IAEA Safety Standards

for protecting people and the environment

Establishing the Safety Infrastructure for a Nuclear Power Programme

Specific Safety Guide

No. SSG-16 (Rev. 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

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

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

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

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.

ESTABLISHING THE SAFETY INFRASTRUCTURE FOR A NUCLEAR POWER PROGRAMME

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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-16 (Rev. 1)

ESTABLISHING THE SAFETY INFRASTRUCTURE FOR A NUCLEAR POWER PROGRAMME

SPECIFIC SAFETY GUIDE

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FOREWORD

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.

Safety Guides

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

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

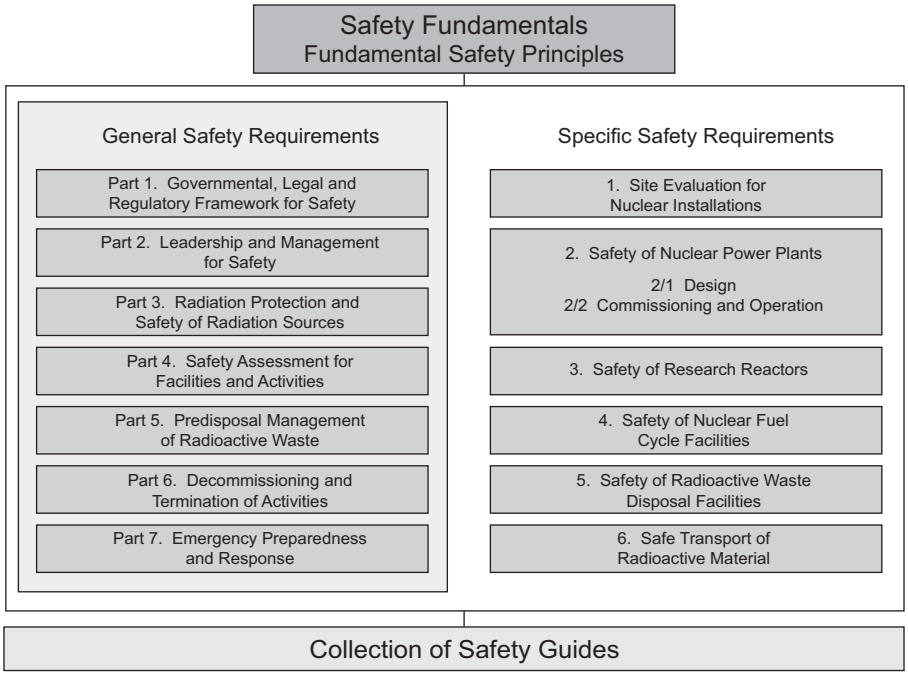

FIG. 1. The long term structure of the IAEA Safety Standards Series.

is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

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

The IAEA safety standards are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes and to protective actions to reduce existing radiation risks. They can be

used by States as a reference for their national regulations in respect of facilities and activities.

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

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

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

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

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

The preparation and review of the safety standards involves the IAEA Secretariat and five safety standards committees, for emergency preparedness and response (EPReSC) (as of 2016), nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), and a Commission on Safety Standards (CSS) which oversees the IAEA safety standards programme (see Fig. 2).

All IAEA Member States may nominate experts for the safety standards committees and may provide comments on draft standards. The membership of the Commission on Safety Standards is appointed by the Director General and includes senior governmental officials having responsibility for establishing national standards.

A management system has been established for the processes of planning, developing, reviewing, revising and establishing the IAEA safety standards.

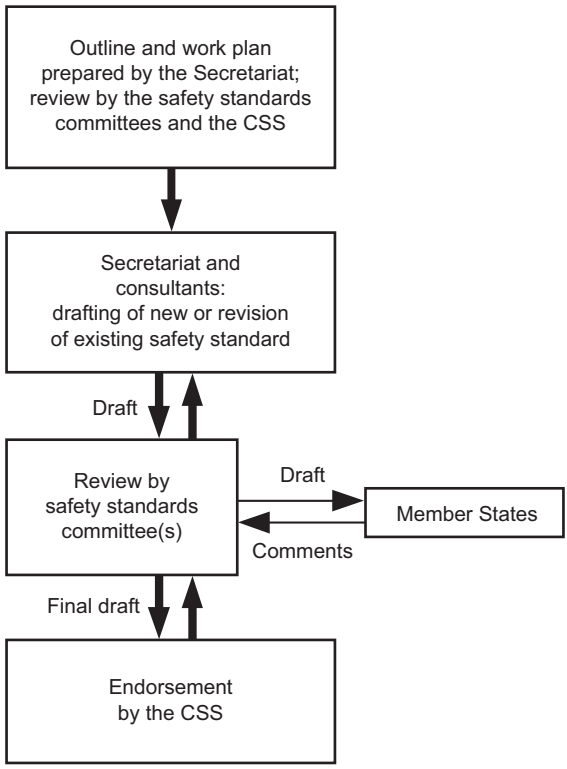

FIG. 2. The process for developing a new safety standard or revising an existing standard.

It articulates the mandate of the IAEA, the vision for the future application of the safety standards, policies and strategies, and corresponding functions and responsibilities.

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

The findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the recommendations of international expert bodies, notably the International Commission on Radiological Protection (ICRP), are taken into account in developing the IAEA safety standards. Some safety standards are developed in cooperation with other bodies in the United Nations system or other specialized agencies, including the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization and the World Health Organization.

INTERPRETATION OF THE TEXT

Safety related terms are to be understood as defined in the IAEA Safety Glossary (see 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. IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1], provides a coherent set of ten safety principles that constitute the basis for establishing safety requirements to achieve the fundamental safety objective of protecting people and the environment from harmful effects of ionizing radiation. The safety principles form a set that is applicable in its entirety. Although in practice different principles might be more or less important in relation to particular circumstances, the appropriate application of all relevant principles is necessary. When a State is considering embarking on a nuclear power programme, Principle 1 (responsibility for safety), Principle 2 (role of government), Principle 3 (leadership and management for safety), Principle 4 (justification of facilities and activities) and Principle 9 (emergency preparedness and response) are crucial to preparing properly for the future safe operation of a nuclear power plant.

1.2. A considerable period of time is needed to acquire the necessary competences and to foster a strong safety culture before constructing and operating a nuclear power plant. While the prime responsibility for safety rests with the operating organization, the State has the responsibility to create a robust framework for safety upon committing itself to a nuclear power programme, which demands significant investment [1]. Establishing a sustainable safety infrastructure is a long process, and it has been internationally acknowledged that a period of 10–15 years under optimum conditions is generally necessary between the consideration of nuclear power as part of the national energy strategy and the commencement of operation of the first nuclear power plant.

1.3. In 2007, the IAEA published a brochure, Considerations to Launch a Nuclear Power Programme [2], and a guide that was revised in 2015, Milestones in the Development of a National Infrastructure for Nuclear Power [3]. While those publications focus on the entire national infrastructure, the focus of this Safety Guide is on the development of the safety infrastructure for a nuclear power programme.

1.4. A 2008 report by the International Nuclear Safety Group (INSAG) [4] defines nuclear safety infrastructure as "*the set of institutional, organizational and technical elements and conditions established in a Member State to provide a sound foundation for ensuring a sustainable high level of nuclear safety.*"

1.5. IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [5], establishes requirements relating to infrastructure for safety. It covers the essential aspects of the governmental and legal framework for establishing a regulatory body and for taking other actions necessary to ensure the effective regulatory control of facilities and activities — existing and new — utilized for peaceful purposes. GSR Part 1 (Rev. 1) [5] applies to all facilities and activities, from the use of a single radiation source to a nuclear power programme. This framework for safety is essentially the part of the 'nuclear safety infrastructure' defined in Ref. [4] that is the responsibility of the government.

1.6. Paragraph 2.2 of GSR Part 1 (Rev. 1) [5] states:

> "The government establishes national policy for safety by means of different instruments, statutes and laws. Typically, the regulatory body, as designated by the government, is charged with the implementation of policies by means of a regulatory programme and a strategy set forth in its regulations or in national standards. The government determines the specific functions of the regulatory body and the allocation of responsibilities. For example, the government establishes laws and adopts policies pertaining to safety, whereas the regulatory body develops strategies and promulgates regulations in implementation of such laws and policies. In addition, the government establishes laws and adopts policies specifying the responsibilities and functions of different governmental entities in respect of safety and emergency preparedness and response, whereas the regulatory body establishes a system to provide effective coordination."

1.7. Reference [4] (consistent with Refs [2, 3]) divides the lifetime of a nuclear power plant into five phases from a nuclear safety standpoint. These phases and their indicative average durations are as follows (see Fig. 1):

(a) Phase 1: Safety infrastructure considerations before a decision to launch a nuclear power programme is taken. Average duration: 1–3 years.
(b) Phase 2: Safety infrastructure preparatory work for the construction of a nuclear power plant after a policy decision has been taken. Average duration: 3–7 years.
(c) Phase 3: Safety infrastructure activities to implement the first nuclear power plant. Average duration: 7–10 years.
(d) Phase 4: Safety infrastructure during the operation phase of the nuclear power plant. Average duration: 40–60 years.

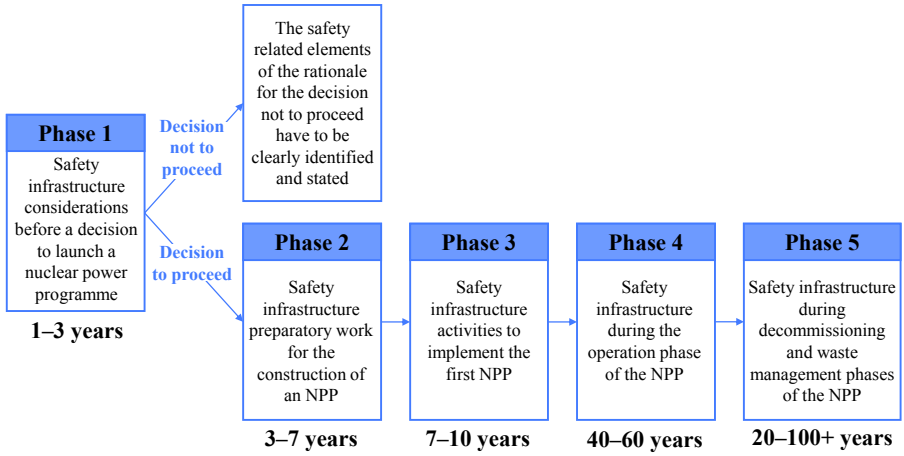

FIG. 1. Main phases of safety infrastructure development over the lifetime of a nuclear power plant.

(e) Phase 5: Safety infrastructure during the decommissioning and waste management phases of the nuclear power plant. Average duration: 20 to more than 100 years.

This Safety Guide uses the same approach in considering Phases 1–3.

1.8. This Safety Guide provides recommendations, presented in the form of sequential actions, on progressively meeting all applicable safety requirements established in the IAEA safety standards during Phases 1–3 in the development of the safety infrastructure. The actions set out in this Safety Guide are not reformulations of safety requirements; they provide recommendations, expressed as 'should' statements, on when to implement the relevant requirements. This Safety Guide does not diminish the application of, or provide a synopsis of or a substitute for, the IAEA Safety Fundamentals and Safety Requirements publications and associated Safety Guides.

1.9. Figure 2 provides an indicative time frame and some important milestones expected in each of the phases. At the end of Phase 1, the State is ready to make a knowledgeable commitment to a nuclear power programme. At the end of Phase 2, the State is ready to invite bids or to negotiate a contract for the first nuclear power plant. At the end of Phase 3, the State is ready to commission and operate the first nuclear power plant.

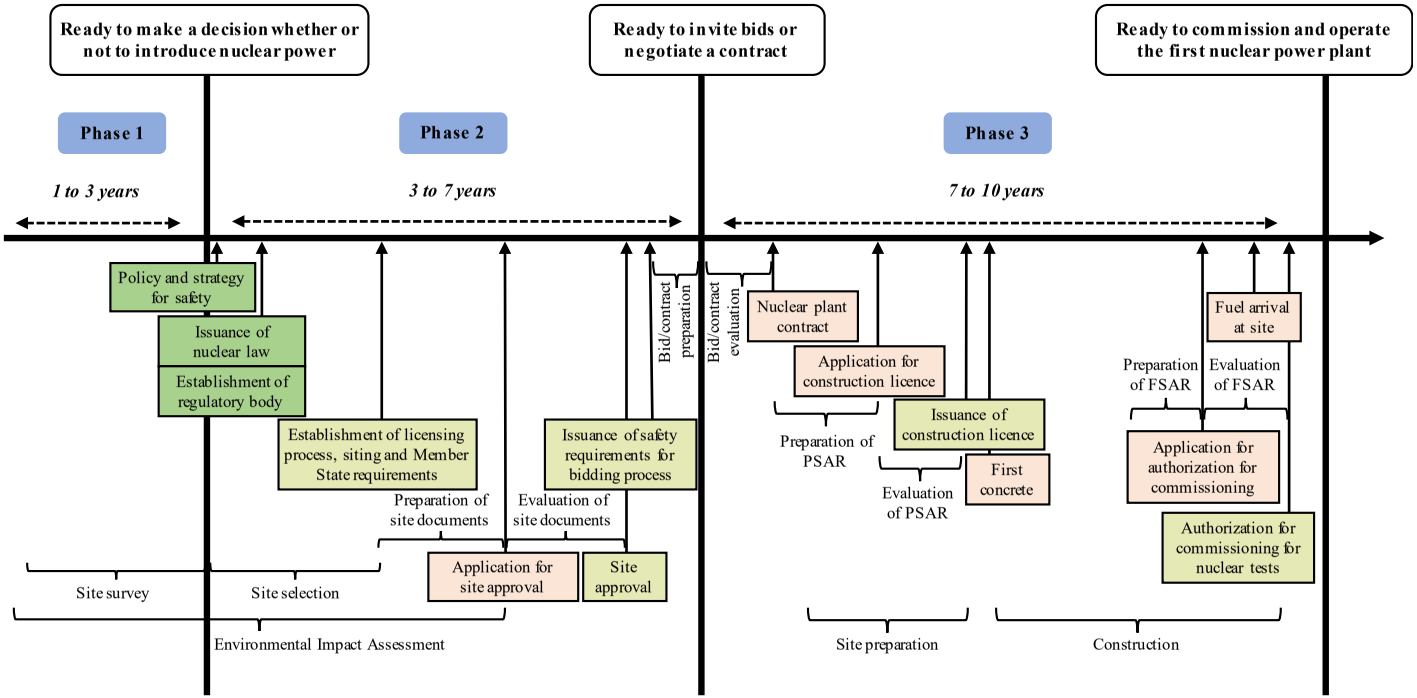

FIG. 2. Indicative time frame and some important milestones for the development of a nuclear safety infrastructure.

1.10. Figure 3 uses the time frame shown in Fig. 2 to provide insights into the progressive involvement of the regulatory body and the operating organization in nuclear power related activities, as well as the progressive allocation of responsibilities from the government to these organizations and other organizations involved in, for example, emergency preparedness and response or radioactive waste management. This progressive involvement also reflects the development of sufficient human resources with the competence to perform the necessary activities. In addition, Fig. 3 identifies for each relevant IAEA Safety Requirements publication at which phases:

(a) There should be awareness of the requirements.
(b) Implementation of the requirements should begin.
(c) The requirements should be fully implemented.

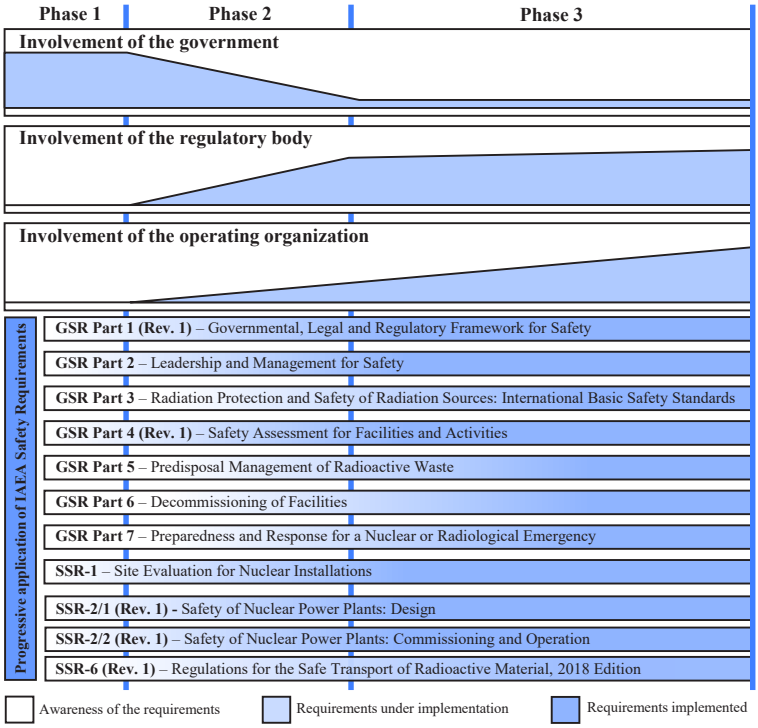

FIG. 3. Progressive involvement of the main organizations in a nuclear power programme and progressive application of IAEA Safety Requirements (indicative only). Note: The initial degree of application of these requirements will vary from State to State, depending on the use of radioactive sources or nuclear installations (other than nuclear power plants) before considering the nuclear power option.

1.11. In addition to meeting safety requirements and in order to understand fully the need for or to develop a safety infrastructure, the persons or organizations using this Safety Guide are expected to apply the recommendations provided in the Safety Guides that support the respective Safety Requirements publications. The IAEA promotes national self-assessments and provides for the application of IAEA safety standards through safety review services such as the Integrated Regulatory Review Service, the Operational Safety Review Team and the Emergency Preparedness Review, upon request by the State, to guide or to peer review a national self-assessment in specific areas.

1.12. States have different legal structures, and therefore the term 'government' as used in the IAEA safety standards is to be understood in a broad sense and is accordingly interchangeable with the term 'State'.

1.13. In identifying actions to be conducted, this Safety Guide tries to specify, as far as practicable, the entity responsible for taking the action. However, since States have different legal structures, it is not possible to specify in general which entity within the State (i.e. the government as a whole, an executive body, the judicial body or the regulatory body) is responsible for a given action. In such cases, the general term 'State' or 'government' is used.

1.14. The IAEA web site provides access to all relevant IAEA Safety Requirements publications and Safety Guides, as well as other key safety related publications, such as INSAG reports. In addition, the IAEA Nuclear Safety and Security Online User Interface provides easy access to the content of all current safety standards.

OBJECTIVE

1.15. The objective of this Safety Guide is to provide recommendations on the establishment of a framework for safety in accordance with IAEA safety standards for States deciding on and preparing to embark on a nuclear power programme. It proposes 197 safety related actions to be taken in the first three phases in the development of a nuclear power programme to set the foundation for a high level of safety throughout the lifetime of the nuclear power plant, including safety in the associated management of radioactive waste and spent fuel, and safety in decommissioning.

1.16. This Safety Guide also contributes to the building of leadership and management for safety and of a strong safety culture. It provides guidance for

self-assessment by all organizations involved in the development of the safety infrastructure.

1.17. The recommendations provided in this Safety Guide are to be understood in the context of the respective functions of the government and the regulatory body described in para. 1.6, although some flexibility might be necessary in following the recommendations, depending on the particular national circumstances.

1.18. This Safety Guide is intended for use by persons or organizations participating in the preparation and implementation of a nuclear power programme. Such persons or organizations are referred to collectively in the text as 'all relevant organizations' and include:

(a) Governmental officials;
(b) Legislative bodies;
(c) Organizations that are given an explicit governmental mandate to assess the feasibility of or to coordinate the development of a nuclear power programme;[1]
(d) Regulatory bodies;
(e) Operating organizations, including owner/operators;
(f) External expert support entities, including technical and scientific support organizations;[2]
(g) Industrial organizations, including plant vendors, manufacturers, designers and constructors;
(h) Organizations for radioactive waste management and spent fuel management;
(i) Organizations involved in preparedness and response for a nuclear or radiological emergency;
(j) Organizations involved in the transport of nuclear material;
(k) Competent authorities for matters relating to nuclear security;
(l) Education and training organizations;
(m) Research centres (government and private sector).

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[1] Such organizations are called 'governmental project management organizations' or 'nuclear energy programme implementing organizations' in other publications of the IAEA and the International Nuclear Safety Group. In this Safety Guide, such organizations are referred to by the general term 'the government'.

[2] The term 'external support organization' is used throughout this Safety Guide to include external experts and external expert support entities, including technical and scientific support organizations.

1.19. International organizations may use this Safety Guide to help to determine the progress accomplished by a State in developing and establishing the infrastructure necessary for executing a nuclear power plant project so that assistance can be provided in a meaningful and timely manner.

1.20. Other relevant organizations, as well as the news media and the public, may also use this Safety Guide for assurance that the State has established the safety infrastructure necessary for commencing the construction of a nuclear power plant. These organizations may also use it for assurance that the State has commenced preparations for the commissioning, operation, maintenance and eventual decommissioning of the plant, as well as for the proper management of the radioactive waste generated during plant operation and decommissioning.

SCOPE

1.21. This Safety Guide covers all the relevant IAEA safety requirements to be incorporated into an effective safety infrastructure for the first three phases of a nuclear power programme. The recommendations are presented for ease of use in the form of 197 actions suggested to achieve a high level of safety throughout the lifetime of the nuclear power plant, including safety in the associated management of radioactive waste and spent fuel, and safety in decommissioning.

1.22. This Safety Guide is applicable for States with various levels of experience with nuclear activities. While some States seeking to establish a nuclear power programme have few or no nuclear activities already established, others have extensive experience in the operation of research reactors and other applications of ionizing radiation. For the purpose of this Safety Guide, it is assumed that the State has little or no experience with a nuclear power programme. In the scenario presented in this Safety Guide, the State has neither a regulatory body nor operating organization at the beginning of the process (Phase 1). This Safety Guide is therefore to be used with flexibility by States that are in a different initial situation. The IAEA welcomes feedback from States for any future revision of this Safety Guide.

1.23. This Safety Guide addresses the progressive application of IAEA safety standards during the development of the safety infrastructure in the first three phases of a nuclear power programme. During Phase 1, the State will analyse all issues that would be involved in introducing nuclear power, so at the end of Phase 1, it is in a position to make a knowledgeable decision on whether or not to introduce nuclear power. During Phase 2, the State will carry out the work

necessary to prepare for the regulating, contracting, financing and construction of a nuclear power plant. For States using competitive bidding, Phase 3 starts with the bidding and subsequent negotiation of the contract for the design, construction and commissioning of the nuclear power plant. For other States, Phase 3 starts directly with the negotiation of the contract. Much of the work on infrastructure development will be well advanced by the beginning of Phase 3, but the greatest capital expenditure for the nuclear power plant will occur during Phase 3.

1.24. Research reactors and nuclear fuel cycle facilities are not explicitly covered in this Safety Guide, which concentrates on the nuclear power programme.

1.25. Paragraph 1.10 of SF-1 [1] states that "Safety measures and security measures have in common the aim of protecting human life and health and the environment." This Safety Guide does not address nuclear security considerations and the actions that need to be taken to incorporate security elements progressively into an effective nuclear security regime for a nuclear power programme. Considerations of nuclear security matters are covered in IAEA Nuclear Security Series publications. Specific recommendations on security for nuclear power plants are provided in IAEA Nuclear Security Series No. 13, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5) [6]. Implementing Guides are also issued in the IAEA Nuclear Security Series. The scope of this Safety Guide includes consideration of the interface between nuclear safety and nuclear security. Further information on this issue can be found in Ref. [7].

1.26. The IAEA's statutory mandate concerns risks associated with ionizing radiation. Conventional risks such as risks associated with chemical hazards are not within the scope of this Safety Guide.

STRUCTURE

1.27. Sections 2 and 3 provide guidance on the development of a nuclear safety infrastructure in line with the IAEA safety standards during Phases 1–3. Section 2 addresses the general safety requirements relevant to this infrastructure (elements 1–14), while Section 3 addresses the specific safety requirements relevant to the infrastructure (elements 15–20), in accordance with the structure of the IAEA safety standards (see Table 1). For each of the elements considered, this Safety Guide identifies the main actions that should be taken in Phases 1, 2 and 3, respectively, and also specifies the IAEA Safety Requirements publications to be complied with.

