone shall be considered when evaluating the feasibility of planning effective emergency response actions.

Requirement 14: Data collection in site evaluation for nuclear installations

The data necessary to perform an assessment of natural and human induced external hazards and to assess both the impact of the environment on the safety of the nuclear installation and the impact of the nuclear installation on people and the environment shall be collected.

4.44. Data on natural and human induced external hazards with the potential to affect the safety of the nuclear installation shall be collected throughout the lifetime of the nuclear installation. Data shall be confirmed to be relevant (spatially and temporally) to the site, with preference given to the use of site specific data in site evaluation.

4.45. The extent, objectives and scope of the data collection process shall be defined on the basis of the safety objective for site evaluation, and shall be commensurate with the hazard posed by the nuclear installation to people and the environment.

4.46. At a minimum, the data collection process shall include the following:

(a) Information on natural and human induced external hazards, including information on sources of hazards, propagation of hazards and the potential effects on the nuclear installation and on people and the environment;
(b) Information describing site conditions and regional environmental conditions;
(c) Information on the proposed engineering and administrative measures for site protection and mitigatory measures;
(d) Information on the potential impact of the nuclear installation on people and the environment for operational states and accident conditions;
(e) Information required for planning effective emergency response actions on the site and off the site in all environmental conditions and for all states of the nuclear installation;

(f) Information on conditions for access to the site and information for supporting design and development of the site infrastructure.

4.47. Information and records, if available, of the occurrence and severity of important prehistoric, historical and recent natural phenomena shall be obtained as appropriate for the hazard to be evaluated and shall be analysed for reliability, accuracy, temporal and spatial relevance, and completeness.

4.48. The data shall be maintained and reviewed periodically, and/or as necessary as part of a review of the site evaluation within the framework of the periodic safety review of the nuclear installation, for example, to address developments in data gathering techniques and in the analysis and use of data and to confirm that the data remain relevant to the site within the context of evolving hazards.

4.49. The data collected for site investigations shall be of sufficient quality and quantity to support the selected methodology for hazard evaluation.

4.50. The details of the information collected for each hazard shall be appropriate for the distance between the source of the hazard and the site and the potential impact on the site. The sources of uncertainties relating to data collection shall be documented.

5. EVALUATION OF EXTERNAL HAZARDS

5.1. This section establishes requirements for the evaluation of external hazards. These requirements are to be applied as appropriate for the type of nuclear installation as well as the site under consideration.

SEISMIC HAZARDS

Requirement 15: Evaluation of fault capability

Geological faults larger than a certain size and within a certain distance of the site and that are significant to safety shall be evaluated to identify whether these faults are to be considered capable faults. For capable faults, potential challenges to the safety of the nuclear installation in terms of ground motion and/or fault displacement hazards shall be evaluated.

5.2. Capable faults[5] shall be identified and evaluated. The evaluation shall consider the fault characteristics in the site vicinity. The methods used and the investigations made shall be sufficiently detailed to support safety related decisions.

5.3. The potential effect of fault displacement on safety related structures, systems and components shall be evaluated. The evaluation of fault displacement hazards shall include detailed geological mapping of excavations for safety related engineered structures to enable the evaluation of fault capability for the site.

5.4. A proposed new site shall be considered unsuitable when reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the nuclear installation and which cannot be compensated for by means of a combination of measures for site protection and design features of the nuclear installation. If a capable fault is identified in the site vicinity of an existing nuclear installation, the site shall be deemed unsuitable if the safety of the nuclear installation cannot be demonstrated.

Requirement 16: Evaluation of ground motion hazards

An evaluation of ground motion hazards shall be conducted to provide the input needed for the seismic design or safety upgrading of the structures, systems and components of the nuclear installation, as well as the input for performing the deterministic and/or probabilistic safety analyses necessary during the lifetime of the nuclear installation.

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[5] A fault is considered capable if, on the basis of geological, geophysical, geodetic or seismological data (including palaeoseismological and geomorphological data), one or more of the following conditions applies:

(a) The fault shows evidence of past movement or movements (significant surface deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to infer that further movements at or near the surface could occur. In highly active areas, where both earthquake data and geological data consistently and/or exclusively reveal short earthquake recurrence intervals, periods of the order of tens of thousands of years may be appropriate for the assessment of capable faults. In less active areas, it is likely that much longer periods will be required.

(b) A structural relationship with a known capable fault has been demonstrated such that movement of one could cause movement of the other at or near the surface.

(c) The maximum potential earthquake associated with a seismogenic structure is sufficiently large and at such a depth that it is reasonable to infer that, in the geodynamic setting of the site, movement at or near the surface could occur.

5.5. Hazards due to earthquake induced ground motion shall be assessed by means of appropriate methods. The effect of the vibratory ground motion in combination with other seismically induced events, if any, shall be considered. The potential for seismicity due to human activities[6] shall also be considered.

VOLCANIC HAZARDS

Requirement 17: Evaluation of volcanic hazards

Hazards due to volcanic activity that have the potential to affect the safety of the nuclear installation shall be evaluated.

5.6. Capable volcanoes[7] shall be identified and evaluated. The evaluation shall consider the volcanic characteristics of a region of sufficient size to ensure that potentially hazardous volcanic phenomena are considered appropriately.

5.7. The hazards of capable volcanoes shall be evaluated to provide the input needed for determining the site specific design parameters or for re-evaluating the site, as well as for deterministic and/or probabilistic safety analyses performed during the lifetime of the nuclear installation.

5.8. A proposed new site shall be considered unsuitable if reliable evidence shows the existence of a capable volcano that has the potential to affect the safety of the nuclear installation and which cannot be compensated for by means of a combination of measures for site protection and design features of the nuclear installation.

5.9. An evaluation of volcanic hazards that focuses on determining the geological characteristics of volcanic phenomena and their spatial extent will usually be more certain than one focusing on an estimation of the likelihood of occurrence of hazardous phenomena. Volcanic hazards shall be evaluated using appropriate information, methods and models with adequate account taken of the uncertainties.

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[6] Such as construction of dams, mining, and operation of oil wells and gas wells.

[7] A capable volcano is a volcano that has a credible likelihood of undergoing future activity and producing hazardous phenomena, including non-eruptive phenomena, during the lifetime of a nuclear installation concerned, and which may potentially affect the site.

5.10. The effect of volcanic phenomena in combination with other volcanically induced hazards shall be considered. This shall include consideration of volcanic ash fall.

METEOROLOGICAL HAZARDS

Requirement 18: Evaluation of extreme meteorological hazards

Extreme meteorological hazards and their possible combinations that have the potential to affect the safety of the nuclear installation shall be evaluated.

5.11. Meteorological phenomena such as wind, precipitation, snow and ice, air and water temperature, humidity, storm surges and sand or dust storms, as well as their credible combinations, shall be evaluated for their extreme values[8] based on available records. If necessary, efforts shall be made to extend the database on meteorological hazards (e.g. by incorporating historical climate data, numerical models and simulations).

5.12. Appropriate methods shall be applied for the evaluation of meteorological hazards, taking into account the amount of data available (both measured data and historical data) and known past changes in relevant characteristics of the region.

Requirement 19: Evaluation of rare meteorological events

The potential for the occurrence of rare meteorological events[9] such as lightning, tornadoes and cyclones, including information on their severity and frequency, shall be evaluated.

Lightning

5.13. The potential for the occurrence and the frequency and severity of lightning shall be evaluated for the site vicinity.

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[8] Extreme values of meteorological parameters are identified by means of statistical analysis of measurement data for different meteorological parameters.

[9] Rare meteorological events are unlikely to be measured at any specific location because of their very low frequency of occurrence at any single place and the destructive effects of the phenomena, which might result in damage to standard measuring instruments.

Tornadoes and cyclones

5.14. The potential for the occurrence and the frequency and severity of tornadoes, cyclones and associated missiles shall be evaluated for the site. The hazards associated with tornadoes and cyclones shall be derived and expressed in terms of parameters such as rotational wind speed, translational wind speed, radius of maximum rotational wind speed, pressure differentials and rate of change of pressure.

FLOODING HAZARDS

Requirement 20: Evaluation of flooding hazards

Hazards due to flooding, considering natural and human induced events including their possible combinations, shall be evaluated.