TABLE 1. STRUCTURE OF SECTIONS 2 AND 3 OF THIS SAFETY GUIDE, IN ACCORDANCE WITH THE STRUCTURE OF THE IAEA SAFETY STANDARDS SERIES

	20 elements of the safety infrastructure	Main supporting IAEA Safety Requirements publications
Section 2 General Safety Requirements	1. National policy and strategy for safety 2. Global nuclear safety regime 3. Legal framework 4. Regulatory framework 5. Transparency and openness 6. Funding and financing 7. External support organizations and contractors	GSR Part 1 (Rev. 1) [5]
	8. Leadership and management for safety 9. Human resources development 10. Research for safety and regulatory purposes	GSR Part 2 [8]
	11. Radiation protection	GSR Part 3 [9]
	12. Safety assessment	GSR Part 4 (Rev. 1) [10]
	13. Safety of radioactive waste management, spent fuel management and decommissioning	GSR Part 5 [11] GSR Part 6 [12]
	14. Emergency preparedness and response	GSR Part 7 [13]
Section 3 Specific Safety Requirements	15. Operating organization	SSR-2/2 (Rev. 1) [14]
	16. Site survey and site evaluation	SSR-1 [15]
	17. Design safety	SSR-2/1 (Rev. 1) [16]
	18. Preparation for commissioning	SSR-2/2 (Rev. 1) [14]
	19. Transport safety	SSR-6 (Rev. 1) [17]
	20. Interfaces with nuclear security	GSR Part 1 (Rev. 1) [5] SSR-2/1 (Rev. 1) [16] SSR-2/2 (Rev. 1) [14]

1.28. For each of the elements considered, numbered actions appear in this Safety Guide as 'should' statements, and the paragraphs following them provide further guidance and the rationale for those actions.

1.29. The Appendix comprises a summary of all the actions (as 'should' statements) that should be taken in Phases 1, 2 and 3, respectively, as well as the bases for these actions.

2. IMPLEMENTING IAEA GENERAL SAFETY REQUIREMENTS FOR THE ESTABLISHMENT OF THE SAFETY INFRASTRUCTURE

ACTIONS 1–10: NATIONAL POLICY AND STRATEGY FOR SAFETY

General

2.1. A nuclear power programme is a major national undertaking requiring careful planning and preparation, and a major investment in time and human and financial resources. While nuclear power is not unique in this respect, it is considered to be different because of the safety issues associated with the possession and handling of nuclear material and the long term commitment to ensuring safety after the decision to embark on a nuclear power programme has been made.

2.2. The national strategy for embarking on a nuclear power programme needs to recognize the possibility of a nuclear emergency, including one resulting from a severe accident, and the State's ability to respond to such an emergency.

2.3. Given the wide spectrum of issues to be considered and the implications and duration of the commitments associated with a nuclear power programme, the decision to embark on a nuclear power programme has to come from the government. The prime importance of safety has to be recognized and reflected in policy decisions as well as in the strategy adopted by the government.

2.4. Past experience shows that there are many possible ways to establish a nuclear power programme. States wishing to embark on a first nuclear power plant project might be at various levels of capability with regard to safety, ranging from no experience, to experience with laboratory scale nuclear facilities and

industrial applications, the operation of research reactors, or the handling of large quantities of radioactive material. In this Safety Guide, it is assumed that the State does not have an institution or organization that would be ready to assess the feasibility of the nuclear power option as part of a national energy policy and present its findings to the decision makers at the highest level of government.

2.5. From the earliest phase in the development of the safety infrastructure, the prime responsibility for safety rests with the operating organization of the prospective facility. The prime responsibility for safety cannot be delegated or outsourced (see Principle 1 of SF-1 [1]); it is discharged by the operating organization through leadership, adequate funding, sufficient expertise, training and education. The government is required to establish an effective governmental, legal and regulatory framework to support a high level of safety, in accordance with Requirement 2 of GSR Part 1 (Rev. 1) [5]. Regulatory oversight is important to verify that the operating organization discharges its responsibility for safety completely and effectively and to enforce compliance with regulatory requirements.

2.6. Having prime responsibility for safety, the person or organization responsible for a facility or an activity should actively evaluate progress in science and technology, as well as relevant information from the feedback of experience, to identify and make safety improvements that are considered practicable. The implementation of such improvements may require prior notification of or authorization from the regulatory body.

2.7. The implementation of safety improvements cannot detract the operating organization of the nuclear power plant or the regulatory body from the day to day work of ensuring that existing safety requirements are met.

2.8. A State that is considering launching a nuclear power programme is likely to look for proven existing technologies rather than develop a specific new design. Nevertheless, the choice will be made from various available technologies. Such a choice might be made at different times depending on the overall policy, but in any case, the policy should emphasize the need for the effective building of competence in safety. If the State has a strategy to establish an early partnership with another State that is a provider of the technology, then the selection of a specific technology can take place in Phase 1 as part of the decision on whether to move forward with the nuclear option. However, the selection of the technology is normally not made until Phase 2, after a State has formally made the decision — independent of the type of technology — to establish a nuclear power programme. In such a case, the partnership between the State providing the technology and the State embarking on the nuclear power programme should

include agreements at the governmental level to establish the framework for and objectives of such cooperation. An alternative strategy — described in this Safety Guide — is first to develop a national knowledge base through a large network of international contacts during Phase 2 and then to open a bidding process or start contract negotiations.

2.9. The government will decide on the level of national participation in the nuclear power programme and the necessary resources to be allocated to develop the nuclear safety infrastructure. In any circumstance, a vigorous programme for the development of a national workforce with the necessary competence to manage the nuclear technology and to conduct nuclear activities safely is essential for a sustainable programme. This development programme for the workforce should be planned and progressively implemented through the three initial phases of the nuclear power programme.

Phase 1

2.10. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 1 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 10 and 29 of IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [9];
(c) Requirement 2 of IAEA Safety Standards Series No. GSR Part 5, Predisposal Management of Radioactive Waste [11];
(d) Requirement 2 of IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency [13].

Action 1. The government should consider the necessary elements of a national policy and strategy for safety to meet the fundamental safety objective and safety principles established in SF-1 [1].

Action 2. The government should provide for the coordination of all activities to establish the safety infrastructure.

Action 3. The government should ensure that the status of the safety infrastructure in relevant areas is assessed and that radiation protection considerations are adequately taken into account.

Action 4. The government should take due account of the assessment of the elements of the safety infrastructure and of the fundamental principle of justification when making a decision on whether to introduce a nuclear power programme.

2.11. The national policy and strategy for safety should reflect an understanding of the fundamental safety objective and safety principles established in SF-1 [1], in particular:

(a) Paragraph 3.8 (Principle 2) of SF-1 [1], which states that "The government is responsible for the adoption within its national legal system of such legislation, regulations, and other standards and measures as may be necessary to fulfil all its national responsibilities and international obligations effectively".
(b) Principle 4 of SF-1 [1], which states that "**Facilities and activities that give rise to radiation risks must yield an overall benefit.**"

Therefore, a full and proper evaluation should be undertaken before deciding to introduce a nuclear power programme in the State. At this first stage, the assessment of the balance between risks and benefits may be of a general nature.

2.12. For the preparation of the information that the government needs as a basis for its decision and for the coordination of all the work that is necessary to facilitate a knowledgeable decision with regard to a prospective nuclear power programme, it may be appropriate for the government to appoint a project organization that is given an explicit governmental mandate.

2.13. The government should also take into account the following:

(a) Binding international instruments and other international instruments (see also paras 2.22–2.41 on the global nuclear safety regime);
(b) The necessary scope and elements of the governmental, legal and regulatory framework for safety (see also paras 2.42–2.60 on the legal framework and paras 2.61–2.101 on the regulatory framework);
(c) The need for and provision for a vigorous competence building programme and the associated human and financial resources (see also paras 2.196–2.217 on human resources development and paras 2.120–2.132 on funding and financing);
(d) The provisions and framework for research and development (see also paras 2.218–2.232 on research for safety and regulatory purposes);

(e) The promotion of leadership and management for safety, including the fostering of a strong culture for safety (see also paras 2.172–2.195 on leadership and management for safety);
(f) The need for and provision for the management of spent fuel and radioactive waste, including the disposal of radioactive waste (see also paras 2.271–2.290 on the safety of radioactive waste management, spent fuel management and decommissioning);
(g) The potential environmental, societal and economic impacts of a prospective nuclear power programme;
(h) The need for the establishment of — or an upgrade to — the supporting infrastructure, including the infrastructure necessary to support the arrangements for emergency preparedness and response.

2.14. Although the State might already have experience in the operation of research reactors and the management of radioactive sources, there are new activities that should commence in a timely manner and that will require the corresponding resources (human, organizational, financial).

2.15. Principle 7 of SF-1 [1] states that "**People and the environment, present and future, must be protected against radiation risks.**" In most States, major projects are subject to environmental restrictions and the organizations responsible for such projects have an obligation to determine the environmental impacts (including the impacts of the alternatives considered and the baseline environmental conditions prior to construction against which the impacts of the plant can later be compared) by means of an environmental impact assessment report. The authority to which such a report should be submitted is typically a ministry of the environment or an environmental authority. The roles of the organizations involved in the environmental impact assessment, and the interfaces and coordination between these organizations, should also be taken into consideration. For a nuclear power plant project, the environmental impact assessment report is likely to be very broad in scope, and the radiological environmental impact assessment is only a part of the overall environmental impact assessment. Non-radiological impacts to be assessed typically include: significant environmental impacts on water, air, flora and fauna; land use; population aspects; residues; and emissions of all types (i.e. water, air and soil pollution, noise, vibration, light, heat). This Safety Guide deals only with the radiological impacts, in accordance with the statutory mandate of the IAEA. The radiological environmental impact assessment is further addressed in paras 2.233–2.247 on radiation protection and paras 3.28–3.59 on site survey and site evaluation. In the event that the State already has a regulatory body that is responsible for radiation protection and nuclear safety, this body

should contribute to the review of the environmental impact assessment in its field of responsibility.

2.16. Before making a knowledgeable decision with regard to the introduction of a nuclear power programme, the government should ensure that all expected impacts of the decision are thoroughly understood and that an adequate assessment of the State's safety infrastructure and associated needs has been conducted. At the end of Phase 1, the government should be fully aware that embarking on a nuclear power programme involves a firm and long term commitment to maintaining activities that are necessary for ensuring safety.

Phase 2

2.17. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 1 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 10 and 29 of GSR Part 3 [9];
(c) Requirement 2 of GSR Part 5 [11];
(d) Requirement 2 of GSR Part 7 [13].

Action 5. The government should establish a clear national policy and strategy for meeting safety requirements in order to achieve the fundamental safety objective and to apply the fundamental safety principles established in SF-1 [1].

Action 6. The government should establish a policy for knowledge transfer for ensuring safety by means of contracts and agreements with organizations in other States that may be involved in the nuclear power programme.

Action 7. The government should ensure identification of responsibilities and their progressive allocation to the relevant organizations involved in the development of the safety infrastructure.

Action 8. The government should ensure that all the necessary organizations and other elements of the safety infrastructure are developed efficiently and that their development is adequately coordinated.

2.18. After the State has decided to introduce a nuclear power programme, the implementation of actions begins in Phase 2, during which the government gradually reduces its involvement, in parallel with the development of other

organizations such as the regulatory body, the operating organization and relevant permanent structures within ministries. This transition should be carefully considered and prepared with a view to preventing any break in the effectiveness of the process and in the national commitment to nuclear safety. The crucial role of coordinating the development of the safety infrastructure among the various permanent organizations continues to be ensured by the government until all organizations and elements are in place and functioning, with a clear definition of roles and responsibilities.

2.19. The government should establish a clear national policy and strategy for safety and demonstrate a firm commitment to safety by providing its support and the necessary resources for the implementation of an effective safety infrastructure.

Phase 3

2.20. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 1 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 10 and 29 of GSR Part 3 [9];
(c) Requirement 2 of GSR Part 5 [11];
(d) Requirement 2 of GSR Part 7 [13].

Action 9. The government should continue to implement the national policy and strategy for safety.

Action 10. The government should ensure that the regulatory body and the operating organization fulfil their responsibilities.

2.21. The government should ensure that the mechanisms put in place for coordination among all the organizations involved in the nuclear power programme are efficient and effective, and should improve them as necessary.

ACTIONS 11–19: GLOBAL NUCLEAR SAFETY REGIME

General

2.22. A nuclear power programme in a State cannot be considered in isolation. A nuclear accident could have harmful effects beyond national borders owing to the potential transboundary consequences of radioactive releases. States have

a shared need for the safe operation of nuclear facilities and the safe conduct of activities. The national safety policy and the strategy adopted by the government should therefore take full advantage of effective participation in the global nuclear safety regime. However, the prime responsibility for safety rests within each State and with the operating organization of each nuclear power plant.

Phase 1

2.23. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 14 and 36 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 7 and 17 of GSR Part 7 [13].

Action 11. The government should prepare for participation in the global nuclear safety regime.

Action 12. The government should begin a dialogue with neighbouring States with regard to its projects for establishing a nuclear power programme.

Action 13. The government and relevant organizations (if such organizations exist) should establish contact with organizations in other States and international organizations to seek advice on safety related matters.

2.24. Specific consideration should be given to neighbouring States whose interests could be affected by the State's nuclear power programme, both in normal operation and in the event of an accident. The government should implement a consultation mechanism that would allow neighbouring States to express their views and concerns. Such a process should be continued during all phases of development of the State's nuclear power programme.

2.25. States embarking on a nuclear power programme should cooperate particularly with those States that might be directly impacted by an emergency (i.e. States with territories within emergency planning zones and emergency planning distances [13]), with the aim of ensuring the exchange of information relevant to emergency preparedness and response in relation to the nuclear power programme. Such coordination and cooperation should be undertaken at all levels: from local authorities and response organizations, to national authorities and response organizations, including the regulatory body, as necessary.

2.26. International cooperation and assistance provide an opportunity to share and benefit from the experience of States that have already implemented, or are in the process of implementing, a nuclear power programme. During Phase 1, States embarking on the development of a nuclear power programme will find it useful to establish contact with States that have advanced nuclear power programmes and with international organizations to seek advice on safety related matters and to benefit from international operating experience and regulatory experience and from the dissemination of lessons identified. Liaising with other States with similar objectives for nuclear power programmes should also be considered.

2.27. The State should prepare for involvement in the global nuclear safety regime, which is promoted by the IAEA on the basis of the following elements:

(a) International conventions that establish robust common principles and obligations for ensuring safety in the use of radiation, radioactive material and nuclear energy and that provide for an effective coordinated response to emergencies;
(b) Codes of conduct that promote good practices in the relevant activities;
(c) Internationally agreed IAEA safety standards, which support the development of harmonized national safety requirements, guides and practices;
(d) International peer reviews of safety that provide mutual learning by participating States;
(e) Knowledge networks and expert networks;
(f) Multilateral and bilateral cooperation in safety matters aimed at enhancing safety by means of harmonized approaches and the increased quality and effectiveness of safety reviews and inspections.

2.28. In Phase 1, the government should give consideration to becoming a Party to international conventions and making a political commitment to codes of conduct such as the following:

(a) The Convention on Nuclear Safety [18];
(b) The Convention on Early Notification of a Nuclear Accident [19];
(c) The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [20];
(d) The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [21];
(e) The Convention on the Physical Protection of Nuclear Material [22] and its Amendment [23];
(f) The Code of Conduct on the Safety and Security of Radioactive Sources [24].

Phase 2

2.29. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 14 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 13 of IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [8];
(c) Requirements 7 and 17 of GSR Part 7 [13];
(d) Requirement 24 of IAEA Safety Standards Series No. SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation [14].

Action 14. All relevant organizations should participate in the global nuclear safety regime.

Action 15. The State should become a Party to the relevant international conventions, as identified in Phase 1.

Action 16. All relevant organizations should strengthen their cooperation on safety related matters with States that have advanced nuclear power programmes.

2.30. One important consideration in the decision making processes for a nuclear power programme is the interdependence of activities between States relating to nuclear power. In Phase 2, activities that are required by the international agreements and conventions identified in Phase 1 should commence. This will help to promote safety nationally and globally, as well as to enhance international confidence and trust.

2.31. Activities and participation in the global nuclear safety regime that were identified and planned during Phase 1 should be progressively implemented by those parties who were identified and were assigned the responsibility to carry them out. The operating organization and the regulatory body should participate in their respective international networks. An important part of international cooperation and assistance is the exchange of construction, operating and emergency management experience. The regulatory body should assess whether experience indicates that modifications to the regulatory requirements are necessary and whether more attention should be given to certain issues in the safety assessment and during inspections. The operating organization should be aware of nuclear power plant operating experience that indicates the need for

design changes or the reconsideration of operation or maintenance practices to provide continued assurance of future safe operation.

2.32. Effective participation of the regulatory body, operating organization and other relevant entities in international activities and networks promotes the transfer of knowledge on lessons learned and best practices from other States on nuclear power plant operation and regulation. It also facilitates the provision of support by States with advanced nuclear power programmes. Such support could include the two way long term assignments of experts, whether consultants from other States coaching developing organizations or experts sent to other States for on the job training.

2.33. The commitment to complying with IAEA safety standards and to participating in international safety reviews and safety services on the basis of IAEA safety standards should be reaffirmed. Consideration should also be given to other international safety standards and to codes of conduct, as well as to INSAG publications.

Phase 3

2.34. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 14 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 13 of GSR Part 2 [8];
(c) Requirements 7 and 17 of GSR Part 7 [13];
(d) Requirement 24 of SSR-2/2 (Rev. 1) [14].

Action 17. All relevant organizations should ensure continued participation in international activities and international networks for strengthening safety.

Action 18. The operating organization should implement a cooperation programme with the vendor and with other organizations operating nuclear power plants of the same type as that selected, for the purpose of strengthening safety.

Action 19. The regulatory body should implement a cooperation programme with the vendor State and with other regulatory bodies that have experience of oversight of nuclear power plants of the same type as that selected.

2.35. The State should participate in the review meetings of the relevant international conventions to which it has become a Party and fulfil other obligations.

2.36. The regulatory body, the operating organization and other relevant entities should strengthen their cooperation with their respective counterparts in other States and with international networks.

2.37. To receive feedback from regulatory bodies in other States, the regulatory body should extend its contacts, in particular through participation in bilateral, multilateral and international cooperation and assistance on the subject of a nuclear power programme.

2.38. Assistance from the regulatory body of the vendor State, as well as from other regulatory bodies that have oversight experience with nuclear power plants of the same type as that selected, including temporary assignments of staff, should be sought to the extent possible.

2.39. An exchange of the results of safety reviews, peer reviews and joint inspections with regulatory bodies in other States that have oversight experience with nuclear power plants of the same type as that selected could be used for increasing the understanding of important safety issues, for sharing experience and for improving transparency among interested parties and the public.

2.40. The operating organization should establish professional cooperation arrangements with operating organizations in other States, especially those using similar technology, as well as with international operator organizations such as the World Association of Nuclear Operators.

2.41. External support organizations, research organizations and academic bodies should also work in close cooperation with their counterparts in other States.

ACTIONS 20–23: LEGAL FRAMEWORK

General

2.42. Principle 2 of SF-1 [1] states that "**An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.**"

2.43. The legal framework usually includes several levels of documents. The nuclear law itself typically does not contain detailed technical requirements: instead, it usually specifies the safety goals and general rules and procedures for licensing nuclear facilities and the tasks and authorities of the parties involved in licensing and regulation. The technical safety requirements will usually be established by the regulatory body in the form of regulations and licence conditions.

Phase 1

2.44. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1–4 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Requirement 1 of GSR Part 5 [11];
(d) Requirement 4 of IAEA Safety Standards Series No. GSR Part 6, Decommissioning of Facilities [12];
(e) Requirements 2 and 20 of GSR Part 7 [13].

Action 20. The government should identify all necessary elements of a legal framework for the safety infrastructure and should plan how to structure and develop this framework.

Action 21. The government should consider the process that should be employed to license nuclear facilities in the later stages of the programme.

2.45. Establishing a nuclear power programme requires dedicated legislation that has not usually been enacted in a State when entering Phase 1. However, some of the needs for legislation might already have been met for other activities in the State, such as the operation of research reactors and other applications of ionizing radiation. The State should therefore perform a complete assessment of the need for legislation and a regulatory framework to support the safe operation and effective licensing and oversight of a nuclear power plant as well as to support the establishment and maintenance of emergency arrangements.

2.46. On the basis of such an assessment, the State should develop a plan to enhance its existing legal and regulatory framework to incorporate all elements of nuclear legislation. The Handbook on Nuclear Law [25] provides detailed guidance on this.

2.47. A nuclear law, which should ensure transparency and should be clearly understandable, is prepared in Phase 1 so as to be enacted early in Phase 2. Paragraph 2.5 of GSR Part 1 (Rev. 1) [5] states that "The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety", and that the framework for safety is to set out the following:

(a) The safety principles for protecting people — individually and collectively — society and the environment from radiation risks, both at present and in the future (see also paras 2.233–2.247 on radiation protection);
(b) The types of facility and activity that are included within the scope of the framework for safety (and that should be licensed in connection with nuclear power production);
(c) The type of authorization[3] that is required for the operation of facilities and the conduct of activities, in accordance with a graded approach;
(d) The rationale for the authorization of new facilities and activities, as well as the applicable decision making process;
(e) Provision for the involvement of interested parties and for their input to decision making (see also paras 2.102–2.119 on transparency and openness);
(f) Provision for assigning legal responsibility for safety to the persons or organizations responsible for the facilities and activities, and for ensuring the continuity of responsibility where activities are carried out by several persons or organizations successively (see also paras 3.1–3.27 on the operating organization);
(g) The establishment of a regulatory body (see also paras 2.61–2.101 on the regulatory framework);
(h) Provision for the review and assessment of facilities and activities, in accordance with a graded approach (see also paras 2.248–2.270 on safety assessment);
(i) The authority and responsibility of the regulatory body for promulgating (or preparing for the enactment of) regulations and preparing guidance for their implementation (see also paras 2.61–2.101 on the regulatory framework);
(j) Provision for the inspection of facilities and activities, and for the enforcement of regulations, in accordance with a graded approach (see also paras 2.61–2.101 on the regulatory framework);

[3] Authorization to operate a facility or to conduct an activity may be granted by the regulatory body or by another governmental body to an operating organization or to a person. 'Authorization' includes approval, written permission, licensing, certification or registration (see SF-1 [1]).

(k) Provision for appeals against decisions of the regulatory body;
(l) Provision for preparedness and response for a nuclear or radiological emergency (see also paras 2.291–2.310 on emergency preparedness and response);
(m) Provision for the interface with nuclear security (see also paras 3.114–3.128 on interfaces with nuclear security);
(n) Provision for the interface with the system of accounting for, and control of, nuclear material (not addressed further in this Safety Guide);
(o) Provision for acquiring and maintaining the necessary competence nationally for ensuring safety (see also paras 2.196–2.217 on human resources development and paras 2.218–2.232 on research for safety and regulatory purposes);
(p) Responsibilities and obligations in respect of financial provision for the management of radioactive waste and spent fuel, and for decommissioning of facilities and termination of activities (see also paras 2.271–2.290 on safety of radioactive waste management, spent fuel management and decommissioning, and paras 2.120–2.132 on funding and financing);
(q) The criteria for release from regulatory control;
(r) The specification of offences and the corresponding penalties;
(s) Provision for controls on the import and export of nuclear material and radioactive material, as well as for their tracking within, and to the extent possible outside, national boundaries, such as tracking of the authorized export of radioactive sources (not further addressed in this Safety Guide).

2.48. For drafters of legislation who are unfamiliar with nuclear law and nuclear technology, an option for consideration in preparing nuclear legislation is to apply models provided by the IAEA and other international organizations or the text of laws adopted by States with developed legal frameworks. This approach could be practicable and should be considered for a number of reasons. First, it reduces the number of new legal texts to be drafted. Second, it takes advantage of the technical or legal expertise of experienced organizations or States. Third, in the case of incorporation of IAEA models, it can help a State to comply with the IAEA Safety Requirements and to receive IAEA technical assistance.

2.49. The advantages described in para. 2.48 are accompanied by difficulties that should be given careful consideration. First, it should be considered whether and how international requirements or the requirements adopted by another State will fit into a State's legal structure. Second, it should be considered whether standards or guidelines prepared elsewhere contain provisions that are inconsistent with, or contradictory to, important features of a State's legal structure. Third, difficulties associated with translation should be considered: terms relating to nuclear

energy that are translated from another language might become meaningless or confusing to persons expected to apply the national law or to comply with it. Fourth, difficulties might arise when external requirements (e.g. international instruments) are subject to change.

2.50. There is a relationship between the development of nuclear legislation and the consideration of becoming a Party to the international conventions in the field of nuclear energy. The State should therefore ensure that the nuclear law is consistent with, and reflects the provisions of, the relevant international instruments.

2.51. After preparation of a reasonably detailed initial draft of the nuclear law, many governments have found it useful to seek IAEA assistance in further drafting and review, as appropriate, of their national nuclear legislation.

2.52. To ensure consistency of legislation and to avoid conflicts and ambiguity in the application of nuclear law, the State should also identify correlated laws to be prepared or amended, both safety related and those not directly related to safety. Such laws concern protection and safety, emergency management and civil protection, industrial safety and fire safety, environmental protection, occupational health and safety, waste management, nuclear liability, criminal law enforcement, land use planning regulations, and international trade law and customs law, as relevant.

2.53. States usually have specific laws and organizations for the management of crises and conventional emergencies, such as fires, earthquakes, floods and releases of hazardous chemicals, and to provide for the protection of the public. In many States, these organizations are usually referred to as civil protection authorities or civil defence authorities and have the responsibility to protect the public in an emergency. For a nuclear emergency, they may also be given a role in implementing public protective actions, but this might require some amendments to the law to harmonize with the nuclear law.

2.54. In Phase 1, the government should recognize that the effective licensing of a nuclear power plant requires a sound legal and governmental infrastructure, including a regulatory body with well defined responsibilities and functions. To conduct licensing effectively, the processes to be used should be considered and communicated to all interested parties as early as possible in the development of the nuclear power programme. This provides the applicant with the information that will be necessary to support licensing submissions, as well as information on the stages of development that will require licensing. Guidance on this topic

is given in IAEA Safety Standards Series No. SSG-12, Licensing Process for Nuclear Installations [26].

Phase 2

2.55. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1–4 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Requirement 1 of GSR Part 5 [11];
(d) Requirement 4 of GSR Part 6 [12];
(e) Requirements 2 and 20 of GSR Part 7 [13].

Action 22. The government should enact and implement the appropriate elements of the legal framework for the safety infrastructure.

2.56. During Phase 2, all essential legislation identified during the assessment process of Phase 1 should be enacted.

2.57. To ensure consistency of legislation, the State should also complement or amend the related laws identified in Phase 1.

Phase 3

2.58. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1–4 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Requirement 1 of GSR Part 5 [11];
(d) Requirement 4 of GSR Part 6 [12];
(e) Requirements 2 and 20 of GSR Part 7 [13].

Action 23. The government should ensure that the legal framework for the safety infrastructure is fully in place and that the legislation is complied with by the relevant organizations.

2.59. During Phase 3, the role of the government is to ensure that the legal framework is fully in place and that the legislation is implemented, complemented and amended, as appropriate.

2.60. Many States have established mechanisms for helping to determine whether legislation is being implemented in a manner consistent with its objectives. This can help to maintain confidence in the regulatory process. Periodic reports by the regulatory body and audits conducted under an appropriate quality management system are examples of such mechanisms.

ACTIONS 24–38: REGULATORY FRAMEWORK

General

2.61. Principle 2 of SF-1 [1] states that "**An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.**"

2.62. In a nuclear power programme, the regulatory body is required to verify that the site evaluation, design, construction, commissioning, operation and decommissioning of a nuclear power plant comply with the relevant regulatory requirements (see para. 4.3 of GSR Part 1 (Rev. 1) [5]). As established in GSR Part 1 (Rev. 1) [5], the core functions of the regulatory body include the following:

(a) Preparation of regulations and guides;
(b) Authorization of facilities and activities;
(c) Review and assessment of information relevant to safety;
(d) Inspection of facilities and activities;
(e) Enforcement of compliance with regulations and standards.

2.63. The regulatory body's responsibilities also include:

(a) Ensuring that on-site emergency arrangements, including emergency plans and procedures, are in place and provide for an effective response and that they are integrated with the emergency arrangements of other response organizations and other plans, as appropriate (see paras 4.11–4.15 of GSR Part 7 [13]);
(b) Establishing appropriate means for providing information to interested parties in a transparent manner (see Requirement 36 of GSR Part 1 (Rev. 1) [5]);
(c) Promoting a culture for safety (see Requirement 12 of GSR Part 2 [8]);
(d) Promoting the necessary coordination with other national bodies and with international bodies.

2.64. The regulatory structures and approaches vary significantly from one State to another. The approaches used in States with large nuclear power programmes may differ from those in States with small nuclear power programmes. Furthermore, the approaches in States with a nuclear power plant vendor may differ from the approaches in States that import nuclear power plants.

2.65. Requirements for an effective regulatory body are provided in GSR Part 1 (Rev. 1) [5], and the implementation of the requirements is supported by IAEA Safety Standards Series Nos GSG-12, Organization, Management and Staffing of the Regulatory Body for Safety [27], and GSG-13, Functions and Processes of the Regulatory Body for Safety [28]. To be effective, the regulatory body is required to have adequate authority (including the right to suspend operation or to impose penalties on licensees), independence, financial resources and technically competent staff (see Requirement 4 of GSR Part 1 (Rev. 1) [5]). The regulatory body should make use of the services of external support organizations (see paras 2.133–2.171) in areas where it needs additional expertise.

2.66. The development of the human resources of the regulatory body and the development of the management system of the regulatory body are addressed in paras 2.196–2.217 and paras 2.172–2.195, respectively.

2.67. The regulatory body should determine the safety objectives to be achieved by the licensees and should verify the implementation of the necessary safety measures. The necessary safety measures need to be implemented by licensees within stipulated deadlines and to be subject to regulatory verification. Inadequate regulatory verification will have a negative impact on safety, particularly if the licensee fails to take the required safety actions in a timely manner.

Phase 1

2.68. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 3, 4, 7 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 2 and 3 of GSR Part 3 [9];
(c) Requirement 1 of GSR Part 5 [11].

Action 24. The government should recognize the need for an effectively independent and competent regulatory body and should consider the appropriate position of the regulatory body in the State's governmental and legal framework for safety.

Action 25. The government should seek advice from the regulatory body on radiation safety issues relating to a nuclear power programme.

Action 26. The government should identify the prospective senior managers of the regulatory body.

2.69. In Phase 1, there may already be a regulatory body for the regulation of radiation safety. In this case, advice from the existing regulatory body should be obtained and consideration should be given to whether the scope of tasks of the existing regulatory body will be extended or whether a new regulatory body will be created. If different authorities are to coexist, their respective roles and responsibilities should be clearly defined, avoiding any conflict of interest. Emphasis should be given to assessing and understanding the appropriate position of the regulatory body in the governmental structure of the State.

2.70. The prospective senior manager of the regulatory body and other senior staff should be identified. These individuals should begin acquiring knowledge of nuclear regulatory matters.

2.71. The development of the regulatory framework involves maintaining a balance between prescriptive approaches and more flexible goal setting approaches. This balance might depend on the State's legal system and regulatory approach. Since the approach chosen will have a major influence on the resources needed by the regulatory body, the persons expected to be in charge of the regulatory body should start learning and considering various regulatory approaches in Phase 1. A strategy should be developed to determine which regulatory approach will be chosen.

2.72. GSG-13 [28] presents some advantages and disadvantages of different regulatory approaches and provides further guidance on this topic.

Phase 2

2.73. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 3, 4, 7, 11, 15–19, 21–26, 30 and 32 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 3 of GSR Part 2 [8];
(c) Requirements 2 and 3 of GSR Part 3 [9];
(d) Requirements 1 and 3 of GSR Part 5 [11];
(e) Requirement 5 of GSR Part 6 [12];
(f) Requirement 2 of GSR Part 7 [13].

Action 27. The government should establish an effectively independent regulatory body and should empower it with adequate legal authority and ensure it has the technical and managerial competence, and the human and financial resources, to discharge its responsibilities in the nuclear power programme.

Action 28. The government should appoint senior managers and key experts to the regulatory body and should assign to them the responsibility for developing the organization.

Action 29. The regulatory body should consider the various regulatory approaches that are applied for nuclear power programmes of the same size and should decide on its approach, taking into account the State's legal and industrial practices and the guidance provided in IAEA safety standards.

Action 30. The regulatory body should establish a process for developing and issuing regulations and guides specifying the documentation and procedures necessary in the various steps of the licensing process and inspections to be conducted.

Action 31. The regulatory body should develop and issue those safety regulations that are needed for the bidding process or contract negotiations.

Action 32. The regulatory body should begin establishing a suitable working relationship with the operating organization and with other relevant national and international organizations.

2.74. The regulatory body's core functions (see GSR Part 1 (Rev. 1) [5]) should be clearly defined in the legislation. Specific recommendations to assist the regulatory body in establishing its regulatory framework are provided in GSG-12 [27] and GSG-13 [28].

2.75. The regulatory body should be functionally separate from, and effectively independent of, all entities (including parts of the government) that have responsibilities or interests that could unduly influence its safety related decision making or that promote the development of the nuclear industry. The regulatory body should have the legal authority, technical competence and resources to fulfil its statutory obligation to regulate facilities and activities, and its regulatory decisions should be free from undue political and economic influence.

2.76. In establishing the regulatory body, a knowledgeable decision should be made on whether to expand the existing regulatory body or to create a new regulatory body. If the regulatory body comprises more than one authority, there should be formal arrangements to ensure that regulatory responsibilities and activities are clearly specified and coordinated to avoid any omissions or unnecessary duplication and to avoid conflicting requirements being placed upon the operating organization.

2.77. The organizational structure and size of the regulatory body could be influenced by many factors, such as the number of authorities involved in the regulatory process, the legal system, the regulatory approach selected, and the role and capability of external support organizations.

2.78. The organization of the regulatory body, its structure and size, and the technical skills of its staff will change as the regulatory body goes through various stages in Phase 2, starting with its early organization and the preparation of its regulatory framework, to the stage where it is able to specify regulations and to make safety assessments as part of the licensing process. The regulatory body thereby develops competences in managing growth and change.

2.79. One of the first things that the regulatory body should consider before starting the recruitment of its staff is its future regulatory approach. The type of approach chosen can have a major impact on the necessary number and qualifications of the regulatory staff. Notwithstanding the approach chosen, an approach should be developed and enough staff should be recruited to cover all core competences necessary for all relevant safety aspects of the nuclear power programme. The regulatory approach also has implications for the need for external expert support for the regulatory body.

2.80. During Phase 2, before the State decides which reactor technology is going to be deployed, the regulatory body should be aware of the two main alternative regulatory approaches: a prescriptive approach with a large number of regulations; or a goal setting approach that focuses on performance, functions and outcomes. Each regulatory approach has benefits and disadvantages, and there are also approaches that combine features of these two main alternatives. When a decision is made in Phase 3 on the reactor technology to be deployed, the regulatory body should adopt the approach that best suits the needs of the State. The regulatory body

should have its chosen approach approved by the government, since there will be resource implications. Specific features of these two alternatives are listed below:

(a) A prescriptive regulatory approach places a great deal of importance on the adequacy of the regulations for safety and requires detailed development. The regulations establish clear requirements and expectations for the regulatory body, as well as for the operating organization, and thus can be used to promote systematic interaction between the regulatory body and other parties. The regulations could establish detailed technical requirements or identify specific issues that the operating organization and its suppliers should address and present for assessment by the regulatory body. For the latter approach, specific technical requirements can then be taken from relevant international industrial standards (including nuclear specific standards) or the industrial standards of other States, as agreed by the regulatory body at an early stage of the licensing process for nuclear power plants. The development and updating of detailed regulations place a high demand on the regulatory body's resources.
(b) A performance based regulatory approach allows the operating organization more flexibility in determining how to meet the established safety goals and necessitates fewer and less detailed regulations. However, this approach requires the establishment of specific safety goals and targets. Verifying that appropriate measures to ensure safety have been identified by the operating organization might be difficult unless the regulatory body's staff, the staff of its external support organization and the staff of the operating organization all have a high level of professional competence and are able to interact to determine whether established safety objectives are met.

2.81. Besides the general alternatives described in para. 2.80, the regulatory approaches in different States vary with respect to the scope and depth of the regulatory functions of review and assessment and inspection. The scope of issues that are under regulatory control might include all structures, systems and components classified as safety relevant or might be limited only to the most safety relevant aspects. The targets of the comprehensive and systematic regulatory control and inspections can then be specified in a deterministic manner on the basis of a safety classification, or they can be chosen on the basis of a probabilistic assessment of risks. As to the depth of the review and assessment: in some States the regulatory body puts the main emphasis on the assessment and auditing of the management system and the operations of the operating organizations and their suppliers; in other States the regulatory body prefers to make its own comprehensive independent analyses (audit calculations) and inspections.

2.82. Throughout Phase 2, the regulatory body should have a firm strategy for prioritizing the development of regulations. Regulations governing the management of safety, site evaluation, design (including decommissioning aspects), construction and manufacturing should be prepared and taken into account in the bidding process or contract negotiations. In setting its requirements, the regulatory body should adopt IAEA safety standards as a reference, which express an international consensus and are neutral towards different vendors. The regulatory body may complement these standards with a well established set of requirements and with industrial standards (including nuclear safety standards) that are in use in States with extensive experience of nuclear power plant operation. If the regulatory body decides on this complementary option, the entire set of standards should be carefully reviewed to avoid conflicts, inconsistencies or incompleteness.

2.83. Regulations that could have an impact on the choice of technology should be established early in the process. The plan and schedule for the development of other regulations should be prepared. In developing regulations and guides, the regulatory body should take into consideration comments and feedback on experience from interested parties.

2.84. The practical arrangements of the licensing process should be specified by the regulatory body in such a way that applicants are aware of the requirements. Typically, licensing will be required for major activities such as construction and operation. The regulatory body should specify which documents are required for a licence application as well as the depth of review and assessment for each document submitted in support of a licence application. Hold points should be specified for certain steps in design, manufacturing, construction and commissioning for the purpose of verifying the results of the work so far and the preparedness to proceed. Whichever process is chosen, it should be established during Phase 2.

2.85. The regulatory body should issue basic guidance on the format and content of the documents to be submitted by the operating organization in support of an application for licensing. Later, at the beginning of Phase 3, this guidance on the content of documents to be submitted in support of a licence application could be further specified and supplemented in more detail (see para. 4.34 of GSR Part 1 (Rev. 1) [5]).

2.86. Further guidance on the licensing process is provided in SSG-12 [26].

2.87. The relationship between the regulatory body and the operating organization should be based on mutual understanding and respect as well as frank and open

communication, providing constructive liaison on safety related issues and in-depth technical dialogue between experts. The relationship should reflect the principle that the prime responsibility for safety rests with the operating organization, and the primary role of the regulatory body is to ensure that the operating organization fulfils its responsibilities.

2.88. The regulatory body should establish links with the regulatory bodies of other States whose expertise is well established and recognized, as well as with regional and international forums and networks. The regulatory body should have staff capable of absorbing the knowledge transferred.

Phase 3

2.89. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 3, 4, 7, 11, 16–18 and 21–33 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 3 of GSR Part 2 [8];
(c) Requirements 2 and 3 of GSR Part 3 [9];
(d) Requirements 1 and 3 of GSR Part 5 [11];
(e) Requirement 5 of GSR Part 6 [12];
(f) Requirement 2 of GSR Part 7 [13].

Action 33. The regulatory body should maintain suitable working relationships with the operating organization.

Action 34. The regulatory body should plan and conduct all the required licensing and oversight activities during the licensing process, including during siting, construction, commissioning and operation, consistent with the regulatory approach that was selected.

Action 35. The regulatory body should establish a consistent procedure for issuing, revising and revoking regulations and guides.

Action 36. The regulatory body should ensure that a full and comprehensive set of regulations and guides is in place for regulating construction, commissioning and operational activities at the appropriate time.

Action 37. The regulatory body should implement its programme for inspection and enforcement during construction including, as applicable, the design and manufacture of items important to safety.

Action 38. The regulatory body should review and assess programmes to be implemented by the operating organization, as appropriate.

2.90. Once the vendor has been chosen through the bid evaluation process or through contract negotiations, the regulatory body should consider cooperation with the regulatory bodies of those States in which the same vendor has supplied similar plants, and especially the regulatory body of the State of the vendor, if possible. The benefits of sharing information on the experience of other States are clear and could influence the planned regulatory approach.

2.91. In many cases, it is helpful to accept the technical standards of the vendor State or of a State that has oversight experience with a reactor of the same type as that selected. It is also useful to learn from the earlier independent analyses and safety assessments of this technology performed in other States. Furthermore, other regulatory bodies can give insights into the levels of quality achieved by key manufacturers and other suppliers, and this allows the auditing and evaluation of these organizations to be more clearly focused.

2.92. A common option for regulation chosen in the past by States into which a first nuclear power plant was being imported was to use the regulations and standards of the vendor State. This had the advantage of the supplier knowing in detail which requirements it had to meet, and it was more straightforward for the regulatory body because such a plant was already licensed in the vendor State. However, this approach has a significant disadvantage. The importing State's regulatory approach should be aligned with the approach of the regulations adopted, and keeping abreast of all changes in those regulations is difficult. If the State subsequently purchases a plant from a supplier with a different regulatory approach or a different licensing system, or if a major backfitting programme is implemented, the two systems would have to be reconciled.

2.93. If the option chosen by the State is to use or further develop its own regulatory system, the State could continue to base its regulatory framework on the approach found most suitable. The State could make the necessary adjustments throughout Phase 2 or Phase 3, depending on the state of readiness of the regulatory body, and on the basis of the experience gained during implementation of the first nuclear power plant project. The regulatory body should have a clear understanding of the basis for the regulations so that subsequent regulatory actions or changes can be fully and knowledgeably evaluated.

2.94. Experience has shown that periodic meetings between high level officials as well as technical staff of the regulatory body and the operating organization are essential.

2.95. In Phase 3, the regulatory oversight should cover the following broad areas: construction, manufacturing of components, training and qualification, technical specifications, maintenance, surveillance testing, management of modifications, fire protection, radiation protection, emergency preparedness, and the management systems (including safety culture) of the operating organization and the various suppliers. In some States, the regulatory body approves the various suppliers involved following audits and inspections of their management systems. The regulatory body should ensure that there is appropriate planning for all these oversight activities in Phase 3. Once the construction licence is issued and other necessary pre-approvals are given by the regulatory body, construction may start, including the manufacture of items important to safety. The construction should proceed in a manner that ensures quality and safe operation. In this phase, the operating organization, and the regulatory body as applicable, should continually monitor the construction of items important to safety, both at the site and at the manufacturing facilities, to ensure that the construction is in accordance with the approved design. Provision should also be made to allow appropriate regulatory oversight of activities relating to the manufacture of some components that will commence before the construction licence has been issued, as well as for the procurement and infrastructure needed for training.

2.96. The management system of the regulatory body should cover the production of regulations and guides. A consistent procedure for establishing, revising and revoking regulations and guides should be established in accordance with the State's legal system. The periodic review of regulations and guides should be established to keep them up to date. Frequent changes should be avoided as they can affect the stability of the regulatory system. Further guidance on the revision of regulations and guides is provided in GSG-13 [28].

2.97. Licensing is a major regulatory activity during Phase 3 and should be based on independent regulatory review and assessment of the documents that are submitted by the operating organization and the results of inspections. It is the practice in many States to issue a construction licence and an operation licence in this phase. As well as the procedure for granting a licence, a procedure for any subsequent amendment, suspension or revocation of the licence should be developed and implemented.

2.98. As the regulatory body needs to conduct inspections, it should ensure that it has the technical knowledge and skills and the statutory power to enforce compliance with its requirements as specified in the applicable regulations and in licence conditions; this also applies during the construction phase. The legislation should include provisions to grant access to the plant for staff of the regulatory body to perform inspections, including unannounced inspections, at any time.

2.99. The regulatory body should develop a comprehensive inspection programme to carry out its inspection function. Consideration should be given to obtaining support from States that have regulatory oversight experience with the selected reactor type. The overall inspection programme may comprise three aspects:

(a) Routine inspections (including unannounced inspections) conducted by resident or non-resident inspectors;
(b) Topical inspections conducted by inspectors with relevant expertise, in accordance with a scheduled programme;
(c) Reactive inspections conducted after abnormal events.

2.100. The extent to which the regulatory body does its own testing and measurement work independently of the operating organization should be defined and included in the regulatory approach, with account taken of the qualifications of the personnel required as well as the instruments and laboratory facilities available (within the regulatory body and through external expert support). The conduct of tests and measurements by the regulatory body or its external support organization does not relieve the operating organization of its prime responsibility for safety.

2.101. A list of programmes that the operating organization should have in place before and during operation is provided in SSG-12 [26]. The regulatory body should review, assess, inspect and, as appropriate, approve such programmes.

ACTIONS 39–47: TRANSPARENCY AND OPENNESS

General

2.102. Societal acceptance is a prerequisite for the implementation of a nuclear power programme, and it should be confirmed before major investments and organizational arrangements are made. To gain true acceptance, the decision makers and the public should be given an opportunity to gain a realistic and credible picture of the benefits as well as of the risks involved, and of the environmental impacts of the operation of the nuclear power plant and the associated activities

(i.e. activities in radioactive waste management, spent fuel management, emergency preparedness). Involvement of the public and other interested parties is a continual process.

Phase 1

2.103. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 36 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 5 and 12 of GSR Part 2 [8];
(c) Requirement 1 of GSR Part 5 [11].

Action 39. The government should establish a policy and guidance to inform the public and other interested parties of the benefits and risks of nuclear power to facilitate their involvement in the decision making process on a prospective nuclear power programme.

Action 40. The government should establish a process to ensure that the comments arising from consultation with the public and other interested parties are considered, and it should communicate the results of these considerations to the interested parties.

2.104. Principle 4 of SF-1 [1] states that "**Facilities and activities that give rise to radiation risks must yield an overall benefit.**" A decision to launch a nuclear power programme requires a broad societal acceptance that such a programme is justified. The government should establish a clear decision making process to justify a nuclear power programme, and this process should be communicated to the interested parties. The public should be involved in the early stages of the decision making process with regard to nuclear power.

2.105. The government should ensure that the public and other interested parties have ready access to general and easily understood information on radiation safety and nuclear safety and that there are opportunities to express opinions. These parties may have a range of concerns, levels of knowledge and experience, which will therefore call for communication at different levels of technical detail, via different channels. Public opinions and comments should be properly summarized and should be considered as an input into the process that is intended to lead to a decision on launching a nuclear power programme.

Phase 2

2.106. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 21, 34 and 36 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 5 and 14 of GSR Part 2 [8];
(c) Requirement 3 of GSR Part 3 [9];
(d) Requirements 1 and 3 of GSR Part 5 [11];
(e) Requirements 10 and 13 of GSR Part 7 [13];
(f) Requirement 2 of SSR-2/2 (Rev. 1) [14].

Action 41. The government should inform the public and other interested parties about the safety implications of the decision on the implementation of a nuclear power programme.

Action 42. All relevant organizations should continue to inform the public and other interested parties about safety issues, including the expected health and environmental impacts of a nuclear power programme.

2.107. The government, the regulatory body, the operating organization and various other entities have a responsibility to communicate the risks and benefits of a nuclear power programme to the public and other interested parties in a clear and transparent manner.

2.108. Requirements on transparent communication and the involvement of the public and other interested parties should be incorporated into the nuclear legislation that is enacted during Phase 2. The legislation should require that the operating organization disseminate information to the public on the planned facilities, their safety features and their expected environmental impacts.

2.109. The government should inform the public and other interested parties about decisions on the implementation of a nuclear power programme, including the long term national and international commitments to maintain safety and adequate preparedness to respond effectively to emergencies in relation to the nuclear power plant (including severe accidents with a very low probability of occurrence) and the necessity of measures such as establishing new organizations, building new national infrastructure and making financial provision for radioactive waste management and spent fuel management, and the transport of nuclear and other radioactive material. Information should be provided to the public, local

governments, committees representing local interests, industry, news media, non-governmental organizations and neighbouring States.

2.110. The involvement of the public and other interested parties, including through public hearings and the resolution of issues expressed in those hearings, should be made part of the licensing process.

2.111. The regulatory body should communicate with the public and other interested parties on its role and its activities, explaining the following:

(a) The responsibility of the regulatory body for the establishment and enforcement of regulations and requirements on nuclear safety;
(b) The authority of the regulatory body to give binding orders for ensuring safety;
(c) The independence of the regulatory body from undue influences in decision making;
(d) The technical competence of the regulatory body and the available human resources;
(e) The independence of the regulatory body.