Floods due to precipitation and other natural causes

5.15. The potential for flooding in the region surrounding the site due to one or more natural causes, such as storm surge, wind generated waves, meteorological tsunamis or seiches, or extreme precipitation — or due to a combination of such events that have a common cause or a relatively high frequency of occurrence — shall be evaluated.

5.16. Appropriate meteorological, hydrological and hydraulic models shall be developed to derive the flooding hazards for the site, including secondary effects such as debris, ice and sediments. Where available, relevant information from studies of historic and prehistoric floods shall be used to inform estimates of the frequency and magnitude of riverine floods.

5.17. The potential for instability of a coastal area or river channel due to erosion or sedimentation shall be investigated.

Water waves induced by earthquakes or other geological phenomena

5.18. The potential for tsunamis or seiches in the region that could affect the safety of the nuclear installation shall be evaluated. The potential for tsunamis or seiches from phenomena other than seismic sources (e.g. from submarine landslides) shall be evaluated, as appropriate for the region.

5.19. The hazards associated with tsunamis or seiches shall be derived from historical records and any available information on prehistoric floods, as well as from physical and/or analytical modelling. Such hazards shall include potential draw-down and run-up[10] that could result in physical effects on the site.

5.20. The hazards associated with tsunamis or seiches shall be evaluated as appropriate for the region, using nearshore bathymetry and coastal topography, with account taken of any amplification due to the coastal configuration (including artificial structures).

Floods and waves caused by failure of water control structures

5.21. Upstream water control structures such as dams shall be analysed to determine the potential hazard associated with the failure of one or more of the upstream structures, including in combination with flooding from other causes.

5.22. If a preliminary examination of the nuclear installation indicates that it would not be able to safely withstand the effects of the failure of one or more of the upstream water control structures, then the hazards associated with the nuclear installation shall be evaluated with the inclusion of such effects. Alternatively, such upstream structures shall be analysed by methods equivalent to those used in determining the hazards associated with the nuclear installation to demonstrate that the upstream structures could survive the event concerned.

5.23. Flooding and associated phenomena caused by an accumulation of water due to a blockage of rivers upstream or downstream (e.g. caused by landslides or ice), or due to a change in land use, shall be considered.

GEOTECHNICAL HAZARDS AND GEOLOGICAL HAZARDS

Requirement 21: Geotechnical characteristics and geological features of subsurface materials

The geotechnical characteristics and geological features of subsurface materials shall be investigated, and a soil and rock profile for the site that considers the variability and uncertainty in subsurface materials shall be derived.

[10] Draw-down is a lowering of the water level at a coastal site. Run-up is a sudden surge of water up a beach or a structure.

5.24. The static and dynamic geotechnical characteristics and geological features of subsurface materials at the site, including any backfill, shall be established. Laboratory and field based methods shall be used, in conjunction with appropriate sampling techniques and sufficient repetition of each test, to characterize each parameter of the subsurface materials at the site.

5.25. The stability and bearing capacity of foundation materials shall be assessed, including consideration of the potential for excessive settlement under static and seismic loading.

5.26. The physical and the geochemical properties of the soil and groundwater shall be studied by appropriate methods and taken into account in the evaluation of the subsurface material at the site.

Requirement 22: Evaluation of geotechnical hazards and geological hazards

Geotechnical hazards and geological hazards, including slope instability, collapse, subsidence or uplift, and soil liquefaction, and their effect on the safety of the nuclear installation, shall be evaluated.

Slope instability

5.27. The site and the site vicinity shall be evaluated to determine the potential for slope instability (such as landslides, rock fall and snow avalanches), caused by natural or human induced phenomena, which could affect the safety of the nuclear installation. In the evaluation of slope instability, the configuration of the site during and after site preparation activities shall be addressed. The evaluation of slope stability shall also take into account extreme meteorological conditions and rare meteorological events.

5.28. The potential for slope instability resulting from seismic loading shall be evaluated using parameters appropriate for describing the seismic hazards and the soil and groundwater characteristics at the site.

Collapse, subsidence or uplift of the site surface

5.29. The potential for collapse, subsidence or uplift of the surface that could affect the safety of the nuclear installation over its lifetime shall be evaluated using a detailed description of subsurface conditions obtained from reliable methods of investigation.