2.112. The operating organization should explain to the public and other interested parties its responsibility for safety, its competence and its compliance with regulatory requirements.

Phase 3

2.113. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 21, 34 and 36 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 5 and 14 of GSR Part 2 [8];
(c) Requirement 3 of GSR Part 3 [9];
(d) Requirements 1 and 3 of GSR Part 5 [11];
(e) Requirements 10 and 13 of GSR Part 7 [13];
(f) Requirement 2 of SSR-2/2 (Rev. 1) [14].

Action 43. All relevant organizations should seek to establish and maintain the confidence and trust of the public and other interested parties on safety issues.

Action 44. All relevant organizations, as appropriate to their role, should continue to explain to the public and other interested parties the risks and benefits of the introduction of nuclear power and the measures taken to limit the risks.

Action 45. The regulatory body should communicate with the public and other interested parties about the licensing process, safety requirements and regulatory oversight.

Action 46. The operating organization and the regulatory body should communicate with the public and other interested parties about safety issues in construction and the commissioning programme.

Action 47. The operating organization and the regulatory body should maintain a transparent approach on safety issues with the public and other interested parties with regard to any problems and difficulties encountered in the construction programme, including the problems and difficulties of suppliers.

2.114. Communication should be continued on a regular basis and in a structured manner.

2.115. The regulatory body and the operating organization should inform the public about the possible radiation risks arising from operational states and from accidents (including events with a very low probability of occurrence but with high consequences) that are associated with the operation of a facility.

2.116. The operating organization should explain to the public the technology that is deployed in the nuclear power plant and the expected environmental impact from the plant. This could be done via a permanent public information centre near the nuclear power plant or temporary public information events at other locations. The operating organization should also inform the news media about the progress of construction activities, including potential problems of general interest.

2.117. The regulatory body should communicate with the public and other interested parties about safety concerns that might arise during construction and commissioning.

2.118. The regulatory body, the operating organization and emergency response organizations should provide information on emergency preparedness and response arrangements, particularly to members of the public who might be

affected by an emergency associated with the nuclear power plant. This should include information on the potential for an emergency and the associated hazards, on how the public will be warned and notified, and on the actions to be taken (see Requirement 10 of GSR Part 7 [13]).

2.119. Both the regulatory body and the operating organization should learn how to use the International Nuclear Event Scale [29] before the commissioning stage.

ACTIONS 48–60: FUNDING AND FINANCING

General

2.120. Sustainable funding of safety related activities, including the emergency arrangements of the respective response organizations, should be provided for the lifetime of a nuclear power plant. After the initial investment for construction of the plant, continued investments are necessary for regular refurbishment: most equipment has a limited lifetime and should be replaced as part of the ageing management programme or as a result of enhanced regulatory requirements resulting from safety research or operating experience. Technologies also have certain design lifetimes, and equipment should be modernized as necessary to ensure the availability of spare parts. Training needs will be continuous over the lifetime of the plant and need to be planned and funded in a systematic fashion. In addition, the costs of decommissioning and the management of radioactive waste and spent fuel represent a significant part of the total costs of a nuclear power programme: funding should be planned for these purposes from the beginning of the operation of a plant. As stated in para. 3.29 (Principle 7) of SF-1 [1]:

> "Radioactive waste must be managed in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management."

This principle should be applied from the initial stage of development of the nuclear power programme.

Phase 1

2.121. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 3, 10 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 9 of GSR Part 2 [8];
(c) Requirement 1 of GSR Part 5 [11];
(d) Requirement 9 of GSR Part 6 [12];
(e) Requirement 2 of GSR Part 7 [13];
(f) Requirements 1, 3 and 4 of SSR-2/2 (Rev. 1) [14].

Action 48. The government should plan funding for education and training, and for research centres and other national infrastructure, to support the safe operation of nuclear power plants, including on-site and off-site emergency arrangements.

Action 49. The government should require that the operating organization allocate the necessary financial resources to ensure the safety of its nuclear power plants until the end of their planned operating lifetime.

Action 50. The government should consider the various possible sources for the funding of the regulatory body.

Action 51. The government should consider the various possible sources and mechanisms of funding for radioactive waste management and spent fuel management, the decommissioning of nuclear power plants and the disposal of radioactive waste.

2.122. Means of ensuring funding for safety for the entire duration of the nuclear power programme should be considered in the early planning stages and should be confirmed with appropriate legislation and government decisions as well as in licence conditions. The government should also take into account the costs of the regulatory body and the financing of the national infrastructure for supporting the safe operation and regulation of nuclear power plants, including adequate emergency arrangements for the nuclear power programme.

2.123. The government should consider the financial aspects that are necessary for establishing and maintaining the safety infrastructure of the nuclear power programme for its entire duration and which ensure that safety is not compromised at any stage.

2.124. Financial aspects should also be considered for basic education and training in subjects relevant to nuclear safety, for research that supports the development of the national knowledge base on the safe use of nuclear energy, and for the regulation of nuclear installations. A systematic and structured approach to training is strongly encouraged for nuclear power plants.

2.125. Funding mechanisms should be considered for radioactive waste management and spent fuel management, for the decommissioning of the nuclear power plant and for the disposal of radioactive waste, including considerations relating to the transport of radioactive material. Funding should be protected to avoid its depletion through being used for other purposes or through monetary inflation. During Phase 1, basic decisions should be made on establishing such funds, on the principal mechanism for the collection of funds and on the organization responsible for managing the funds.

Phase 2

2.126. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 3, 10 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 9 of GSR Part 2 [8];
(c) Requirement 1 of GSR Part 5 [11];
(d) Requirement 9 of GSR Part 6 [12];
(e) Requirement 2 of GSR Part 7 [13];
(f) Requirements 1, 3 and 4 of SSR-2/2 (Rev. 1) [14].

Action 52. The government should make provision for long term funding for education and training, and for research centres and other national infrastructure, to support the safe operation of nuclear power plants, including on-site and off-site emergency arrangements.

Action 53. The government should decide on the mechanism for sustainable funding of the regulatory body.

Action 54. The operating organization should establish a policy for ensuring adequate funding so as not to compromise safety at any stage of the nuclear power programme.

Action 55. The government should enact legislation that requires financial provision for the funding of long term radioactive waste management, spent fuel management and decommissioning.

2.127. All the necessary arrangements should be made to ensure that adequate resources will be allocated in a sustainable manner for developing and maintaining the national knowledge base commensurate with the national strategy.

2.128. The funding mechanism for the oversight of the safety of nuclear facilities by the regulatory body should be decided. Depending on government policy, the regulatory body's oversight could be funded entirely from the State budget, or at least part of the costs could be collected from operating organizations. In the latter case, the regulatory body could be given the right to charge actual costs directly to the operating organizations, or the funds could be collected by the government and be made available to the regulatory body through the State budget. Whatever the funding mechanism, the adequacy and assurance of the funding should be mandated in legislation, and the funding should be flexible enough to accommodate variations in the workload of the regulatory body.

2.129. Financial assurance mechanisms and plans for the allocation of decommissioning funds and waste management funds should be in place before granting a licence to operate a nuclear power plant. In addition, the mechanism, timing and plans for funding for the long term management and disposal of radioactive waste and for decommissioning and the management of spent fuel should be reviewed periodically to ensure the availability of necessary funds. This periodic review should take into account the fact that the plant might be forced to stop operation before the end of its design lifetime.

Phase 3

2.130. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 3, 10 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 9 of GSR Part 2 [8];
(c) Requirement 1 of GSR Part 5 [11];
(d) Requirement 9 of GSR Part 6 [12];
(e) Requirement 2 of GSR Part 7 [13];
(f) Requirements 1, 3 and 4 of SSR-2/2 (Rev. 1) [14].

Action 56. The government should provide sustainable funding for the efficient and effective conduct of the regulatory body's activities and for the emergency arrangements of the respective response organizations.

Action 57. The operating organization should ensure that funding is sufficient for ensuring the safe operation of the nuclear power plant.

Action 58. The operating organization should ensure that arrangements are in place for the funding of radioactive waste management and decommissioning.

Action 59. The regulatory body should verify, as part of the licensing process, that the operating organization has sufficient financial resources.

Action 60. The government or the regulatory body should verify that a system for the funding of decommissioning activities, radioactive waste management and spent fuel management, including disposal, is in place.

2.131. By the end of Phase 3, the operating organization should establish rates for electricity generated, with due consideration of the national tariff structure. The rate fixed should take into consideration the funding required for the sustainable safe operation of the nuclear power plant.

2.132. Funding for decommissioning and for the management and disposal of radioactive waste and spent fuel, as necessary, should be established in accordance with legislative requirements. Provision should be made to ensure that the full amount of the required funding is raised and is not depleted later by unauthorized use or by monetary inflation.

ACTIONS 61–71: EXTERNAL SUPPORT ORGANIZATIONS AND CONTRACTORS

General

2.133. The operating organization and the regulatory body should have the competence to understand fully the basis of all the safety related decisions that they are responsible for making. However, it might not be feasible for these organizations to conduct for themselves all the detailed assessments of design information and inspection results or to verify the correctness of all the safety analyses. Such assessments and verification are necessary to ensure that sound

decisions are taken. Technical or other expert professional support may therefore be sought from external organizations or individuals through formal partnerships or contracts. This approach provides the operating organization and the regulatory body with access to scientists, engineers and other experts.

2.134. As an example, the regulatory body might have a need for services such as those for developing safety analysis tools, conducting independent safety analyses and assessments, and conducting experimental research. The operating organization should liaise with various suppliers, both for the construction of the nuclear power plant and for its operation and maintenance. In particular, contractor personnel may be used to perform tasks that are of a specialized or temporary nature for which it is not feasible to use full time plant employees.

2.135. Organizations from which the regulatory body might obtain support typically include:

(a) Advisory bodies;
(b) Dedicated external support organizations;
(c) Research centres;
(d) Academic institutions;
(e) Regulatory bodies of other States;
(f) International and regional organizations;
(g) Consultants with experience in specific technical or scientific topics.

2.136. Further guidance on the use of external expert support by the regulatory body is provided in GSG-12 [27].

2.137. Organizations and contractors with which the operating organization should liaise typically include:

(a) Plant vendors;
(b) Suppliers of equipment and services;
(c) External maintenance organizations;
(d) Organizations conducting material testing and inspections;
(e) Dedicated external support organizations;
(f) Research centres;
(g) Academic institutions;
(h) Consultants with experience in specific technical or scientific topics.

2.138. Further information about the interface between the operating organization and external supporting organizations can be found in IAEA Safety Standards Series No. NS-G-2.4, The Operating Organization for Nuclear Power Plants [30].

2.139. The roles and functions of universities and other academic institutions may differ from those of other external support organizations, as the former will be best used in providing training for engineers and scientists, in conducting specialized analysis of specific problems and longer term safety related research, and in supporting the development of longer term regulatory approaches.

2.140. The functions of dedicated external support organizations can include: conducting independent confirmatory analyses or research; technical assistance in the resolution of specific regulatory issues; and the development of technical bases for safety policy and regulations. External support organizations can also fulfil a longer term function of serving as a technical training centre and maintaining expertise in nuclear safety and radiation safety. The size, scope and responsibilities of external support organizations are best determined in accordance with the specific needs of the organizations they support. The external support organizations should be flexible enough to allow changes over time as the needs of the organizations they support evolve.

2.141. Independent standing bodies or temporary advisory bodies, with membership drawn from other national institutions, regulatory bodies of other States, scientific organizations and the nuclear industry, may be established to provide broad, independent advice to the regulatory body over the long term on issues relevant to the regulatory decision making process. Advisory bodies could, for example, confirm in licensing reviews that the regulatory body has properly addressed relevant safety issues. They could also support the development of regulations, as well as provide a broad perspective on the formulation of regulatory policy. Members of advisory bodies should be independent, highly experienced and respected by their peers in their respective fields.

2.142. Short term external support could be provided by suitable highly specialized consultants, private engineering companies and other industrial organizations. However, in the longer term, more permanent in-house expertise should be developed and relied upon.

2.143. External experts or contractor personnel should be trained and qualified for the task to be performed. It should be the responsibility of the organizations obtaining external support to ensure that safety related activities are performed by personnel with proven skills and competence. For example, documented assurance

that contractor personnel have the necessary qualifications could be requested prior to their involvement in safety related work. This should be assessed, tracked and evaluated through the organization's systematic approach to training.

2.144. When external expertise or advice is provided to the regulatory body, it should be ensured that such support is independent of any support provided to the operating organization.

2.145. The roles and responsibilities of external support organizations should be clearly defined and understood. When the work of external support organizations can affect the safety of the plant, then the management system of the operating organization or the regulatory body, as appropriate, should provide for the proper supervision of external support organization activities.

2.146. The regulatory body and the operating organization need to keep a questioning attitude on safety matters and avoid over-reliance on advice from external experts, in particular in cases of conflicting conclusions with regard to the analysis of low probability, high consequences events. This is particularly relevant in the analysis of external hazards that are associated with large uncertainties. Therefore, the regulatory body should make conservative decisions in these instances.

2.147. Any support obtained by the regulatory body or the operating organization will not relieve them of their responsibilities. The regulatory body and the operating organization should have an adequate core competence to make informed decisions. This requires an adequate number of personnel having the knowledge and experience necessary to supervise and evaluate the work of external support organizations and contractors. Adequate contractual arrangements should be made to specify the roles and responsibilities of external support organizations.

2.148. Domestic organizations should participate in the construction of nuclear power plants because competences will be needed within the State to ensure adequate support for safe long term operation.

2.149. Certain technical services, such as dosimetry services and environmental monitoring services, in-service testing and inspection, and metrological activities, are needed within a State embarking on a nuclear power programme. Such services could be set up within the operating organization, taking into account the need to avoid conflicts of interest (perceived, potential or actual) relating to such services, or the services could be outsourced.

Phase 1

2.150. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 4, 11, 13 and 20 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 3 and 11 of GSR Part 2 [8];
(c) Requirement 2 of GSR Part 3 [9];
(d) Requirement 3 of SSR-2/2 (Rev. 1) [14].

Action 61. The government should consider the availability of expertise, industrial capability and technical services that could support the safety infrastructure in the long term.

Action 62. The government should assess the need to create or enhance national organizations to provide technical support to the regulatory body and the operating organization for the safe operation of nuclear power plants.

2.151. At the beginning of the nuclear power programme, expertise may be acquired from expert organizations in other States, but subsequently the support available within the State will be of increasing importance in ensuring the safe long term operation of nuclear power plants.

2.152. In Phase 1, efforts should therefore be made to identify national and international expert organizations that could provide support either to the regulatory body or to the operating organization. If new national organizations or capabilities need to be established, or if the existing organizations or capabilities need to be enhanced, then the necessary planning should be started.

2.153. The government should start to identify and encourage industrial organizations that could possibly participate in civil construction and in supplying structures, systems and components. During operation, these organizations could provide support in the maintenance of the plant and of the equipment that they have supplied. This would help to ensure the availability in the State of professional and high quality maintenance over the lifetime of the plant.

2.154. Even though there might not be the necessary industrial capability in the State in Phase 1, the government could adopt a strategy for national participation and could decide to build and develop local industrial, educational and research organizations. For the coordinated development of industry in the State and for training the industry to handle nuclear projects, the development of a dedicated

engineering organization that specifically incorporates a systematic approach to training should be considered. Such an organization should acquire broad knowledge in the nuclear field and should subsequently support manufacturers and other industrial organizations in their nuclear projects.

2.155. Operation of a nuclear power plant might require the provision of external technical services such as:

(a) Individual monitoring and environmental monitoring;
(b) In-service testing and inspection;
(c) Maintenance of special technical equipment;
(d) Metrological activities.

2.156. The availability of technical services, whether in the State or in other States, should be considered in Phase 1, and gaps should be identified. Consideration should be given to strategies for filling the gaps.

Phase 2

2.157. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 4, 11, 13, 17 and 20 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 3 and 11 of GSR Part 2 [8];
(c) Requirements 2 and 3 of GSR Part 3 [9];
(d) Requirements 3 and 31 of SSR-2/2 (Rev. 1) [14].

Action 63. The operating organization and the government should encourage industrial organizations in the State to develop their capabilities with the objective of participating in the construction of nuclear power plants and supporting their safe long term operation.

Action 64. The government, and the operating organization if applicable, should establish organizations to provide expertise and engineering support or other external support for regulatory oversight and for the safe operation of nuclear power plants, as identified in Phase 1.

Action 65. External support organizations and potential contractors should begin to build competence and quality management systems for ensuring safety.

Action 66. The regulatory body and the operating organization should plan arrangements for overseeing the activities performed by their respective external support organizations and contractors.

2.158. From Phase 2, external support organizations should start developing their technical capabilities and competences, as well as the experimental and analytical tools that will be necessary to provide technical justification for nuclear safety. Universities and other academic institutions should establish proper curricula and should start providing basic training in nuclear engineering and other disciplines relevant for nuclear safety. External support organizations should develop their readiness for making independent confirmatory analyses and conducting research, and for providing technical assistance for the resolution of nuclear safety issues.

2.159. The operating organization and the government, if applicable, should promote the building of a network of industrial organizations in the State that are interested in entering and remaining in the nuclear industry. Such independent competences will support the safe long term operation of nuclear power plants in the State. The independence of the regulatory body from this process should be preserved, and the public should be informed that this is the case.

2.160. In Phase 2, the operating organization should conduct a realistic assessment of the national and local capabilities to supply commodities, components and services for the nuclear facility, giving due consideration to requirements for the management system in the evaluation criteria. The operating organization will need to ensure that the providers of equipment and services follow good management practices, taking into account the entire chain of possible subcontractors.

2.161. The application of quality standards for nuclear equipment and services is generally more stringent than for other industrial operations. The operating organization needs to ensure that contractors and service providers develop management systems and needs to verify compliance with requirements for quality management.

2.162. One or more engineering organizations allied with the operating organization should be in the process of acquiring broad competences in the nuclear field. These competences could be used to supply engineering services directly to the operating organization or to support construction industries and manufacturing industries in learning aspects of the nuclear industry. The engineering organizations dedicated to the nuclear industry should also be prepared to support the constructors, manufacturers and other suppliers in making

bids or negotiating contracts with the vendor or the operating organization. Due consideration should be given to the establishment of appropriate management systems (including quality management) in such organizations so as to meet the level of quality required for nuclear installations.

Phase 3

2.163. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 4, 11, 13, 17 and 20 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 3, 10 and 11 of GSR Part 2 [8];
(c) Requirements 2, 3 and 20 of GSR Part 3 [9];
(d) Requirements 3 and 31 of SSR-2/2 (Rev. 1) [14].

Action 67. The regulatory body should establish a framework for the qualification of technical services that are significant for nuclear safety.

Action 68. External support organizations should continue the recruitment of staff and the building of competence in safety related matters.

Action 69. All relevant organizations should ensure clarity in specifying the roles and responsibilities of external support organizations.

Action 70. All relevant organizations should make appropriate arrangements to avoid conflicts of interest when obtaining external support.

Action 71. The regulatory body and the operating organization should oversee the activities performed by their respective external support organizations and contractors, and should assess the quality of the services provided, in accordance with their management systems.

2.164. In Phase 3, external support organizations should be well established and should be ready to fulfil their roles as determined by the regulatory body or the operating organization.

2.165. External personnel providing a service or providing advice to the operating organization cannot have direct authority over plant personnel. As the operating organization retains the prime responsibility for the safety of the plant, it should always remain responsible for making decisions. Knowledgeable and skilled personnel of the operating organization should be clearly identified and

should be assigned to the supervision of contractors or temporary support staff. The specific training needs of the contractors for the operating organization should be assessed, tracked and evaluated through a systematic approach to training.

2.166. Areas in which the operating organization should be supported by the vendor include the following:

(a) Training of operating staff;
(b) Preparation of documentation, including that required for licensing;
(c) Commissioning of the plant;
(d) Maintenance and in-service inspection;
(e) Technical assistance during operation;
(f) Preparation of normal operating procedures and emergency operating procedures.

2.167. The roles of different external support organizations should be studied carefully to avoid conflicts of interest, such as if the same organization provides support to both the regulatory body and the operating organization (see also para. 2.144).

2.168. The construction of a nuclear power plant involves numerous contractors, and it is incumbent on the operating organization to ensure that this complex chain of contractors is adequately managed so that the end products are acceptable from a safety standpoint. The responsibility of the operating organization in this respect is the same no matter which option is selected for the nuclear power plant supply contract. The operating organization should verify from the very beginning the quality of equipment and services supplied by the vendor and its subcontractors under contracts of all types, including 'turnkey' and 'super turnkey' projects.[4]

2.169. The operating organization should reassess the local and national capabilities to supply commodities and components and to provide services for the nuclear power plant. It should give primary importance to the management system and to safety culture in allocating the supply of spare parts, consumable supplies, maintenance services and calibration services.

[4] In a turnkey project, a single contractor or a consortium of contractors takes overall technical responsibility for the entire work. In a super turnkey project, a single contract is placed for the entire nuclear power plant. The prime responsibility for the technical success of the project, and therefore for the design of the plant, is placed upon the contractor.

2.170. Supplier qualification requirements are normally issued by the operating organization and included in contracts. The operating organization should promote a common understanding of the key aspects of safety culture and design requirements among the suppliers.

2.171. The operating organization has prime responsibility for the quality (and thus the safety) of the products or the technical services provided. However, depending on the system in the State, the regulatory body, or some other national certifying body, may establish certification requirements for the providers of technical services that have implications for safety. Management systems, including safety culture and training, should be considered in the evaluation criteria.

ACTIONS 72–84: LEADERSHIP AND MANAGEMENT FOR SAFETY

General

2.172. Principle 3 of SF-1 [1] states that "**Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks.**"

2.173. In all relevant organizations, leadership for safety, management for safety, an integrated management system and a systemic approach (in which the interactions between technical, human and organizational factors are duly considered) are essential to the specification and application of adequate safety measures and the fostering of a strong safety culture. The managers at all levels are required to demonstrate leadership that gives an overriding priority to safety and fosters a strong safety culture (see GSR Part 2 [8]).

2.174. The operating organization retains responsibility for safety when contracting any processes and receiving any item, product or service. Effective arrangements should be put in place with suppliers to specify, monitor and control the supply of items, products and services that might affect safety.

2.175. Safety culture is defined as the assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance [31].

2.176. A management system needs to integrate all elements of management including safety, health, environmental, security, quality, human and organizational factors, and societal and economic elements so that safety is not compromised.

2.177. Efficient and effective management systems constitute a cross-cutting element of the safety infrastructure, applicable for all the organizations involved in the nuclear power programme. However, as indicated in Fig. 4, the extent of involvement of the different organizations will vary considerably during the different phases of implementation of the nuclear power programme. The government is the main party in Phase 1, the regulatory body might not be created before Phase 2, and Phase 3 is the main phase for the implementation of the operating organization's programmes.

2.178. All the actions taken by the relevant organizations should be included in the framework of effective management systems. The requirements established in GSR Part 2 [8] should provide the basis for the management systems, which should be established before the actions are conducted by the applicable organizations in each phase.

2.179. All organizations should avoid complacency and maintain the overall attention to safety.

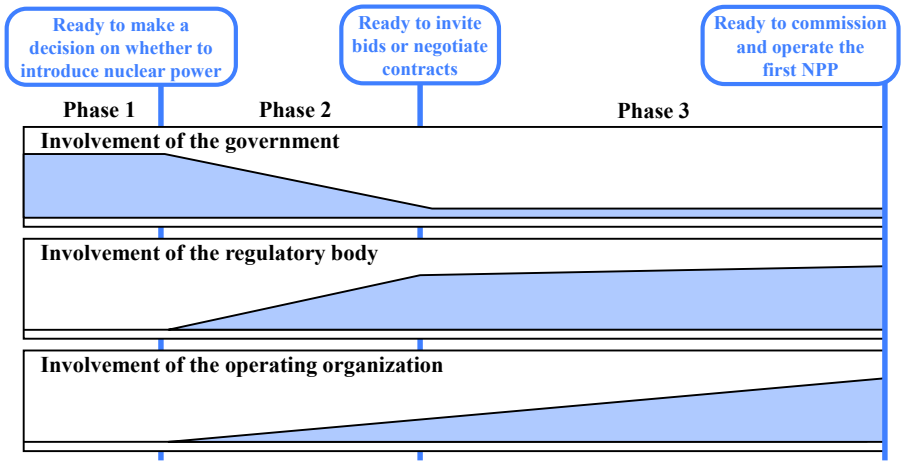

FIG. 4. Progressive involvement of the main organizations in the nuclear power programme.