Soil liquefaction

5.30. The potential for liquefaction and non-linear effects of the subsurface materials at the site shall be evaluated using parameters appropriate for describing the seismic hazards and geotechnical properties of the subsurface materials at the site.

5.31. The evaluation of soil liquefaction shall include the use of accepted methods for field and laboratory testing in combination with analytical methods to assess the hazards.

OTHER NATURAL HAZARDS

Requirement 23: Evaluation of other natural hazards

Other natural phenomena that are specific to the region and which have the potential to affect the safety of the nuclear installation shall be investigated.

5.32. Other natural external hazards, such as wild fires, drought, hail, frazil ice formation, diversion of a river, debris avalanche and biological hazards (e.g. jellyfish, small animals and barnacles) shall be identified and assessed so that the site specific design parameters for these hazards can be derived.

HUMAN INDUCED EVENTS

Requirement 24: Evaluation of hazards associated with human induced events

The hazards associated with human induced events on the site or in the region shall be evaluated.

5.33. Human induced events to be addressed shall include, but shall not be limited to:

(a) Events associated with nearby land, river, sea or air transport (e.g. collisions and explosions);
(b) Fire, explosions, missile generation and releases of hazardous gases from industrial facilities near the site;
(c) Electromagnetic interference.

5.34. Human activities that might influence the type or severity of natural hazards, such as resource extraction or other significant re-contouring of land or water or reservoir induced seismicity, shall be considered.

Aircraft crashes

5.35. The potential for accidental aircraft crashes on the site shall be assessed with account taken, to the extent practicable, of potential changes in future air traffic and aircraft characteristics.

Chemical hazards

5.36. Current or foreseeable activities in the region surrounding the site that involve the handling, processing, transport and/or storage of chemicals having a potential for explosions or for producing gas clouds capable of deflagration or detonation shall be addressed.

5.37. Hazards associated with chemical explosions or other releases shall be expressed in terms of heat, overpressure and toxicity (if applicable), with account taken of the effect of distance and non-favourable combinations of atmospheric conditions at the site. In addition, the potential effects of such events on site workers shall be evaluated.

6. EVALUATION OF THE POTENTIAL EFFECTS OF THE NUCLEAR INSTALLATION ON THE REGION

Requirement 25: Dispersion of radioactive material

The dispersion in air and water of radioactive material released from the nuclear installation in operational states and in accident conditions shall be assessed.

Atmospheric dispersion of radioactive material

6.1. The analysis of the atmospheric dispersion of radioactive material shall take into account the orography, land cover and meteorological features of the region, including parameters such as wind speed and direction, air temperature, precipitation, humidity, atmospheric stability parameters, prolonged atmospheric

inversions and any other parameters required for modelling of atmospheric dispersion. If possible, long term meteorological data for nearby locations shall be obtained, evaluated for quality and used.

6.2. A programme for meteorological measurements shall be prepared and carried out at or near the site using instrumentation capable of measuring and recording the main meteorological parameters at appropriate elevations, locations and sampling intervals. Data from at least one representative full year shall be collected and used in the analyses of atmospheric dispersion, together with any other relevant data available from other information sources. The meteorological data shall be expressed in terms of appropriate meteorological parameters.

Dispersion of radioactive material through surface water and groundwater

6.3. A survey programme shall be designed to gather relevant data to characterize the hydrogeological and hydrological parameters at the site and in the region to permit the assessment of the potential movement of radionuclides through surface water and groundwater and the subsequent assessment of the radiological impact. This measurement programme shall be carried out for at least one full year prior to hydrogeological investigations (see para. 6.5). The data shall be expressed in terms of appropriate parameters for surface hydrology and groundwater.

6.4. A programme of surface water investigations (including the interactions between surface water and groundwater) for the region shall be developed. The description of surface water shall include the main physical and chemical characteristics of the water bodies, both natural and artificial, the major structures for water control, the locations of water intake structures and information on water use in the region.

6.5. A programme of hydrogeological investigations for the region shall be developed, including descriptions of the main characteristics of the water-bearing formations and their interaction with surface water, as well as data on the uses of groundwater in the region.