Phase 1

2.180. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 19 of GSR Part 1 (Rev. 1) [5];
(b) Requirements of GSR Part 2 [8] as a whole;
(c) Requirement 5 of GSR Part 3 [9];
(d) Requirement 2 of IAEA Safety Standards Series No. SSR-1, Site Evaluation for Nuclear Installations [15].

Action 72. The government should take into account the essential role of leadership and management for safety to achieve a high level of safety and to foster a strong safety culture within organizations.

Action 73. The government should ensure that all the activities conducted are included within the framework of an effective integrated management system.

Action 74. The government, when identifying senior managers for the prospective organizations to be established, should look for people with leadership capabilities and an attitude that emphasizes safety culture.

2.181. The selection of senior managers should be accorded great importance in establishing an effective management focused on keeping safety as an overriding priority. The senior managers will define the mission, strategies, objectives and policies of the organizations and will make decisions accordingly. In identifying people for top positions in the prospective operating organization and regulatory body, priority should be given to people with leadership capabilities and attitudes emphasizing safety culture.

2.182. If the senior managers of the regulatory body are recognized as having the highest level of competence (in nuclear technology, law, public administration or some other relevant discipline), appropriate experience and a sound character, their judgements and the decisions made by the regulatory body are likely to be respected. Organizations headed by people who are perceived as lacking competence or as holding their positions for political reasons will have difficulty in maintaining confidence internally and externally and might be perceived as compromising the independence of the regulatory body.

2.183. Leadership in safety should be demonstrated at all levels in an organization. Safety should be achieved and maintained by means of an effective integrated management system. Leadership and management for safety will ensure, in a coherent manner, that safety will not be compromised by other requirements or demands. Management systems (including quality management systems) should ensure, among other things, the fostering of safety culture at all levels of the organization, the regular assessment of safety performance, and the identification of lessons from experience, including recognizing potential precursors to accidents and taking actions to eliminate them. Human factors should also be taken into account, with due consideration of all possible interactions of individuals at all levels with technology and with organizations.

Phase 2

2.184. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 19 and 35 of GSR Part 1 (Rev. 1) [5];
(b) Requirements of GSR Part 2 [8] as a whole;
(c) Requirement 5 of GSR Part 3 [9];
(d) Requirement 7 of GSR Part 5 [11];
(e) Requirement 2 of SSR-1 [15];
(f) Requirement 2 of SSR-2/2 (Rev. 1) [14];
(g) Paragraph 306 of IAEA Safety Standards Series No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition [17].

Action 75. The regulatory body and the operating organization should start developing and implementing effective integrated management systems in their respective organizations and should foster a strong safety culture.

Action 76. The regulatory body and the operating organization should develop competences in managing the growth of and change in the organization.

Action 77. The regulatory body and the operating organization should make appropriate arrangements for measurement, assessment (both self-assessment and independent assessment) and continual improvement of their integrated management systems.

2.185. Early in Phase 2, all the top positions in the operating organization and in the regulatory body should be filled on the basis of criteria defined in Phase 1.

A safety culture takes time to develop, and the leadership of both the operating organization and the regulatory body should initiate, from the very beginning, programmes and practices to build a safety culture in their respective organizations. As an effective way of establishing a safety culture and promoting the development of leadership for safety, management systems should be implemented that provide structure and direction to the relevant organizations that will have responsibilities for safety, in accordance with GSR Part 2 [8].

2.186. The regulatory body should develop a safety culture policy, incorporate safety culture into regulatory processes, and train its management and staff in their respective roles and responsibilities in the implementation of the safety policy.

2.187. The regulatory body should also implement a process of regulatory oversight of the culture for safety in the operating organization.

Phase 3

2.188. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 19 and 35 of GSR Part 1 (Rev. 1) [5];
(b) Requirements of GSR Part 2 [8] as a whole;
(c) Requirement 5 of GSR Part 3 [9];
(d) Requirement 7 of GSR Part 5 [11];
(e) Requirement 26 of GSR Part 7 [13];
(f) Requirement 2 of SSR-1 [15];
(g) Requirement 2 of IAEA Safety Standards Series No. SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design [16];
(h) Requirements 2, 8, 9 and 15 of SSR-2/2 (Rev. 1) [14];
(i) Paragraph 306 of SSR-6 (Rev. 1) [17].

Action 78. The senior management of all relevant organizations should provide effective leadership and effective management for safety to ensure a sustainable high level of safety and a strong safety culture.

Action 79. All relevant organizations should continue the implementation of a management system that promotes the concept that requirements for safety shall be paramount within the organization, overriding all other demands.

Action 80. The operating organization and the regulatory body should ensure that the effectiveness of their integrated management systems is

monitored and measured, and that self-assessments as well as independent assessments are conducted regularly for continual improvement.

Action 81. All relevant organizations should ensure that appropriate arrangements for the management of safety related knowledge (including record management and report management) and knowledge transfer are in place.

Action 82. All relevant organizations should ensure that leadership and succession development programmes are in place to develop future leaders with a strong emphasis on safety.

Action 83. The operating organization should describe the provisions for management for safety in the corresponding chapter of the safety analysis report.

Action 84. The regulatory body should review and assess the operating organization's programme on safety management.

2.189. Individuals should be made accountable for and encouraged to take 'ownership' of their work and to strive for improvements in their performance. Managers and leaders should encourage and welcome the reporting of possible safety related concerns by individuals throughout the organization and should respond to valid concerns promptly and in a positive manner.

2.190. A common understanding of the key aspects of safety culture within the organization should be ensured, and a questioning attitude should be promoted at all levels of the organization.

2.191. The operating organization and the regulatory body should establish and maintain a system for the control of records and reports that are important to safety. Documentation should be controlled in a consistent and compatible manner throughout its preparation, revision, review, approval, release, distribution and archiving.

2.192. To sustain the effectiveness of the management system, the system should be measured and monitored on a periodic basis. Self-assessment is an important mechanism that organizations should use to improve their performance.

2.193. Self-assessment can be reinforced by independent assessment, which can be carried out by independent audit teams within the organization or by bodies

that are external to the organization. During Phase 3, processes for self-assessment should be established for continual monitoring of the effectiveness of the operating organization and the regulatory body.

2.194. Senior management should treat information as an essential resource. Proper transmission and continuity of knowledge is vital for the sustainable long term management of safety.

2.195. Programmes and processes should be in place for the development of future leaders and for the preservation and management of corporate knowledge (both explicit and tacit) of the organization.

ACTIONS 85–98: HUMAN RESOURCES DEVELOPMENT

General

2.196. Requirement 11 of GSR Part 1 (Rev. 1) [5] states that "**The government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities.**" The parties covered by this requirement include the regulatory body, the operating organization, research organizations, external support organizations, industrial organizations and organizations that provide technical services.

2.197. Requirement 9 of GSR Part 2 [8] states that "**Senior management shall determine the competences and resources necessary to carry out the activities of the organization safely and shall provide them.**" This requirement applies to all organizations involved in safety related activities.

2.198. Recommendations on human resources development for the regulatory body are provided in GSG-12 [27]; recommendations for the operating organization are provided in IAEA Safety Standards Series No. NS-G-2.8, Recruitment, Qualification and Training of Personnel for Nuclear Power Plants [32].

Phase 1

2.199. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 11 and 18 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 9 of GSR Part 2 [8];

(c) Requirement 2 of GSR Part 3 [9];
(d) Requirements 21 and 25 of GSR Part 7 [13];
(e) Requirement 4 of SSR-2/2 (Rev. 1) [14].

Action 85. The government should consider a strategy for attracting, recruiting, training and retaining an adequate number of experts to meet the needs of all organizations involved in ensuring safety in a prospective nuclear power programme.

Action 86. The government should identify competences required in areas relating to nuclear safety and the approximate number of experts needed.

Action 87. The government should identify national institutions and institutions in other States that could provide education and training and could start training in key areas relating to nuclear safety.

Action 88. The government should identify gaps in safety related training at existing training institutions and should plan to strengthen existing training institutions or to establish new training institutions to fill these gaps.

Action 89. The government should ensure that prospective senior regulators identified by the government and prospective safety experts to be involved in the nuclear power programme gain an understanding of the principles and criteria of nuclear safety.

2.200. Human resources development is a demanding and complex task in terms of resources (both time and money), and it should be properly addressed. An assessment of education and training needs should be conducted as one of the first tasks in Phase 1. Cooperation with other States and international organizations should be pursued to provide insights into the competences and human resources necessary for implementing a nuclear power programme.

2.201. The assessment of education and training needs should include the preparation of a list of the areas of expertise necessary to support the development of the legal and regulatory framework, site evaluation, design assessment, construction, regulatory oversight, and emergency preparedness and response, together with estimates of the number of individuals necessary in these areas of expertise. In later phases, expertise should be available for commissioning, operation, maintenance and radioactive waste management. The education and training needs identified by this assessment process should be managed by the relevant organization through a systematic approach to training.

2.202. The assessment process should also include an examination of the capabilities of existing academic facilities, research and development centres, and technical training institutions to provide training in certain areas of technical expertise that will be required for the licensing, operation and oversight of nuclear power plants. The assessment should determine the adequacy of the current capabilities to meet the training needs in areas such as reactor physics, thermal hydraulics, chemistry, radiation protection, materials science, strength analysis, reliability technology, mechanical engineering, civil engineering, earth sciences, assessment of radiological environmental impact, electrical engineering, instrumentation and control engineering, human behavioural science, testing of materials, project management, organizational management and emergency management.

2.203. On the basis of the assessment of education and training needs, a comprehensive plan for either upgrading existing training institutions or building new training institutions should be developed. Possibilities for collaboration in human resources development with potential vendor States and other States in which nuclear power plants are being operated should be explored at an early stage.

2.204. Experience shows that, before education and training curricula are put in place, it could be useful to make use of opportunities for education in institutions in other States, to send nuclear trainees abroad and to hire specialists from other States to provide academic and practical education and training, so as to start developing human resources from the earliest phase.

2.205. Consideration should also be given to hiring staff from other industries. Due consideration should be given to securing and maintaining human resources, since the loss of trained human capital might jeopardize the implementation and sustainability of the safety infrastructure. In light of the experience of developing States, a strategy to attract and retain high quality staff within the State should be developed. This strategy could include measures such as adequate return arrangements for trainees sent to other States, sufficient salaries, and good working conditions and career positions. Furthermore, all national organizations with safety related functions, especially the regulatory body, should be provided with the means to attract and retain high quality staff, in potential competition with recruitment by the operating organization and industrial organizations.

Phase 2

2.206. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 11 and 18 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 9 of GSR Part 2 [8];
(c) Requirements 2–4 and 26 of GSR Part 3 [9];
(d) Requirements 21 and 25 of GSR Part 7 [13];
(e) Requirements 4 and 7 of SSR-2/2 (Rev. 1) [14];
(f) Paragraphs 311–315 of SSR-6 (Rev. 1) [17].

Action 90. All relevant organizations should implement a strategy to attract and retain high quality trained personnel.

Action 91. All relevant organizations should support the safety related training of their prospective staff in nuclear organizations in other States.

Action 92. The regulatory body and the operating organization should actively recruit staff so as to ensure capability in areas relevant to safety in a timely manner.

Action 93. The government and relevant organizations should establish new institutes or new curricula relevant to safety, as identified in Phase 1.

Action 94. All relevant organizations should commence the education and training in academic and vocational institutions of the number of persons necessary for ensuring safety.

2.207. A strategy to attract and retain trained high quality personnel should be implemented. As identified in Phase 1, this might include measures such as adequate return arrangements for trainees sent to educational institutions in other States, sufficient salaries, and good working conditions and career positions. The government should also verify that all organizations with crucial safety related responsibilities, especially the regulatory body, have been able to attract high quality staff.

2.208. Early in Phase 2, a policy decision should be made with regard to the implementation of the plans that were developed in Phase 1 for ensuring the availability of experts. Implementation of the selected plan should begin early enough in Phase 2 that sufficient numbers of individuals can complete the

necessary training and occupy positions in the regulatory body, the operating organization, external support organizations and industrial organizations before the commissioning of the first nuclear power plant.

2.209. Where the assessment in Phase 1 has shown the need for new institutions or extended curricula, such institutions and curricula should be established. The operating organization should manage their training programme through a systematic approach to training.

2.210. At the beginning of Phase 2, the senior management positions of the regulatory body should be filled. The management of the regulatory body should develop the staffing strategy in parallel with the development of the national regulatory process. Throughout Phase 2, the regulatory body should gradually recruit and develop the necessary expertise. It should be an objective early in Phase 2 to already have staff of the regulatory body who are able to specify and understand safety requirements for use by the operating organization in the bidding process or contract negotiations and for use by the regulatory body in the review of the site and the application for the construction licence. The staff also have to be able to make other safety related decisions when such decisions are necessary. The specific needs for competence and training for Phase 3, notably for the staff who will have to perform inspections during construction, as well as assess compliance and the achievement of safety objectives, should be identified in Phase 2.

2.211. At the end of Phase 2, the operating organization should have sufficient technical expertise to specify competently the safety requirements in a call for bids or contract negotiations for a nuclear power plant and to evaluate the safety relevant parts of the bids or contracts to be received early in Phase 3. Even if the support of consultants is available internationally for this purpose, the operating organization should start early to recruit experts with a good overall understanding of the safety issues, the site specific safety features and the nuclear power plant designs. The implementation of the future stages of the programme should be taken into account during the recruitment process.

Phase 3

2.212. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1, 11 and 18 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 9 of GSR Part 2 [8];

(c) Requirements 2–4 and 26 of GSR Part 3 [9];
(d) Requirements 21 and 25 of GSR Part 7 [13];
(e) Requirements 4 and 7 of SSR-2/2 (Rev. 1) [14];
(f) Paragraphs 311–315 of SSR-6 (Rev. 1) [17].

Action 95. The operating organization, the regulatory body, external support organizations and relevant response organizations should ensure the availability of sufficient competent human resources for the efficient and effective conduct of all activities at the appropriate time.

Action 96. The operating organization should prepare a human resources management programme (including staffing, qualification and training) as well as the corresponding parts of the safety analysis report.

Action 97. The regulatory body should review and assess the operating organization's programme with regard to human resources management.

Action 98. The government should continue promoting the development of education in the nuclear field so as to continue providing a flow of qualified people in areas relevant to safety.

2.213. A sustainable level of expertise in nuclear power technology and safety should be maintained by means of the continual recruitment of competent staff and long term generic research programmes on safety that provide and preserve the strength of the nuclear power programme (see paras 2.218–2.232 on research for safety and regulatory purposes).

2.214. The operating organization should recruit and train its staff to support construction, preparation for operation and licensing. The operating organization should manage its training programme through a systematic approach to training. At the beginning of this phase, staff should be recruited with experience of project management, civil construction, equipment manufacturing, welding, non-destructive testing, instrumentation and control engineering, fire prevention and protection, and quality management. The operating organization should begin to use integrated competences early in the construction stage to verify that the plant is built to high standards of quality and in accordance with design requirements. Competences are also needed in the operating organization to foster a strong safety culture in the other organizations involved throughout the construction project. The need for verification of quality by the customer is not diminished, even in a turnkey type project. This is because the operating organization will have the prime responsibility for safety during plant operation, and this requires assurance

of the quality during construction. Experience in various areas of plant design should be available in order to assess the detailed plans for construction and the manufacture of components. The control room operators and the supervisory staff for plant operation, maintenance and specific technical areas should be recruited, and their plant specific training should commence before plant construction is half completed. A full scope, plant specific simulator should be acquired for training the control room operators, and training should be arranged early during the construction stage and in consideration of the relevant regulatory requirements.

2.215. The regulatory body should continue recruiting and training staff to be able to provide adequate oversight of construction, equipment manufacturing and, towards the latter part of Phase 3, commissioning of the plant. The staff should have a strong technical background as well as a thorough knowledge and understanding of the regulations and guides. Actions should be taken to address the specific competence and training needs identified in Phase 2.

2.216. For the purpose of providing highly skilled experts for the operating organization, the regulatory body and other organizations with crucial safety related tasks, educational institutions should continue to offer curricula that can meet the needs of the nuclear power programme, including safety culture.

2.217. All organizations involved in the nuclear power programme should have a systematic way of categorizing, disseminating and retaining the knowledge (including training material) obtained through international cooperation and assistance and contracted commercial services. This approach should be sustainable in terms of the continuous development of human resources and institutional knowledge.

ACTIONS 99–104: RESEARCH FOR SAFETY AND REGULATORY PURPOSES

General

2.218. Vendors and other organizations can provide technical advice and support to the operating organization in the licensing stages and in the early years of operation, but these competences should be integrated in due time within the State. Long term safety research objectives should be established so as to reduce reliance upon vendors that cannot be assumed to continue to exist throughout the lifetime of the nuclear power plant.

2.219. Research in States commencing a nuclear power programme should be focused on the safety features and operation of the prospective nuclear power plants as well as on-site related safety issues. Analytical methods should be learned through national research by developing tools (e.g. computer programs) and models as well as experimental methods (e.g. taking samples to be analysed in laboratories) that can be used for plant specific safety analyses in later stages. The accumulated knowledge can then be used for deterministic safety analysis and probabilistic safety analysis as well as for the assessment of the behaviour of the reactor in transient conditions. Experience has shown that such analyses should be repeated throughout the plant operating lifetime: for independent analysis for licensing and relicensing; for planning potential power upgrades or other modifications; and for analysing operational events and considering measures to prevent their recurrence. The experimental research should focus on, among other things, understanding the properties and ageing of materials in the reactor, as well as other phenomena relating to the ageing of structures and components. An in-depth understanding of the behaviour of materials should be acquired to address the safety related concerns that can arise when indications of cracking are found in pressure retaining components and piping.

2.220. In addition to providing an increased understanding of the safety features and operation of the prospective nuclear power plant and the safety issues relating to these characteristics, the research should support the general development of knowledge and competences in nuclear science and technology as well as in the scientific bases of radiation protection and waste management in the State. Research and development in the State should also be directed at building specific competence in certain areas. Research also constitutes good training for all interested parties in preparation for what will be needed during the nuclear power plant project.

2.221. In addition to research focused on technical areas, attention should be given to safety related research into management systems and human factors.

2.222. If a decision is made to use a research reactor to support safety related research or to develop human resources capacity for nuclear safety, the research facility should meet the requirements established in IAEA Safety Standards Series No. SSR-3, Safety of Research Reactors [33], and the recommendations provided in the associated Safety Guides.

Phase 1

2.223. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 11 of GSR Part 1 (Rev. 1) [5].

Action 99. The government should consider in which areas in-depth knowledge is necessary for assessing and analysing safety related aspects of a nuclear power plant project and should identify research centres that can start research programmes in safety related areas of knowledge.

Action 100. The government should identify the capabilities of domestic research centres to meet needs in core areas of knowledge and should plan to establish new research centres for such areas as necessary.

2.224. National research activities should be considered and initiated as early as possible when considering the introduction of a nuclear power programme. The areas of science and technology in which research and development are of vital importance for every State with an operating nuclear power plant include reactor physics, thermal hydraulics, material sciences, strength analysis and probabilistic safety assessment. Examples of other areas in which research may be considered are fire safety, human performance, seismic analyses, consequence analysis for design basis accidents and design extension conditions, and the management of organizations.

2.225. In establishing new research programmes, consideration should be given to whether the research can best be conducted within existing institutions in which the necessary structures and scientific and academic networks are already in place, or whether a new institution should be established. Both approaches have been used by States.

Phase 2

2.226. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 3 of GSR Part 5 [11].

Action 101. The operating organization and the regulatory body should be involved in identifying areas for safety research.

Action 102. The government should implement plans to establish new institutions for research relating to safety as necessary.

Action 103. Research centres should begin conducting research relating to safety in areas in which in-depth knowledge is essential to support the safe long term operation of nuclear power plants.

2.227. In the development of a nuclear power programme, the operating organization and the regulatory body should contribute to identifying areas in which research relating to safety should be conducted to fill gaps in knowledge. An integrated research plan should be developed, consistent with the national strategy for safety, that consolidates all the current and planned activities for identifying gaps in knowledge and the associated needs for research.

2.228. The national knowledge base should be strengthened by means of research groups that are established in vital areas of safety. These groups should participate in international networks in their respective areas, and some group members should be temporarily assigned to on the job training in research organizations in other States. The research in vital areas of safety is aimed at creating an independent knowledge base within the State, which will be necessary to support the contracting and licensing processes, and later to support construction, commissioning, safe plant operation and radioactive waste management, as well as final disposal, decommissioning or closure of facilities and regulatory oversight of safety.

2.229. If vital research on nuclear safety cannot be conducted within existing research organizations, a dedicated nuclear research organization should be established.

Phase 3

2.230. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 1 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 3 of GSR Part 5 [11].

Action 104. Research centres and other relevant organizations should focus their research on the features and safety aspects of the nuclear power plant that will be constructed, including features and aspects specific to the actual plant site.

2.231. As soon as the contract for a new nuclear power plant has been signed and the type of plant is known, the national research community should develop a comprehensive set of tools tailored to the safety analyses that will be undertaken for the facility. Plant specific models should be incorporated into the generic tools. Comprehensive analyses should be conducted to gain an understanding of the safety margins, the impact of changes in the model on the results of the safety analysis, and potential cliff edge effects[5]. The aim of such research is to provide a capability for fast and reliable support to the operating organization and the regulatory body in their safety assessments and to gain an understanding of the safety consequences of any abnormal event.

2.232. Arrangements to maintain close contact with academic research and educational establishments should be implemented. Such arrangements could include participation in conducting specialized training and confirmatory research projects. A nuclear power programme requires a pool of highly skilled and innovative personnel with appropriate expertise, which can only be maintained through an active national commitment to education and research on safety.

ACTIONS 105–116: RADIATION PROTECTION

General

2.233. Humans have always been exposed to ionizing radiation (termed 'natural background radiation') because of the radioactivity contained in rocks that form the Earth's crust and due to the exposure of the Earth's surface to cosmic rays. As noted in para. 1.1, the fundamental safety objective established in SF-1 [1] is to protect people and the environment from harmful effects of ionizing radiation.

[5] A cliff edge effect, in a nuclear power plant, is an instance of severely abnormal plant behaviour caused by an abrupt transition from one plant status to another following a small deviation in a plant parameter, and thus a sudden large variation in plant conditions, in response to a small variation in an input [31].

2.234. The principles of radiation protection are not specific to nuclear power plants but apply to all facilities and activities in which ionizing radiation is produced, as well as to exposure due to natural sources of radiation.

2.235. Principle 4 of SF-1 [1] states that "**Facilities and activities that give rise to radiation risks must yield an overall benefit.**" Principle 5 of SF-1 [1] states that "**Protection must be optimized to provide the highest level of safety that can reasonably be achieved.**" Principle 6 of SF-1 [1] states that "**Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.**"

Phase 1

2.236. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 7 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 2 and 43 of GSR Part 3 [9];
(c) Requirements 25–27 of SSR-1 [15].

Action 105. The government should consider the additional radiation risks and special needs associated with the operation of nuclear power plants.

Action 106. The government should ensure that an initial radiological environmental impact assessment is conducted, as appropriate, on the basis of a defined set of criteria, at a regional scale and with the use of available data.

Action 107. The government should recognize the need to integrate radiation protection regulations and new safety regulations for nuclear power plants.

2.237. The State is likely already to be engaged in activities involving sources of radiation (e.g. research reactors, or industrial or medical applications of radiation) for which legislation and other provisions for radiation protection have been established. However, the implementation of a nuclear power programme would give rise to additional hazards that would necessitate amending or complementing the existing national framework.

2.238. Preparation of a radiological environmental impact assessment is a key component in the process of demonstrating the protection of the environment from radiation risks. The process, which is part of a more general environmental impact

assessment, as addressed in para. 2.15, should be based on a graded approach to ensure that the resources devoted to safety are commensurate with the magnitude of the radiation risks and in accordance with Principle 5 of SF-1 [1].

2.239. Recommendations on radiological environmental impact assessment are provided in the following publications of the IAEA Safety Standards Series:

(a) GSG-8, Radiation Protection of the Public and the Environment [34];
(b) GSG-9, Regulatory Control of Radioactive Discharges to the Environment [35];
(c) GSG-10, Prospective Radiological Environmental Impact Assessment for Facilities and Activities [36].

Phase 2

2.240. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 7 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 1–4, 6–16, 18–32 and Schedule III of GSR Part 3 [9];
(c) Requirements 25–27 of SSR-1 [15];
(d) Requirements 78 and 79 of SSR-2/1 (Rev. 1) [16];
(e) Paragraphs 301–303 of SSR-6 (Rev. 1) [17].

Action 108. The regulatory body and/or the government should amend the legislation and/or regulations, as appropriate, for the purposes of regulating radiation protection to include specific aspects of the nuclear power programme.

Action 109. The regulatory body should establish or approve, as appropriate, the limits and constraints with regard to workers and the public both for normal operation and for potential exposures in a nuclear power plant.

Action 110. The operating organization should update the radiological environmental impact assessment for the site selected, as appropriate.

Action 111. The regulatory body should review and assess the radiological environmental impact assessment for the site selected, as appropriate.

Action 112. The operating organization should commence a radiological environmental monitoring programme.

Action 113. The operating organization should use all appropriate safety principles and requirements and regulatory requirements with regard to radiation protection in preparing the bid specifications or contract negotiations for the nuclear power plant.

2.241. The State should adapt its arrangements for radiation protection to include specific needs for radiation protection in the commissioning, operation, associated fuel transport, management and storage of radioactive waste and spent fuel, and decommissioning of a nuclear power plant. This should cover radiation monitoring and radiation protection for workers and the public and protection of the environment, as appropriate, against radiation risks. To establish dose limits (in nuclear laws or more commonly in the accompanying regulations), the requirements to be fulfilled by the regulatory body and/or the government, as appropriate, are established in paras 3.26–3.28 of GSR Part 3 [9].

2.242. The regulatory body and the operating organization should also give consideration to the recommendations provided in GSG-9 [35] and IAEA Safety Standards Series No. NS-G-1.13, Radiation Protection Aspects of Design for Nuclear Power Plants [37], within the context of issuing regulations and preparing bid specifications or contract negotiations.

2.243. The radiological environmental monitoring programme should be planned with the intent to verify that solid, liquid and gaseous radioactive releases from the operation of the nuclear power plant are kept as low as reasonably achievable and are satisfactorily controlled and monitored so that authorized limits on discharges are complied with. Training in radiation protection should be incorporated in the operating organization's systematic approach to training. Responsible individuals should be certified and periodically requalified. Non-radiological impacts may be addressed in separate documentation and may be submitted to a separate authority, as appropriate. The environmental monitoring should commence early to obtain accurate reference information on natural conditions with regard to baseline radiation and other conditions in the vicinity of the site selected for the nuclear power plant.

Phase 3

2.244. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 7 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 1–4, 6–16, 19–32 and Schedule III of GSR Part 3 [9];

(c) Requirements 25–27 of SSR-1 [15];
(d) Requirements 5, 78 and 79 of SSR-2/1 (Rev. 1) [16];
(e) Requirement 21 of SSR-2/2 (Rev. 1) [14];
(f) Paragraphs 301–303 of SSR-6 (Rev. 1) [17].

Action 114. The operating organization should establish a radiation protection programme, should continue implementing an environmental radiological monitoring programme and should prepare the corresponding chapters of the safety analysis report.

Action 115. The regulatory body should review and assess the operating organization's programmes with regard to radiation protection and relevant environmental protection and should verify compliance with the regulatory requirements.

Action 116. The regulatory body should ensure that arrangements are in place for the monitoring of all discharges from the nuclear power plant to the environment.

2.245. The radiation protection programme established by the operating organization should include arrangements for the control of contamination and for the monitoring of radiation levels inside the facility, releases of radioactive effluents and doses from occupational exposure. The objective of the radiation protection programme is to protect people, individually and collectively, by ensuring that doses to individuals remain within the relevant dose limits and are as low as reasonably achievable. Due consideration should also be given to the appropriate design and location of structures, systems and components as prerequisites for proper radiation protection (see Requirement 5 of SSR-2/1 (Rev. 1) [16]) and to the accuracy and reliability of the measuring equipment used for radiation monitoring.

2.246. Previous estimates of the radioactive discharges in operational states, as well as the radioactive releases in design basis accident and design extension conditions, should be confirmed when the final configuration of the plant is known.

2.247. Several IAEA Safety Guides [35, 38–40] provide recommendations on radiation protection programmes and radiation monitoring.

ACTIONS 117–121: SAFETY ASSESSMENT

General

2.248. Safety assessment should be carried out for a nuclear power plant to determine whether an adequate level of safety has been achieved for the plant and whether the safety objectives and safety criteria specified by the plant designer, the operating organization and the regulatory body have been met.

2.249. Safety assessment plays an important part throughout the lifetime of a nuclear power plant whenever decisions are made on safety issues.

2.250. Safety assessment should be a systematic process throughout the lifetime of the plant to identify radiation risks that arise for workers, the public and the environment during normal operation, in anticipated operational occurrences, and in accident conditions, including design extension conditions with core melting. The aim of the safety assessment is to determine whether adequate measures have been taken to control radiation risks to an acceptable level, with account taken of both the prevention of abnormal events and the mitigation of their consequences. The scope and level of detail of the safety assessment should increase as the design develops and as the way in which the plant will be operated is defined. Requirements for carrying out a safety assessment are established in IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), Safety Assessment for Facilities and Activities [10].

2.251. The operating organization has the responsibility for carrying out the safety assessment. It should be responsible for the method by which the assessment is performed and for the quality of the results.

2.252. A general understanding of the safety features of a nuclear power plant is required in order to make a knowledgeable decision on whether to embark on a nuclear power programme. A comprehensive safety assessment is required to support the decisions made by the operating organization on the design and operation of the plant. An independent safety assessment is also required by the regulatory body before issuing authorizations for the construction, commissioning and operation of the plant (see para. 3.15 of SF-1 [1]).

2.253. The safety assessment should cover all the scientific and technical issues that relate to the safety of the plant and the associated radiation risks. This includes the safety analysis, which consists of a set of different analyses for evaluating and assessing challenges to safety in various plant states, including anticipated

operational occurrences and accident conditions (including design extension conditions with core melting). The safety assessment uses both deterministic and probabilistic methods. As stated in GSR Part 4 (Rev. 1) [10]:

> "4.54. The aim of the deterministic approach is to specify and apply a set of deterministic rules and requirements for the design and operation of facilities or for the planning and conduct of activities. When these rules and requirements are met, they are expected to provide a high degree of confidence that the level of radiation risks to workers and members of the public arising from the facility or activity will be acceptably low. Conservatism in the deterministic approach compensates for uncertainties, such as uncertainties in the performance of equipment and in the performance of personnel, by providing a sufficient safety margin.
>
> "4.55. The objectives of a probabilistic safety analysis are to determine all significant contributing factors to the radiation risks arising from a facility or activity, and to evaluate the extent to which the overall design is well balanced and meets probabilistic safety criteria where these have been defined. In the area of reactor safety, probabilistic safety analysis uses a comprehensive, structured approach to identify failure scenarios. It constitutes a conceptual and mathematical tool for deriving numerical estimates of risk. The probabilistic approach uses realistic assumptions whenever possible and provides a framework for addressing many of the uncertainties explicitly. Probabilistic approaches may provide insights into system performance, reliability, interactions and weaknesses in the design, the application of defence in depth, and risks, that it may not be possible to derive from a deterministic analysis."

2.254. The safety assessment should be carried out by suitably qualified and experienced people who are knowledgeable in the relevant areas of science and technology and in all aspects of safety assessment and analysis that are required for the particular type of nuclear power plant to be built.

2.255. The safety assessment may be supported by a programme of research and development.

Phase 1

2.256. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 5, 6 and 8 of GSR Part 4 (Rev. 1) [10].

Action 117. The government should familiarize itself with the IAEA safety standards and with practices in other States, as appropriate, to gain an understanding of the resources and competences needed for the safety assessment.

2.257. The government should recognize the need to develop expertise in the relevant organizations in nuclear safety and safety assessment.

2.258. The government should engage in a dialogue with governmental organizations in other States and international organizations (e.g. IAEA, OECD Nuclear Energy Agency) so as to take account of developments in nuclear safety and safety assessment.

2.259. The government should consider the optimum ways of using safety assessments that have already been carried out by designers, operating organizations and regulatory bodies in other States, and by international organizations.

Phase 2

2.260. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 24–26 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 13 of GSR Part 3 [9];
(c) Requirements 1–6, 8 and 14–16 of GSR Part 4 (Rev. 1) [10].

Action 118. The operating organization, the regulatory body and external support organizations, as appropriate, should start to develop the expertise to conduct or review the safety assessments.

2.261. The operating organization and the regulatory body, together with the external support organizations, advisory bodies, research organizations, academic institutions, and specific experts or consultants, should start to develop their skills for safety assessment in all technical fields that are relevant for safety.

2.262. The development and use of the safety assessment should provide the framework for the production of the necessary information to demonstrate compliance with the relevant safety requirements and for the radiological environmental impact assessment that is carried out to support site evaluation and plant selection.

2.263. The operating organization, which has the prime responsibility for safety, should recruit and train personnel with the necessary skills and expertise to develop the safety analysis to be included in the safety analysis report or to assess the safety analysis report that will be provided by the vendor in the following phase. The result of the safety assessment should serve as an input into the operating organization's systematic approach to safety.

2.264. The operating organization and the regulatory body may need support from external support organizations or individuals with specialist skills in particular areas. External expert support is addressed in paras 2.133–2.171.

Phase 3

2.265. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 24–26 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 13 of GSR Part 3 [9];
(c) Requirements 1–24 of GSR Part 4 (Rev. 1) [10];
(d) Requirements 5 and 10 of SSR-2/1 (Rev. 1) [16];
(e) Requirement 12 of SSR-2/2 (Rev. 1) [14].

Action 119. The operating organization should perform comprehensive safety assessments of the nuclear power plant and should produce safety analysis reports to demonstrate that all relevant safety requirements have been met.

Action 120. The regulatory body should carry out a comprehensive review and an independent verification of the safety analysis reports submitted by the operating organization to verify compliance with the regulatory requirements.

Action 121. The operating organization and/or the regulatory body should obtain support from external support organizations or individual experts in performing or reviewing safety assessments, as necessary.

2.266. The operating organization should carry out a comprehensive safety assessment of the proposed design and operation of the plant as part of the preparation of the safety analysis report. This safety assessment should address nuclear safety and all radiation risks to workers, the public and the environment from the operation of the nuclear power plant. The safety assessment should demonstrate that these risks have been controlled and reduced to a level that is as low as reasonably achievable. The assessment should also demonstrate that the structures, systems and components, including the barriers incorporated into the design, fulfil the safety functions required of them and that adequate defence in depth and adequate safety margins have been provided in the design. Where weaknesses are identified in the design or in operation, improvements should be made to remedy them. The safety assessment should incorporate both deterministic and probabilistic approaches. The results of the safety assessment should also be used for preparing emergency plans.

2.267. The operating organization should conduct an assessment of the safety information and analyses provided by the vendor. The results of this assessment should be used by the operating organization in the preparation of the safety analysis report before submitting it to the regulatory body. This requires the use of appropriate assessment tools and the application of a management system. The assessment should include independent verification of the analyses provided by the vendor. This verification could be conducted either by the staff of the operating organization or by external support organizations.

2.268. The regulatory body should carry out a comprehensive review and independent verification of the safety analysis report to verify whether the regulatory requirements have been met or whether safety related improvements are required. This should be completed as a condition for the authorizations required for the construction and commissioning of the plant to proceed beyond the hold points defined in the licensing process.

2.269. In the design and construction phase, the contacts established between the vendor, the operating organization, the regulatory body and other organizations in the nuclear field should be used to identify improvements and to determine which of these improvements are applicable to the plant being built. Such improvements include any safety related improvements to meet national safety requirements, improvements that are being made at other plants (in particular at plants of the same design) and improvements in the tools that are available to carry out the safety assessment. Such contacts should also be used to identify relevant research activities and emerging nuclear safety issues.

2.270. An example of the format and content of the safety analysis report can be found in IAEA Safety Standards Series No. SSG-61, Format and Content of the Safety Analysis Report for Nuclear Power Plants [41].

ACTIONS 122–132: SAFETY OF RADIOACTIVE WASTE MANAGEMENT, SPENT FUEL MANAGEMENT AND DECOMMISSIONING

General

2.271. Paragraph 3.29 of SF-1 [1] states:

> "Radioactive waste must be managed in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management."

2.272. A State considering a nuclear power programme is likely already to be engaged in activities involving sources of radiation (e.g. research reactors, or industrial or medical applications of radiation) that require arrangements for the predisposal management and disposal of low level and intermediate level radioactive waste.

2.273. Implementation of a nuclear power programme will cause a significant increase in the volume and activity of the waste that will need to be safely managed and disposed of. High level radioactive waste with a very long half-life poses a challenge for radioactive waste management. In addition to high level radioactive waste, there may also be spent fuel for which no future use is foreseen.

2.274. Spent fuel management includes all activities relating to the handling and storage of spent fuel, whether or not it has been designated as radioactive waste. The designation will depend on whether the chosen nuclear fuel cycle is closed or open (i.e. whether the fuel cycle involves the reprocessing or the direct disposal of the spent fuel). In either case, storage of the spent fuel will be necessary. The time period for storage will be a significant factor in determining the provisions required for safety.

2.275. In some States, a dedicated organization is established for radioactive waste management. In other States, the operating organization takes care of the predisposal management and disposal of radioactive waste generated by its

nuclear power plants, or at least of the low level waste and intermediate level waste. If a decision is made to establish a dedicated organization for radioactive waste management, some of the tasks assigned to the operating organization in this Safety Guide could be under the responsibility of the organization for waste management. Irrespective of the State's decision as to the establishment of a dedicated waste management organization, the responsibility of the licensees has to be clearly defined. This implies that it has to be made clear in which steps the responsibility rests with the waste generator and in which steps this responsibility is transferred to a waste management organization.

2.276. The scope of this Safety Guide does not include nuclear fuel cycle facilities. However, if nuclear fuel cycle facilities form part of the nuclear power programme, the safety requirements established in IAEA Safety Standards Series No. SSR-4, Safety of Nuclear Fuel Cycle Facilities [42], should be met.

2.277. Financial aspects relating to the safety of radioactive waste management and spent fuel management are addressed in paras 2.120–2.132.

Phase 1

2.278. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 7 and 10 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Requirements 1 and 2 of GSR Part 5 [11];
(d) Requirements 1, 4, 5 and 9 of GSR Part 6 [12].

Action 122. The government should recognize the long term nature of the safety requirements for, and the cost implications of, radioactive waste management (including disposal of waste), spent fuel management and decommissioning.

Action 123. The government should consider the feasible options for radioactive waste management (including disposal of waste), spent fuel management and decommissioning on the basis of a comprehensive long term policy and strategy.

2.279. The availability of alternative options for managing high level radioactive waste, including its disposal or the return of spent fuel to the fuel supplier, should be considered before making a decision on embarking on a

nuclear power programme. For each option, the need to ensure long term safety and the uncertainty of cost estimates should be taken into account. It should be recognized that dependence on services in other States for spent fuel management, as included in some options, would increase the uncertainty of the cost estimate.

2.280. An important issue that should be considered in making a decision on the approach to radioactive waste management is the type of nuclear fuel cycle chosen. The options are an open fuel cycle with direct disposal of spent fuel or a closed fuel cycle in which the spent fuel is reprocessed and the high level waste arising from reprocessing has to be disposed of. The option that is chosen will have implications for the approach to waste disposal, for the costs of spent fuel management and, in the longer term, for the sustainability of the nuclear power programme. The decision to select a particular option depends on many factors, including cost and technical issues or matters of policy, including security. Regardless of the option selected, cost estimates for waste disposal should be made to assess the economics of nuclear power production and to be able to provide sufficient funds for radioactive waste management (see also paras 2.120–2.132).

2.281. The radiological impacts and costs of decommissioning a nuclear power plant should be part of the consideration of whether to implement a nuclear power programme. In addition to the waste generated during operation, large amounts of solid waste of low and very low activity concentration are produced in decommissioning activities. Specific requirements for decommissioning are established in GSR Part 6 [12].

Phase 2

2.282. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 7 and 10 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 2 and 31 of GSR Part 3 [9];
(c) Requirements 1–12 and 17 of GSR Part 5 [11];
(d) Requirements 1, 4–6, 8 and 9 of GSR Part 6 [12];
(e) Requirement 15 of GSR Part 7 [13];
(f) Requirements 35, 36 and 38 of SSR-2/1 (Rev. 1) [16];
(g) Requirement 21 of SSR-2/2 (Rev. 1) [14].

Action 124. The government and other interested parties, as appropriate, should establish the national policy and strategy for radioactive waste management, spent fuel management and decommissioning, and should set

the goals for its implementation to an appropriate schedule, including site investigations for the purposes of radioactive waste disposal.

Action 125. The government, together with the operating organization, should consider the need to establish a national organization responsible for radioactive waste management or to extend the organization for radioactive waste management if one already exists in the State.

Action 126. The regulatory body should establish the necessary regulatory requirements on radioactive waste management, spent fuel management and decommissioning, as necessary for bid specifications or contract negotiations.

Action 127. The operating organization should consider the arrangements that are necessary for ensuring the safety of radioactive waste management, the safety of spent fuel management and safety in decommissioning, and for minimizing the generation of radioactive waste.

2.283. Alternative storage and disposal strategies for low level, intermediate level and high level radioactive waste and for spent fuel should be studied during Phase 2. The studies should focus on the safety, feasibility and costs of alternative strategies. With regard to the disposal of low level and intermediate level radioactive waste, it should be decided whether the operating organization will do this on the site or whether there will be a national approach with a disposal facility, and possibly a dedicated organization to operate such a facility. This should be decided early enough that the processing facilities and storage facilities for low level and intermediate level radioactive waste can be taken into account in the design of the nuclear power plant. It should be ensured that optimum arrangements are made for the reduction of waste volumes to be performed on the plant site.

2.284. For long lived radioactive waste, high level radioactive waste and spent fuel, the government and the waste management organization should assess whether the management of radioactive waste and spent fuel can be provided for by means of national arrangements or whether assistance from other States is necessary. In general, national arrangements are feasible in an open nuclear fuel cycle with direct disposal of spent fuel. However, the use of a closed nuclear fuel cycle in a small nuclear power programme would probably require services to be rendered by a reprocessing organization in another State.

2.285. Although the disposal solutions with respect to low level, intermediate level and high level radioactive waste will probably not have been selected, the

government should ensure that the funding mechanisms are determined and that the costs are estimated as accurately as possible. This is so that an informed decision can be made on the funds to be allocated for the purposes of radioactive waste management.

2.286. Detailed regulations governing the back end of the nuclear fuel cycle are not necessary by the end of Phase 2, but work should be started to establish the policy and regulations governing activities such as the transport and storage of radioactive waste and spent fuel.

Phase 3

2.287. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 7 and 10 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 2 and 31 of GSR Part 3 [9];
(c) Requirements 1–20 of GSR Part 5 [11];
(d) Requirements 1, 4–6 and 8–10 of GSR Part 6 [12];
(e) Requirement 15 of GSR Part 7 [13];
(f) Requirements 35, 36 and 38 of SSR-2/1 (Rev. 1) [16];
(g) Requirements 21 and 33 of SSR-2/2 (Rev. 1) [14].

Action 128. The operating organization should prepare a programme for radioactive waste management and spent fuel management, as well as a programme for decommissioning management, in accordance with the national policy and strategy, and should prepare the corresponding chapters of the safety analysis report.

Action 129. The regulatory body should review and assess the operating organization's programmes for waste management and spent fuel management and for decommissioning and should verify their compliance with the regulatory requirements.

Action 130. The operating organization, and the radioactive waste management organization if applicable, should make their respective storage facilities fully operational and ready to receive radioactive waste and spent fuel from the nuclear power plant.

Action 131. The regulatory body should implement its regulatory oversight programme for facilities and activities for radioactive waste management and spent fuel management.

Action 132. All relevant organizations should be aware of international efforts and progress with regard to the disposal of radioactive waste.

2.288. Work should be started by the operating organization, and by the radioactive waste management organization if applicable, to determine and evaluate the sites and the arrangements that would be viable for the disposal of low level and very low level radioactive waste.

2.289. The processing facilities for low level and intermediate level radioactive waste should be incorporated, as necessary, into the nuclear power plant. It should be ensured that the arrangements for reducing the volume of waste and the arrangements for the packaging of waste are in accordance with the strategy for radioactive waste management. The facilities should be fully operational at the time of startup of the first reactor.

2.290. The mechanism for funding the decommissioning costs and the costs for radioactive waste management (including disposal of waste) should be established by legislation before the startup of the first reactor (see also paras 2.120–2.132).

ACTIONS 133–145: EMERGENCY PREPAREDNESS AND RESPONSE

General

2.291. Safety features incorporated into the design of nuclear power plants and an effective leadership and management for safety that foster a strong safety culture are necessary to achieve a very low probability of plant event sequences that could result in high radiation doses or in an early radioactive release or a large radioactive release. However, despite the high level of confidence that the occurrence of such sequences is extremely unlikely, the application of defence in depth requires additional barriers or other measures to mitigate the consequences of radioactive releases that could potentially result from accident conditions.

2.292. Emergency preparedness and response for the protection of human life, health, property and the environment, in accordance with Principle 9 of SF-1 [1], is an essential element of nuclear safety, as has been demonstrated in past emergencies.

2.293. Emergency arrangements need to be developed and implemented for adequate preparedness to respond effectively to a full range of postulated nuclear or radiological emergencies in relation to the nuclear power programme, including those of very low probability. These arrangements need to be based on a comprehensive hazard assessment to be performed in accordance with the requirements established in GSR Part 7 [13]. Further recommendations are provided in IAEA Safety Standards Series Nos GS-G-2.1, Arrangements for Preparedness for a Nuclear or Radiological Emergency [43], GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency [44], and GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency [45]. In addition, Ref. [46] considers the development of an adequate level of emergency preparedness and response for a State embarking on a nuclear power programme.

2.294. In addition to the specific roles and responsibilities of the regulatory body and the operating organization in relation to plant safety in general and to on-site emergency arrangements specifically, considerations of overall emergency preparedness and response will include response organizations at local, regional and national levels. These response organizations should be engaged as early as possible in the consideration of a nuclear power programme. During Phase 1, these organizations will be involved in: the evaluation of their existing capabilities in emergency preparedness and response; the identification of needs for the strengthening of their capabilities with regard to the nuclear power programme; and the development of an associated action plan. During Phases 2 and 3, these response organizations will be increasingly involved in the development of adequate arrangements in accordance with the action plan and their respective roles and responsibilities.

2.295. The full emergency arrangements in relation to the nuclear power programme should be established and tested in exercises conducted before the fuel is brought to the site.

2.296. The IAEA safety standards on emergency preparedness and response [13, 43–45] provide detailed requirements, recommendations and guidance for ensuring adequate preparedness and response for a nuclear or radiological emergency, irrespective of the cause.

Phase 1

2.297. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 7 and 8 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 43 of GSR Part 3 [9];
(c) Requirements 1 and 2 of GSR Part 7 [13].

Action 133. The government should develop awareness of the need for the early establishment of emergency plans.

Action 134. The government should identify response organizations and new arrangements for supporting emergency preparedness and response.

2.298. An appreciation of the need for emergency planning should be developed with the involvement of the entire community, including the public, local authorities and national organizations. Appropriate local and national organizations in the State, and the public, should be aware that emergency arrangements require the involvement of many organizations and complex interactions between those (mostly non-nuclear) organizations. During Phase 1, the need to agree on the allocation of responsibilities for developing arrangements for emergency preparedness and response should be recognized, as well as the need to agree on how these arrangements should be coordinated. A close examination of emergency planning options and costs should also be considered at this stage.

2.299. International cooperation plays a key role in emergency preparedness and response. Due consideration should be given at the national level to the steps by which a State becomes a Party to the Convention on Early Notification of a Nuclear Accident [19] and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [20].

Phase 2

2.300. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 7 and 8 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 43 and 44 of GSR Part 3 [9];
(c) Requirements 1, 2, 4, 5 and 20–23 of GSR Part 7 [13];
(d) Requirements 18 and 19 of SSR-2/2 (Rev. 1) [14];

(e) Paragraphs 304 and 305 of SSR-6 (Rev. 1) [17].

Action 135. The government should determine the national response organizations with responsibilities for emergency preparedness and response.

Action 136. The government should specify the general approach for emergency preparedness and response on the basis of the probability and severity of the emergency.

Action 137. The government should start implementing new arrangements as identified in Phase 1 for strengthening the infrastructure for emergency preparedness and response.

Action 138. The regulatory body should develop the regulations on emergency preparedness and response, as necessary for the development of infrastructure.

Action 139. The operating organization should start developing a general emergency preparedness programme for nuclear power plants.