6.6. The programme of hydrogeological investigations for the region shall include investigations of the migration and retention characteristics of radionuclides in groundwater and investigations of the associated exposure pathways.

6.7. The hydrogeological and hydrological investigations shall determine, to the extent necessary, the dilution and dispersion characteristics of water bodies,

the re-concentration ability of sediments and biota, the migration and retention characteristics of radionuclides, the transfer mechanisms for radionuclides in the hydrosphere, as well as the associated exposure pathways.

Requirement 26: Population distribution and public exposure

The existing and projected population distribution within the region over the lifetime of the nuclear installation shall be determined and the potential impact of radioactive releases on the public, in both operational states and accident conditions, shall be evaluated and periodically updated.

6.8. Information on the existing and projected population distribution in the region, including resident populations and (to the extent possible) transient populations, shall be collected and kept up to date over the lifetime of the nuclear installation. Special attention shall be paid to vulnerable populations and residential institutions (e.g. schools, hospitals, nursing homes and prisons) when evaluating the potential impact of radioactive releases and considering the feasibility of implementing protective actions.

6.9. The most recent census data for the region, or information obtained by extrapolation of the most recent data on resident populations and transient populations, shall be used in obtaining the population distribution. In the absence of reliable data, a special study shall be carried out.

6.10. The data shall be analysed to obtain the population distribution in terms of the direction and distance from the site. This information shall be used to carry out an evaluation of the potential radiological impact of normal discharges and accidental releases of radioactive material, including reasonable consideration of releases due to severe accidents, with the use of site specific design parameters and models as appropriate.

Requirement 27: Uses of land and water in the region

The uses of land and water shall be characterized in order to assess the potential effects of the nuclear installation on the region.

6.11. The characterization of the uses of land and water shall include investigations of the land and surface water and groundwater resources that might be used by the population or that serve as a habitat for organisms in the food chain.

7. MONITORING AND PERIODIC REVIEW OF THE SITE

Requirement 28: Monitoring of external hazards and site conditions

All natural and human induced external hazards and site conditions that are relevant to the licensing and safe operation of the nuclear installation shall be monitored over the lifetime of the nuclear installation.

7.1. The monitoring of external hazards and site conditions shall be commenced no later than the start of construction and shall be continued until decommissioning. The monitoring plan shall be developed as part of the objectives and scope of the site evaluation.

7.2. The monitoring plan shall include the parameters to be monitored, the type of data to be collected, the methodology for data collection (including the location and frequency of data collection), the necessary resolution and precision of any measurements, data backup requirements, as well as requirements for data processing and analysis.

7.3. Before commissioning of the nuclear installation begins, the levels of background radioactivity in the atmosphere, hydrosphere and lithosphere and in biota in the region shall be measured so as to make it possible to determine any additional radioactivity due to the operation of the nuclear installation.

Requirement 29: Review of external hazards and site conditions

All natural and human induced external hazards and site conditions shall be periodically reviewed by the operating organization as part of the periodic safety review and as appropriate throughout the lifetime of the nuclear installation, with due account taken of operating experience and new safety related information.

7.4. As part of periodic safety review (or as part of safety assessments conducted under alternative arrangements), natural and human induced external hazards and site conditions shall be reviewed throughout the lifetime of the nuclear installation using updated information. Such reviews shall be undertaken at regular intervals (typically no less than once in ten years), and in the event of any of the following:

(a) An update of the regulatory requirements;

(b) Indications of inadequate design against external hazards;
(c) New technical findings, such as the vulnerability of particular structures, systems and components to external hazards;
(d) New information, experience and lessons from the occurrence of actual external events that affected the safety of another nuclear installation or an industrial facility;
(e) Changes of hazards over time for which new information and assessments have become available;
(f) A need to provide additional confidence that there are sufficient margins to prevent cliff edge effects;
(g) As part of a programme for long term operation, or in support of an application for an extension to the operating licence for the nuclear installation;
(h) The development of new methods to analyse hazards that substantially improve earlier estimates.

7.5. The site specific external hazards and the site conditions shall be re-evaluated, as necessary, based on the outcome of the periodic review of site specific hazards or because of new data relevant to the radiological environmental impact assessment or to the safe operation of the nuclear installation.

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