2.301. During Phase 2, details of the implementation of the arrangements for emergency preparedness and response do not need to be in place, but implementation of the general approach for emergency planning should be started and development of a protection strategy should be initiated. These arrangements should cover, among other things:

(a) Basic legislation and regulations for emergency preparedness and response;
(b) Hazard assessment;
(c) Emergency plans, including concepts of operations and procedures;
(d) Procedures for emergency classification;
(e) Procedures for protecting emergency workers and helpers in an emergency;
(f) Procedures for providing public warnings, information and instructions;
(g) Procedures for the implementation of urgent and early protective actions and other response actions;
(h) Procedures for requesting and effectively using assistance resources from other identified organizations capable of augmenting the planned response;
(i) Procedures for medical response;
(j) Procedures for dealing with non-radiological consequences;
(k) Procedures for managing radioactive waste following the emergency;
(l) Guidelines for terminating the emergency and for analysis of the emergency and the emergency response;

(m) Procedures for effective communication;
(n) Procedures for effective radiation monitoring;
(o) Development of drill, training and exercise programmes.

2.302. Any gaps identified in existing emergency arrangements and in the capabilities of response organizations and communication networks at all levels should be filled. Alternatively, an action plan should be developed to fill any such gaps, with the implementation of this plan initiated in Phase 2 and completed in Phase 3. The operating organization should track the progress of training towards filling these gaps through a systematic approach to training.

2.303. The establishment of an effective emergency response organization should commence in Phase 2 as it can take a long time.

2.304. The operating organization, response organizations and the regulatory body should give due consideration to the requirements for preparedness and response for a nuclear or radiological emergency, as established in GSR Part 7 [13], and the respective guidance and recommendations provided in GS-G-2.1 [43], GSG-2 [44] and GSG-11 [45]. These considerations need to account for a sufficient number of emergency workers to respond to simultaneous emergencies on all units.

2.305. National activities to support the intention of becoming a Party to the Convention on Early Notification of a Nuclear Accident [19] and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [20] should be continued and should be completed as early as possible.

Phase 3

2.306. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 7 and 8 of GSR Part 1 (Rev. 1) [5];
(b) Requirements 43–46 and Schedule IV of GSR Part 3 [9];
(c) Requirements 1–26 and appendices I and II of GSR Part 7 [13];
(d) Requirement 18 of SSR-2/2 (Rev. 1) [14];
(e) Paragraphs 304 and 305 of SSR-6 (Rev. 1) [17].

Action 140. The regulatory body should establish detailed regulations on emergency preparedness and response.

Action 141. The operating organization should develop and implement an emergency plan and emergency procedures for the nuclear power plant and should put in place adequate arrangements to support preparedness for an effective response.

Action 142. The government and the regulatory body should develop and implement emergency plans and emergency procedures and should put in place adequate arrangements to support preparedness for an effective response at the local, national and, as appropriate, international levels.

Action 143. The government and the regulatory body should establish arrangements for coordination between the emergency plan of the nuclear power plant and the plans of the relevant response organizations that would be involved in emergency response.

Action 144. The regulatory body should review and assess the emergency plan and emergency procedures for nuclear power plants to the extent necessary to verify compliance with the regulatory requirements.

Action 145. The government, the regulatory body and the operating organization should demonstrate their emergency response capabilities by conducting appropriate exercises that include all the organizations concerned, the people who are potentially affected and representatives of the news media.

2.307. In Phase 3, by the time the nuclear fuel first arrives on the site, the development of emergency arrangements should be completed. These arrangements should be tested and/or exercised with local and national organizations and demonstrated to the regulatory body. Scenarios including the possible disruption of local and regional infrastructure should also be considered.

2.308. Programmes, plans and procedures for preparedness for a nuclear or radiological emergency should be implemented at the international, national, regional, local and operating organization levels. Emergency notification systems should be in place and should be thoroughly tested. The State should be responsible for establishing arrangements for coordination between the emergency plan of the nuclear power plant, the plans of the relevant national response organization involved in emergency response at all levels, and other States, consistent with the relevant IAEA safety standards, particularly GSR Part 7 [13], and international conventions [18–21].

2.309. The communication procedures and protocols for the chains of command and control between the various emergency centres of the operating organization, the local, regional and national authorities and the regulatory body should be developed, established and tested.

2.310. At this stage, the regulatory body should have reviewed and, as appropriate, approved the on-site emergency plans. The government, through the national coordination mechanism, should have reviewed and approved, as necessary, the respective emergency plans at local, regional and national levels. The government, through the national coordination mechanism, and the regulatory body should also have verified the adequacy and consistency of those plans in emergency drills and exercises conducted with the participation of local and national organizations and, if appropriate, organizations in other States and international organizations involved in response in all phases of an emergency.

3. IMPLEMENTING THE IAEA SPECIFIC SAFETY REQUIREMENTS FOR THE ESTABLISHMENT OF THE SAFETY INFRASTRUCTURE

ACTIONS 146–159: OPERATING ORGANIZATION

General

3.1. In a nuclear power programme, the safety related responsibilities of the operating organization include the following:

(a) Specifying the safety requirements for the plant design in accordance with national laws and regulations and appropriate international standards, and verifying that these requirements are met;
(b) Ensuring the quality of structures, systems and components of the plant;
(c) Ensuring that a knowledgeable workforce is acquired and maintained, including the plant operators and other plant staff;
(d) Ensuring the safe operation of the plant by implementing an adequate organizational structure, and allocating responsibilities and delegating authority within the organization to achieve proper management and to address interface issues, including interfaces between safety and security, and between maintenance and operations;

(e) Establishing safety policies and implementing management programmes for safe operation and verifying their effectiveness;
(f) Establishing and implementing a policy for personnel qualification, as well as programmes for the continuing training of staff;
(g) Establishing and implementing an appropriate policy on an individual's suitability for duty, and addressing the adequacy of the physical and mental fitness of all employees, contractors and visitors, as applicable;
(h) Establishing liaison with the regulatory body and other public authorities for the purposes of considering, understanding and ensuring compliance with regulatory requirements;
(i) Establishing liaison with organizations for design, construction, commissioning and manufacturing, and other organizations involved in the nuclear power programme, to ensure the proper understanding and transfer of information and experience;
(j) Providing resources, services and facilities to plant management and adequately supervising safety related work performed by contractors;
(k) Providing adequate information for the purposes of liaison and public relations;
(l) Ensuring the collection, evaluation, implementation and dissemination of operating experience;
(m) Ensuring that the decision making process gives adequate consideration to the selection of priorities and the organization of activities.

3.2. Principle 1 of SF-1 [1] states: "**The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.**" It is therefore the operating organization that has to meet the fundamental safety objective "**to protect people and the environment from harmful effects of ionizing radiation**" [1] by taking the measures stated in para. 2.1 of SF-1 [1], as follows:

> "(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."

3.3. The operating organization has a responsibility to demonstrate that the design, construction and operation of the nuclear power plant meet the applicable safety criteria defined in national regulations and/or approved by the regulatory body. In addition, the operating organization is responsible for the establishment

of procedures and arrangements for ensuring the safe control of the nuclear power plant under all conditions, for the establishment and maintenance of a competent staff with a strong safety culture, and for the control of the fissile material and radioactive material that is used or generated. These responsibilities should be discharged in accordance with applicable safety goals and the requirements established by or approved by the regulatory body.

3.4. SSR-2/2 (Rev. 1) [14] establishes requirements, and NS-G-2.4 [30] provides further recommendations and guidance, on how to set up an operating organization with a strong safety culture for high performance in terms of safety.

3.5. Staffing of the operating organization and the development of its management system are addressed in paras 2.196–2.217 on human resources development and paras 2.172–2.195 on leadership and management for safety.

Phase 1

3.6. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 5, 6 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 4 of GSR Part 3 [9];
(c) Requirements 1 and 4 of SSR-2/2 (Rev. 1) [14].

Action 146. If the operating organization has already been established or identified in Phase 1 (which is not the scenario developed in this Safety Guide, in which the operating organization is established at the beginning of Phase 2), it should be involved together with the government in activities for the development of the safety infrastructure from the beginning.

Action 147. The government should consider the financial resources and the necessary competences and staffing that are expected from an organization operating a nuclear power plant so as to ensure long term safety.

Action 148. The government should consider the different ways of establishing an operating organization so as to ensure long term safety.

3.7. In Phase 1, the prospective operating organization may not yet have been identified or established, and even if it exists, it is not expected to start activities on a broad basis. Nevertheless, a vision of the operating organization that is going to implement a future project should be defined, and potential forms of ownership

should be envisaged. In order to ensure that the future operating organization can discharge its responsibility for safety, a core group of the prospective organization should be established and should start early to plan and implement progressively all the necessary provisions, structures and procedures. The first goal is preparation for the bidding process or contract negotiations to take place by the end of Phase 2. An appropriate programme for human resources development for achieving this goal, and for continuing further with preparations for construction, should be planned in Phase 1.

3.8. Considerations in Phase 1 include topics such as:

(a) The capabilities and resources of existing electrical power producing companies to enter into the nuclear field;
(b) The safety implications of various contract options for nuclear power plants, such as turnkey, super turnkey, split package or multicontract approaches;[6]
(c) The possibilities of joint ventures with operating organizations in other States to strengthen safety capabilities, and the legal implications of such ventures;
(d) The possibilities of ownership by other States, and the legal implications of such ownership;
(e) The design authority function (see Action 177 and paras 3.60–3.83);
(f) The preliminary environmental impact assessment (both radiological and non-radiological).

3.9. These topics should be assessed together with the financial arrangements and the staff numbers and competences expected from the operating organization at all stages of the preparation and implementation of construction projects, as well as during operation, to provide for long term safety.

[6] In a turnkey project, a single contractor or a consortium of contractors takes overall technical responsibility for the entire work. In a super turnkey project, a single contract is placed for the entire nuclear power plant. The prime responsibility for the technical success of the project, and therefore for the design of the plant, is placed upon the contractor. In a split package project, the technical responsibility is divided between a relatively small number of contractors, each building a large fraction of the works. In a multicontract project, the owner or the architect–engineer assumes responsibility for the engineering of the plant and issues a large number of contracts.

3.10. In planning to establish the general structure of the operating organization, consideration should be given to four kinds of management function:

(a) Policy making functions, such as making investment decisions, setting management objectives, establishing a policy for nuclear safety and for quality, developing human resources, allocating resources, approving the contents of management programmes, and setting policies on fitness for duty;
(b) Operating functions, which include executive decision making and actions for the operation of the plant, both in operational states and in accidents;
(c) Support functions, which include obtaining from both on-site and off-site organizations the technical and administrative services and facilities necessary to perform the operating functions;
(d) Safety functions and quality management functions, which include review of the design and oversight of the construction, manufacturing and supporting functions, as well as the internal quality management processes of the operating organization.

Phase 2

3.11. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 5, 6 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 4 of GSR Part 3 [9];
(c) Requirements 1–5 of SSR-2/2 (Rev. 1) [14].

Action 149. The operating organization should be formed, if it has not already been formed, and it should be expressly assigned its prime responsibility for safety.

Action 150. The operating organization should appoint managers and key experts, should specify its organizational structure and should establish its policy for human resources development for discharging its responsibility for safety.

Action 151. The operating organization should establish an integrated management system in which safety is the overriding priority.

Action 152. The operating organization should establish a constructive working relationship with the regulatory body and with relevant national and international organizations, consistent with governmental policy.

Action 153. The operating organization should establish a process for bidding or contract negotiations and should specify the safety requirements to be included, consistent with national regulations.

Action 154. The operating organization should make provision to include matters relating to the transfer of safety knowledge in the bid specifications or contract negotiations, consistent with governmental policy.

3.12. The operating organization should recognize its prime responsibility for safety. Key management positions of the operating organization, or of a separate project organization for the nuclear power plant within an existing electrical power company, should be filled. The organizational structure and the staffing strategy of the operating organization should be the outcome of the assessment performed in Phase 1.

3.13. The operating organization ensures, in Phase 2, that it has a clear understanding of all relevant safety requirements (IAEA Safety Requirements and national safety requirements, if already established) and will have the necessary capabilities:

(a) To implement the project management on its own;
(b) To train and maintain its staff to ensure safe plant operation;
(c) To specify the site characteristics, including the external events and the features of the local infrastructure that should be taken into account in plant design;
(d) To gain an understanding of how to meet all safety requirements and to incorporate the safety requirements properly into the call for bids or contract negotiations;
(e) To specify the evaluation process for bids or contract negotiations, giving due importance to safety criteria;
(f) To assess, with the help of external support organizations, as necessary, the safety features of the plants being offered by vendors, and to explain the conclusions of the safety assessment to the regulatory body;
(g) To verify the capabilities of the potential vendor organizations, including the vendor's management system, in-house competences, practices and contractual arrangements in using subcontractors for major tasks and

equipment supplies, as well as the vendor's experience in managing large construction projects;

(h) To verify the preparedness of potential vendors to implement the project, including the maturity of the detailed design;

(i) To develop the operating organization's own effective and efficient integrated management system, including quality control, for construction and manufacturing, on the basis of good knowledge of national and international standards and requirements;

(j) To consider approaches to spent fuel management and radioactive waste management.

3.14. Provisions for effective knowledge transfer, including its funding, should be made, and it should be ensured that these provisions are properly incorporated into the agreements and commercial contracts associated with the nuclear power programme.

3.15. Cooperation between the main entities involved in the programme, as well as international organizations, is of paramount importance to the success of the nuclear power programme. Their efforts should be coordinated, and the operating organization is likely to play the lead role in coordinating the main partners.

3.16. It is recognized that in some States the operating organization may not be the eventual legal owner of the nuclear power plant. Where this is the case, the roles and responsibilities of each organization should be clearly defined. However, the prime responsibility for safety rests with the authorized party that becomes the operating organization of the nuclear power plant.

Phase 3

3.17. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 5, 6 and 11 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 3 of GSR Part 2 [8];
(c) Requirement 4 of GSR Part 3 [9];
(d) Requirement 2 of GSR Part 7 [13];
(e) Requirement 1 of SSR-2/1 (Rev. 1) [16];
(f) Requirements 1–32 of SSR-2/2 (Rev. 1) [14];
(g) Requirements 58, 63 and 68 of SSR-4 [42].

Action 155. The operating organization should implement, as part of its integrated management system, a safety policy that includes goals and objectives that give safety matters the highest priority.

Action 156. The operating organization should give primary consideration to safety aspects during the evaluation of bids or contract negotiations.

Action 157. The operating organization should, in coordination with the vendor as necessary, prepare all the safety documentation as required in the licensing process for submission to the regulatory body.

Action 158. The operating organization should develop all necessary programmes for operational management (including programmes for operations, maintenance and training) and should submit them to the regulatory body, as appropriate.

Action 159. The operating organization should ensure completion of the construction of the nuclear power plant in accordance with the design basis licence conditions, and with primary consideration given to safety aspects.

3.18. A clear safety policy emphasizing the priority to be given to safety over the demands of production and project schedules should be developed by the operating organization and should be communicated to its own personnel and to all contractors. The safety policy should demonstrate the commitment of the management to high performance in terms of safety. It should be supported by the provision of the resources necessary to achieve the safety targets and quality targets.

3.19. The operating organization should actively foster a strong safety culture among its own personnel and among contractor organizations.

3.20. During Phase 3, the operating organization should grow progressively larger. The organization should plan for the rapid change in its size, functions, responsibilities, organization and management techniques. Training of all staff should be systematically designed, delivered and evaluated. The growth and the change should be achieved while the safety culture continues to be developed throughout the organization. The organization will undergo a transition in focus from construction oriented to operation oriented during Phase 3.

3.21. The description of the structure and of the functions to be performed by the individual departments in the operating organization, on the site and off the

site, and by individuals in each department, as well as the lines of responsibility, authority and communication, should be unambiguous.

3.22. In the evaluation of bids or negotiation of contracts, the operating organization should ensure that the proposed designs comply with the national safety requirements.

3.23. Irrespective of the type of contract, the operating organization should verify the quality of structures, systems and components, in accordance with its responsibility for safety.

3.24. The operating organization should prepare all the documentation required for obtaining the necessary licences in accordance with the regulatory requirements. Depending on the national licensing process, this may include:

(a) Safety analysis reports (see paras 2.248–2.270 on safety assessment).
(b) Probabilistic safety analyses (which might be included in the safety analysis report).
(c) Operational limits and conditions (which might be included in the safety analysis report). The operation of the nuclear power plant should be controlled in accordance with a set of operational limits and conditions, derived from the safety analysis, which identify the boundaries of safe operation. The application of these operational limits and conditions is intended to prevent conditions arising that could lead to accidents and to mitigate the consequences of any such accidents, if they do occur. Operational limits and conditions are developed as part of ensuring that the plant is operated in accordance with the design assumptions and design intent as well as with its licence conditions.

3.25. The operating organization should also be prepared to manage the licensing process, including providing any additional information requested by the regulatory body during the course of the licensing process (often the review of the safety analysis report generates a large number of requests for additional information).

3.26. As required by SSR-2/2 (Rev. 1) [14], it is the responsibility of the operating organization to develop operating procedures and a range of management programmes important to safety. Procedures should be developed for normal operation, as well as to control anticipated operational occurrences and accident conditions (including design basis accidents and design extension conditions without significant fuel degradation). Specific guidelines should be developed for design extension conditions without significant fuel degradation and for

design extension conditions with core melting, including for accident conditions affecting the spent fuel pool. As described in NS-G-2.4 [30], the areas to be covered by various management programmes for the safe operation of the plant should include the following:

(a) Staffing (see paras 2.196–2.217 on human resources development);
(b) Qualification and training (see paras 2.196–2.217 on human resources development);
(c) Commissioning (see paras 3.84–3.95);
(d) Plant operations (in conjunction with the operational limits and conditions);
(e) Maintenance;
(f) In-service inspection;
(g) Surveillance;
(h) Fuel management;
(i) Chemistry;
(j) Safety analysis and review;
(k) Radiation protection (see paras 2.233–2.247);
(l) Industrial safety;
(m) Waste management (see paras 2.271–2.290 on safety of radioactive waste management, spent fuel management and decommissioning);
(n) Environmental monitoring (see paras 2.233–2.247 on radiation protection and paras 3.28–3.59 on site survey and site evaluation);
(o) Emergency preparedness (see paras 2.291–2.310 on emergency preparedness and response);
(p) Fire safety;
(q) Quality assurance (see paras 2.172–2.195 on leadership and management for safety and paras 2.133–2.171 on external support organizations and contractors);
(r) Human factors;
(s) Feedback on operating experience;
(t) Plant modifications (see paras 3.60–3.83 on design safety);
(u) Document control and records (see paras 2.172–2.195 on leadership and management for safety);
(v) Management of ageing;
(w) Decommissioning (see paras 2.271–2.290 on safety of radioactive waste management, spent fuel management and decommissioning).

3.27. Operating experience should be considered during construction and commissioning to incorporate any required design changes before operation. The operating organization should perform periodic evaluations of the operating experience and submit or make available the results to the regulatory body, as

appropriate. The operating organization should ensure that any reasonably practicable safety improvements identified in the review are implemented in a timely manner, consistent with regulatory requirements.

ACTIONS 160–169: SITE SURVEY AND SITE EVALUATION

General

3.28. Principle 8 of SF-1 [1] states that "**All practical efforts must be made to prevent and mitigate nuclear or radiation accidents**", and para. 3.31 of SF-1 [1] states that "The primary means of preventing and mitigating the consequences of accidents is 'defence in depth'." The implementation of defence in depth includes adequate site selection, as described in para. 3.32 of SF-1 [1].

3.29. The site survey and site evaluation process for a new nuclear installation is divided into five stages (see Fig. 5). In the first stage ('site survey'), usually large regions are investigated to find potential sites and candidate sites on the basis of available data (Phase 1). In the second stage ('site selection'), the candidate sites are compared and ranked on the basis of safety and other criteria. In the third stage ('site assessment'), detailed site characterization is performed and the site related parameters necessary for the design of the nuclear power plant are derived (Phase 2). In the fourth stage ('pre-operational'), the site is confirmed on the basis of site monitoring and detailed information obtained during site preparation for construction (Phase 3). Site monitoring and periodic re-evaluation of site hazards and site parameters continue during the fifth stage (operational stage, Phase 4).

3.30. The site evaluation process starts after the site survey stage and should be continued throughout the lifetime of the nuclear power plant (Phases 3 and 4) to take into account changes in the site characteristics and associated environmental impacts, in evaluation methodologies and in safety standards (see Fig. 5). Site evaluation is usually divided into four stages: site selection, site characterization, pre-operational and operational.

3.31. The emphasis on safety aspects during the site survey stage (Phase 1) evolves with time. As the process progresses to screen out more and more potential sites (and therefore to retain only a few candidate sites), the safety aspects become more important. The data collected and the methods used for these few sites should all be treated and scrutinized with similar care, because these data will be used in the subsequent stages of the licensing process for the site that is finally selected (i.e. the preferred candidate site).

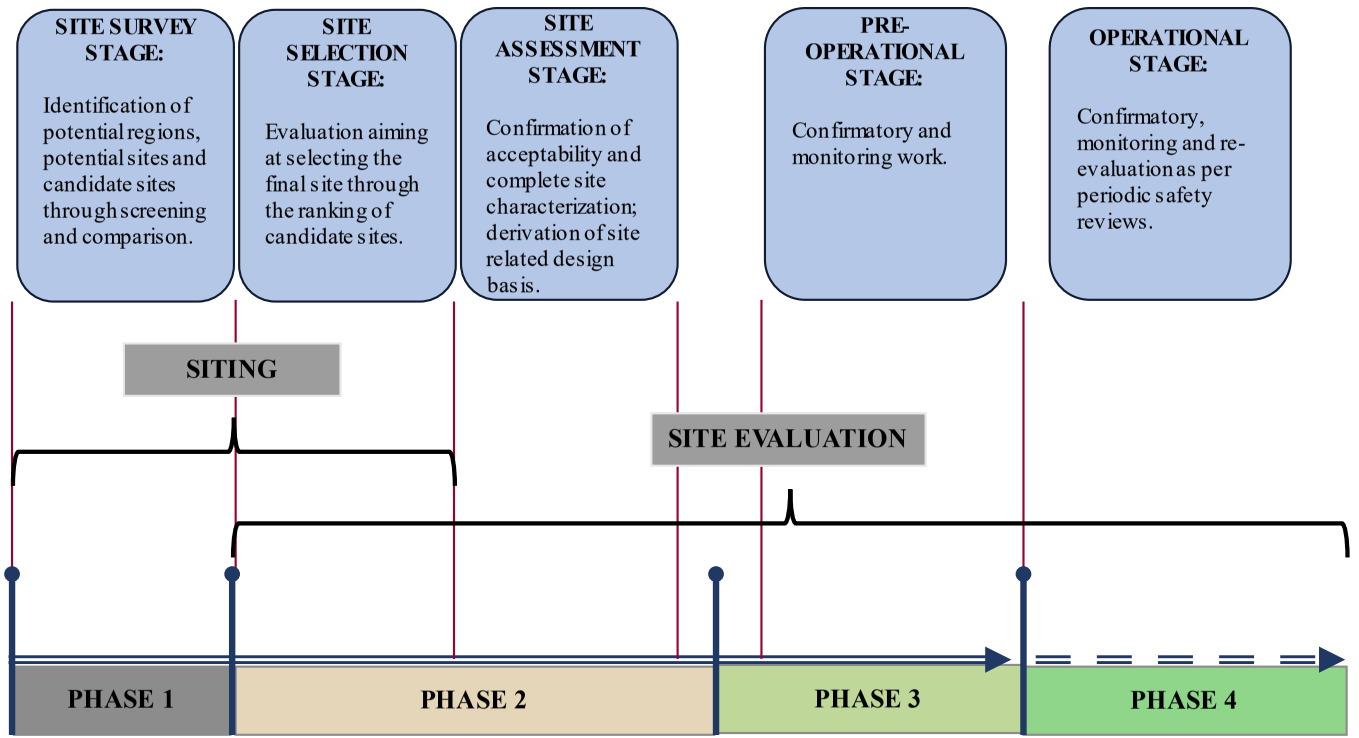

FIG. 5. The consecutive stages of site survey and site evaluation.

3.32. During Phase 2, after the site selection stage, the confirmation of acceptability of the site and a complete site characterization are performed in the site characterization stage. This process precedes the preparation of the site evaluation report. The site evaluation report should be approved by the regulatory body.

3.33. After approval of the site evaluation report by the regulatory body, confirmatory work and site monitoring should be continued throughout the pre-operational stage (Phase 3).

3.34. A periodic review of site specific hazards should be performed, and the findings of the review should be used to re-evaluate the safe operation of the nuclear installation.

Phase 1

3.35. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 31 of GSR Part 3 [9];
(b) Requirements 1–27 of SSR-1 [15].

Action 160. The government should ensure that potential sites are identified and candidate sites are selected on the basis of a set of defined criteria, at a regional scale and with the use of available data.[7]

3.36. In accordance with Principle 8 of SF-1 [1], and in order to enable an informed policy decision to be made at the end of Phase 1 on whether to introduce a nuclear power programme, it should be determined whether suitable sites are available for a nuclear power plant. A general survey should be conducted at the national and regional scale, on the basis of data, information and documentation that are already available, to determine the availability and acceptability of such sites. The public should be involved at these early stages. The objectives of this phase cannot be fulfilled if no suitable sites are available on the basis of established safety criteria.

[7] If the operating organization is already established or identified in Phase 1 (which is not the scenario developed in this Safety Guide, in which it is established at the beginning of Phase 2), it should be involved in the site survey.

3.37. A set of criteria relating to the acceptability and comparison of sites should be identified from the beginning of Phase 1. Safety related aspects and non-safety related aspects should be properly taken into account. This will provide for the development of the site selection and site evaluation processes during the subsequent phases and avoid having to revert to earlier steps because of a lack of suitable available sites.

3.38. While exclusion criteria in relation to safety are well defined in accordance with IAEA Safety Standards Series No. SSG-35, Site Survey and Site Selection for Nuclear Installations [47], the criteria for comparison of the candidate sites might differ from State to State — and from one phase to another — on the basis of the results obtained and the iterative nature of the process.

3.39. The criteria should provide for a consistent set of boundary conditions for a variety of considerations (e.g. safety considerations, development and societal needs, security considerations, historical and archaeological conditions) that will exclude unacceptable sites in the early stages of the siting process. This will leave for further consideration only those sites that fulfil the acceptability conditions.

3.40. The requirements for safety conditions for site evaluation for nuclear installations are established in SSR-1 [15], and recommendations are provided in SSG-35 [47].

3.41. Each site has specific characteristics that should be taken into account in adapting the design of the nuclear power plant. These characteristics, which could represent risks for the plant, include natural hazards such as earthquakes and surface faulting, meteorological events, flooding, geotechnical hazards and the potential combination of such events. They also include human induced hazards due to nearby industrial activities or transport routes. The risk of malicious acts might also be (to some extent) site dependent (e.g. some site features might provide protection against malicious acts).

3.42. The expected impact of the plant on the public and the environment, in terms of the consequences of radioactive discharges in operational states and potential radioactive releases in accidents, should be considered. This requires a preliminary analysis of the dispersion of radioactive material through the atmosphere, surface water and groundwater. The prospective population distribution should also be analysed, and dietary habits, as well as the uses of land and water in the region, should be characterized. This preliminary analysis is to raise the awareness of the possible radiological impacts to the environment that need to be addressed during Phase 2 through the environmental impact assessment process. This should be

done as part of the radiological environmental impact assessment addressed in paras 2.233–2.247 on radiation protection.

3.43. With regard to the conditions that are not directly related to safety, the criteria to be established include national needs and specific local needs in all the relevant aspects (e.g. legal aspects, archaeological and historical aspects, economics and social development, land use, energy distribution networks, accessibility and availability of local infrastructure, public acceptability, proximity to industrial and military centres).

Phase 2

3.44. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 31 of GSR Part 3 [9];
(b) Requirements 1–27 of SSR-1 [15].

Action 161. The regulatory body should establish specific safety requirements for site evaluation, including requirements for the process of authorizing the site selected, in compliance with the relevant IAEA safety standards.

Action 162. The operating organization should complete the investigations relating to the acceptability of the candidate sites and should select the preferred candidate site for the first nuclear power plant, making use of specific data, information and studies, as well as assessments conducted on the fullest possible temporal and spatial scales of investigation.

Action 163. The operating organization should prepare the site evaluation report and should submit it to the regulatory body on the basis of a full assessment of the site selected and including the confirmation of site acceptability and the characterization of the site for the definition of the site related design basis parameters.

Action 164. The regulatory body should review and assess the site evaluation report and should make a decision with regard to the acceptability of the site selected and the site related design basis.

Action 165. The operating organization should use all the appropriate information relevant to safety and to regulatory control that relates to or is

derived from the site characterization to prepare the bid specifications or to negotiate a contract for the first nuclear power plant.

Action 166. The operating organization should start to evaluate and modify the site and the radiological environmental monitoring programme, as necessary, after the site evaluation report has been approved.

3.45. The licensing process by the regulatory body should be well defined to provide the operating organization with a clear indication of the stages and the requirements of the regulatory processes (e.g. review and approval of the site evaluation report, issuance of a site permit).

3.46. Two main stages are implemented during Phase 2 as follows:

(a) Comparison and ranking studies of the candidate sites, focusing on a number of sites as identified, selected and preliminarily ranked in Phase 1;
(b) A detailed evaluation and assessment, focusing on the selected site and making use of specific data, information and studies, as well as assessments conducted on a large scale of investigation, both temporal (e.g. prehistoric, historical and instrumental time periods) and spatial (e.g. regional, near-regional, site vicinity and site areas).

3.47. To be ready to invite bids or to negotiate a contract for the first nuclear power plant during Phase 2, the assessment of the candidate sites — which were identified, screened and compared in Phase 1 — should be completed by means of a specific evaluation process for ranking each site and selecting the preferred candidate site following the site selection stage. This site selection stage is followed by the site characterization stage. At this stage, a full, specific and detailed evaluation of the selected site is carried out to confirm its acceptability, to derive the site related design basis and to prepare the radiological environmental impact assessment, as well as the non-radiological impact assessment (e.g. impacts of thermal discharges, chemical discharges) in accordance with the national regulatory framework. This is done by means of detailed evaluation studies and investigations that are specific to the site and commensurate with the objectives of Phase 2 of being ready to invite bids or to negotiate a contract.

3.48. The operating organization should define in the early stages of the site selection process the maximum nuclear capacity to be installed at the site. The assessment of emergency plans should consider collocated nuclear installations with special emphasis on those that could experience concurrent accidents.

3.49. In accordance with the requirements of SSR-1 [15] and with regard to the potential radiological impacts on the region for operational states and for accidents warranting emergency response measures, an estimate should be made of expected releases of radioactive material. Since the design of the plant and its safety features might not be known in Phase 2, the potential releases should first be estimated using generic and bounding values and should be updated later in Phase 3 when the design and safety features are known.

3.50. During Phase 2, all site evaluation tasks should be conducted in accordance with the requirements established in SSR-1 [15] and the recommendations provided in Refs [48–54] on site evaluation.

3.51. Information on frequency and severity derived from the characterization of the hazards resulting from external events is required to establish the design basis hazard level for the nuclear installation, taking into account uncertainties in the design basis hazard level.

3.52. The site characterization process should lead to the preparation by the operating organization of the site evaluation report, which includes confirmation of site acceptability and complete site characterization. This should be used as the basis for the chapter on site evaluation in the safety analysis report in Phase 3. In some States, the site evaluation report is called a site safety report.

3.53. The operating organization should identify necessary improvements to the site (to be built in Phase 3) that are important to safety, such as site protection measures against external hazards (e.g. external floods, groundwater level, hydrogeological conditions), provision of an ultimate heat sink, road access, communications and water supplies, which might also have an impact on the implementation of emergency plans. Items important to safety should not be compromised by disturbances in the external electrical power grid.

3.54. The regulatory body should engage in intensive interactions with the public, in particular with the local population, and with local organizations and local authorities.

3.55. An environmental monitoring programme around the power plant site should be started well before commissioning of the plant to obtain reference data on the radioactive isotopes found in the environment before operation of the plant is commenced. These data can later be used when identifying radioactive isotopes that might have been released from the nuclear power plant.

Phase 3

3.56. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 31 of GSR Part 3 [9];
(b) Requirements of SSR-1 [15] as a whole.

Action 167. The operating organization should prepare the chapter on site evaluation in the safety analysis report and then update it, taking into account the specificities of the nuclear power plant selected and the data and information gathered during the pre-operational stage.

Action 168. The operating organization should implement necessary safety improvements to the site, as site protection measures determined as a result of the external hazard assessment.

Action 169. The operating organization should continue to implement the environmental programme and the site monitoring programme.

3.57. Requirement 28 of SSR-1 [15] states:

> "**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.**"

3.58. Paragraphs 7.4 and 7.5 of SSR-1 [15] state:

> "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)...
>
> "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."

3.59. Activities for radiological environmental impact assessment or environmental monitoring are addressed in paras 2.233–2.247 on radiation protection.

ACTIONS 170–184: DESIGN SAFETY

General

3.60. Principle 8 of SF-1 [1] states that "**All practical efforts must be made to prevent and mitigate nuclear or radiation accidents**", and para. 3.31 of SF-1 [1] states that "The primary means of preventing and mitigating the consequences of accidents is 'defence in depth'."

3.61. Requirements for the design of nuclear power plants are established in SSR-2/1 (Rev. 1) [16]. The key safety principles and issues that should be taken into account in the design include:

(a) The concept of multiple barriers and defence in depth for the prevention and mitigation of accidents and the independence of safety provisions for different levels of defence in depth;
(b) The concept of deterministic analysis for design safety, failure criteria, redundancy, diversity and physical separation;
(c) The concept of postulated initiating events and minimization of the plant's sensitivity to such events;
(d) The concepts of design basis accidents and design extension conditions;
(e) The practical elimination of event sequences that could lead to an early or large radioactive release;
(f) Design with sufficient margins or protection of items important to safety against internal and external hazards, with consideration of the potential for specific hazards to impact several units at the site simultaneously;
(g) High reliability of heat transfer to an ultimate heat sink including during conditions generated by natural hazards more severe than those derived from the site evaluation;
(h) Design features to enable the safe use of non-permanent equipment for cooling and power supply;
(i) The systematic consideration of human factors, including the human–machine interface;
(j) Verification of a balanced design by means of probabilistic analyses;
(k) Safety classification of structures, systems and components and the correlation of safety classes with requirements on quality and reliability;

(l) The use of proven codes and standards for the design of structures, systems and components;
(m) Active versus passive safety functions;
(n) Safety aspects of structures, systems and components important to safety, such as the reactor core, the reactor cooling system, the containment, the emergency power system and the instrumentation and control systems.

3.62. Other factors that should be considered in the design include:

(a) Optimization of radiation protection (for occupational and public exposure);
(b) Minimization of the generation of radioactive waste;
(c) Feasibility of decommissioning.

3.63. The codes and standards that are used by different vendors in the design of structures, systems and components depend on the State of origin. A high level of safety can be achieved by the consistent application of codes and standards, together with the use of national practices for quality assurance. Paragraph 4.15 of SSR-2/1 (Rev. 1) [16] states:

> "National and international codes and standards that are used as design rules for items important to safety shall be identified and evaluated to determine their applicability, adequacy and sufficiency, and shall be supplemented or modified as necessary to ensure that the quality of the design is commensurate with the associated safety function."

The vendor usually proposes a set of codes and standards. The operating organization and the regulatory body should assess the applicability of those codes and standards and their consistency with national safety requirements.

3.64. The maturity of the national technical infrastructure is an important factor that should be considered in ensuring the safety of the operation of a nuclear power plant. A nuclear power plant does not exist in isolation; the safe and reliable operation of the plant should be supported by a number of external factors. These include the reliability of external electrical power grids and water supplies. These external factors should be taken into account in the design. One vital factor for the safety of a nuclear power plant is the reliability of the external electrical power grid.

Phase 1

3.65. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements of SSR-2/1 (Rev. 1) [16] as a whole.

Action 170. The government should understand the objectives for nuclear safety and how they are taken into account in nuclear power plants of various designs.

Action 171. The government should consider the availability of the technical infrastructure and the reliability of the national power grid and should consider their potential impact on the design requirements for the safety of the nuclear power plant.

3.66. Individuals that are to be involved in the nuclear power programme should acquire knowledge of the principal technical requirements given in SSR-2/1 (Rev. 1) [16], as well as the features of the various nuclear reactor technologies. It is not necessary to include a lot of technical detail in this phase, but the main features and principles of safety in design should be understood.

3.67. The supply of electrical power is a vital service for a nuclear power plant, and the reliability of the power supply depends mostly on the reliability of the external grid. The stability of the grid should be sufficient to minimize electrical disturbances that could result in a reactor trip.

3.68. The reliability of on-site emergency and alternate power sources also depends on external elements such as the provision of high quality industrial products (e.g. diesel fuel, fluids including oils, gases). Among other factors contributing to safety are the supply chain for spare parts and consumables, and access to a skilled workforce. The reliability of the technical infrastructure should be assessed, and compensatory measures should be planned as necessary.

Phase 2

3.69. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 5, 15, 16 and 29 of GSR Part 3 [9];
(b) Requirements of SSR-2/1 (Rev. 1) [16] as a whole;

(c) Requirements 15 and 16 of SSR-4 [42].

Action 172. All relevant organizations should obtain an in-depth understanding of the safety principles and safety requirements applicable in the design of a nuclear power plant.

Action 173. The operating organization should conduct a thorough market survey of the available nuclear power technologies and should investigate their safety features.

Action 174. The regulatory body should prepare and enact national safety regulations on design that are necessary for bid specification or contract negotiations.

Action 175. The government and the operating organization, as applicable, should start to implement plans for improving the national technical infrastructure, as necessary, to fill in previously identified gaps in the capabilities necessary for ensuring safety.

Action 176. The operating organization should include in the bid specification or contract negotiations all the safety and regulatory aspects that should be considered in the design, with account taken of the status of the national technical infrastructure.

3.70. In the preparation of bid specifications or contract negotiations, the operating organization should take into account the information identified in the site evaluation to make sure that it is adequately reflected in the design basis for structures, systems and components.

3.71. The call for bids or contract negotiations should stipulate that potential vendors specify the codes and standards that they are planning to use and confirm that these codes and standards meet the safety requirements included in the bid specifications or contract negotiations.

3.72. At this stage of the process, the decisions that should be made typically include the type of nuclear power plant to be built, including its main safety characteristics, the specification of any additional safety features that should be incorporated into the design, and the choice of site on which the plant will be built.

3.73. During Phase 2, the government and the operating organization should develop plans for improving the national technical infrastructure, as feasible,

and should start implementing these plans. In so doing, they should ensure that, among other things, the national electricity system will be capable of withstanding the sudden loss of the largest generating unit (and also its prolonged scheduled maintenance) without compromising the safety of the nuclear power plant. The necessary funding should be allocated for this purpose, with the objective of completing the necessary improvements before the commissioning of the nuclear power plant.

3.74. When the supply of external services cannot be ensured with adequate reliability, compensatory measures should be planned and taken into account in the bid specifications or contract negotiations, since these measures might have impacts on the safety of the plant design. These compensatory measures could involve the strengthening of certain plant systems with respect to reference plants or generic plant designs.

3.75. The interfaces between safety and nuclear security should be considered as part of the design process. These interfaces should be considered in such a way that the impacts of safety on security and the impacts of security on safety are taken into account from the design stage onwards and an appropriate balance is achieved. Safety measures and security measures should be designed and applied in an integrated manner, and as far as possible in a complementary manner, so that security measures do not compromise safety and safety measures do not compromise security.

Phase 3

3.76. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirements 5, 15, 16 and 29 of GSR Part 3 [9];
(b) Requirements of SSR-2/1 (Rev. 1) [16] as a whole;
(c) Requirements 10 and 11 of SSR-2/2 (Rev. 1) [14];
(d) Requirements 15 and 16 of SSR-4 [42].

Action 177. The operating organization should establish a 'design authority' that will maintain the knowledge of the safety design and its configuration management over the lifetime of the plant.

Action 178. The operating organization should conduct an adequate safety review of the designs proposed by the vendors in the submitted bids or

contract negotiations, including an assessment of the associated sets of codes and standards.

Action 179. The operating organization should establish proper interaction with the selected vendor for the preparation of the safety documents.

Action 180. The government and the operating organization should ensure the completion of all the required improvements of the national technical infrastructure consistent with the plant design.

Action 181. The operating organization should prepare and provide to the regulatory body the safety documents required in the licensing process.

Action 182. The regulatory body should review and assess the safety documentation, such as the safety analysis report, and should verify the compliance of the design with regulatory requirements.

Action 183. The operating organization should ensure the adequate validation and verification of the design of the nuclear power plant and its structures, systems and components, and the regulatory body should review this validation and verification.

Action 184. The operating organization and the regulatory body should implement their respective processes to address modifications made to the design during construction and afterwards.

3.77. When evaluating bids or in contract negotiations, the operating organization should verify that the proposed designs satisfy the national safety requirements.

3.78. Although a comprehensive design review before the acceptance of a bid or contract is not a widespread practice, the operating organization should conduct an adequate design verification of the submitted bid or contract proposal so as to provide confidence that the main design features are in compliance with the respective safety requirements, including those relating to qualified personnel.

3.79. Once the bid or contract proposal has been accepted, finalization of the design and preparation of a safety analysis report should start early in Phase 3. The safety analysis report should be prepared in accordance with the format and content specified in the national regulations or as agreed with the regulatory body.

3.80. All improvements of the national technical infrastructure consistent with the plant design, such as the reliability of the electrical power supply, the availability of diesel fuel and the availability of spare parts for the safe operation of the nuclear power plant, should be completed. The operating organization should establish proper coordination with the management organization of the electrical power grid and should test the reliability of the external grid.

3.81. Early in Phase 3, the operating organization should submit the safety analysis report to the regulatory body, together with the application for construction. A radiological environmental impact assessment should be submitted at the same time. The safety related construction activities on the site cannot commence until a construction licence has been granted.

3.82. The regulatory body should review the safety analysis report, and supporting documentation as necessary, to verify that the design requirements established in the national regulations for the safe operation of the nuclear power plant and for preventing safety related incidents and accidents — or for mitigating their consequences — are met. The review of the safety analysis report will take time, and the review schedule should be discussed and agreed (to the extent possible) between the regulatory body and the operating organization.

3.83. At this stage, a process should be specified by means of which the changes in design made during construction of the plant can be considered, with the involvement of the regulatory body where appropriate. The operating organization should establish a procedure to ensure the proper design, review, control and implementation of any permanent or temporary modifications. This procedure should be followed to ensure that the design basis for the plant is maintained, that limits and conditions are observed, and that applicable codes and standards are met. These modifications should be taken into account in the safety analysis report.

ACTIONS 185–188: PREPARATION FOR COMMISSIONING

General

3.84. Phase 3 ends just before the beginning of commissioning tests: consequently, commissioning activities are beyond the scope of this Safety Guide. However, some activities in preparation for commissioning are conducted in Phase 3.

3.85. By the end of Phase 3, the entire safety infrastructure necessary to operate the nuclear power plant should be in place in compliance with the relevant IAEA safety standards and national regulations.

3.86. IAEA Safety Standards Series No. SSG-28, Commissioning for Nuclear Power Plants [55], provides recommendations on all steps of the commissioning stage.

Phase 3

3.87. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 25 of SSR-2/2 (Rev. 1) [14].

Action 185. The regulatory body should issue requirements on commissioning, including the establishment of a severe accident management programme.

Action 186. The operating organization should establish a comprehensive commissioning programme, should prepare the corresponding chapter of the safety analysis report, as appropriate, and should ensure that there are a sufficient number of competent operating staff to be involved in commissioning activities.

Action 187. The operating organization should establish mechanisms for the transfer of responsibilities for safety with the constructor at the end of Phase 3.

Action 188. The regulatory body should review and assess the commissioning programme, should verify compliance with requirements and should prepare a programme to oversee the commissioning of systems important to safety in the next phase.

3.88. The regulatory body should establish requirements concerning commissioning, which might include the establishment of hold points beyond which the operating organization cannot proceed without the approval of the regulatory body, such as:

(a) Overall cold and hot system performance tests;
(b) Fuel loading;
(c) First criticality and zero power tests;

(d) Power tests on different levels;
(e) Trial operation;
(f) Commercial operation.

3.89. The operating organization should develop a commissioning programme so as to provide evidence that the plant as built meets the design intent and complies with safety requirements. Operating procedures should be validated to the extent practicable as part of the commissioning programme, with the participation of the operating personnel of the nuclear power plant. The operating personnel should be trained through participation in the operating organization's systematic training programme and by being present on the site during the construction phase.

3.90. Commissioning includes both non-nuclear and nuclear tests. Nuclear tests are performed with nuclear fuel in the core and consist of fuel loading tests, first criticality tests, zero power level tests, power escalation tests at different power levels, and trial operation.

3.91. On account of its responsibilities in the subsequent operating phase of the plant, the operating organization should verify that the commissioning programme checks the characteristics of the plant as exhaustively as possible. In particular, the commissioning programme should:

(a) Confirm that the plant as built is consistent with the provisions of the safety analysis report, and record baseline data — to be used later as reference data — on the performance of structures, systems and components;
(b) Ensure that the plant meets the requirements of the regulatory body;
(c) Demonstrate the validity of the operating instructions and procedures, and provide an opportunity for the operating personnel to learn operating skills and acquire experience in the plant's response to control commands;
(d) Supply the information and data necessary to verify the adequate implementation of the integrated management system.

3.92. Even if commissioning activities are performed by the supplier or other groups, the operating organization should make the necessary arrangements to participate in, review and approve these activities at all stages, since the responsibility for safety rests with the operating organization.

3.93. The operating organization should establish mechanisms to transfer the ownership of the plant systems from the vendor.

3.94. The operational phase of the plant is generally considered to commence when fuel is initially loaded into the reactor. This phase will overlap with activities for the commissioning of the plant. All essential elements for the safe operation of the nuclear power plant should be in place prior to initial fuel loading. These essential elements will consist of many factors, both organizational and technical, as considered in SSR-2/2 (Rev. 1) [14].

3.95. Specific authorization by the regulatory body should be necessary before the start of normal operation. Such authorization should be granted on the basis of an appropriate safety analysis report and the results of the commissioning programme.

ACTIONS 189–192: TRANSPORT SAFETY

General

3.96. The implementation of a nuclear power programme involves the transport of radioactive material with specific characteristics, which might necessitate amending or complementing the existing national framework for safety in transport. This radioactive material will include fresh and used nuclear fuel, and depending on the national strategy for radioactive waste management, the transport of other radioactive waste may increase significantly.

3.97. The safe transport of radioactive material is principally assured through a graded approach, including elements of design, testing and review of the transport package, as established in SSR-6 (Rev. 1) [17]. The graded approach to the transport of radioactive material is based on the type and quantity of radioactive material to be shipped. Fresh nuclear fuel has a low level of radioactivity, and the main technical means for ensuring its safe transport should be the design of a transport package that controls the risk of nuclear criticality through its structural and containment features. Depending on the type of transport package to be used and the national requirements for fresh fuel shipment, additional testing and regulatory reviews could be required.

3.98. Spent fuel, in contrast, is highly radioactive, and the main technical means for protection against hazards during its transport are the design, testing and review of a transport package that has been type tested in all credible accident conditions and has been shown to maintain its integrity and leaktightness. Another important safety measure is the control of external radiation levels of the transport package. The risk of nuclear criticality and damage caused by heat and other hazardous conditions should also be taken into consideration. The transport of certain

radioactive material requires prior approval of the package design and, depending on the material to be shipped, approval of the shipment by a competent authority.

3.99. Unlike the situation in a stationary facility, the environment of radioactive material being transported is subject to change, and this should be taken into account in planning the shipment, and in the respective emergency plans.

3.100. SSR-6 (Rev. 1) [17] establishes a comprehensive set of international regulations for the safe transport of radioactive material, and these regulations should be incorporated into the national regulatory framework.

3.101. Different modes of transport (by road, rail, sea, air) have their own international or regional regulations for the transport of dangerous goods (including radioactive material), as issued by the respective transport organizations. An adequate legal framework should be established to implement international regulations for the transport of dangerous goods. The provisions of SSR-6 (Rev. 1) [17] are implemented through incorporation into these regulations.

Phase 1

3.102. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 7 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Provisions of SSR-6 (Rev. 1) [17] as a whole.

Action 189. The government should consider the implications for the legal and regulatory framework of the transport of nuclear fuel and radioactive waste, in addition to the existing transport of other radioactive material.

3.103. Activities involving radioactive sources (e.g. at research reactors or in industrial or medical applications of radiation) that require the establishment of regulations relating to the transport of radioactive material will already be taking place in most States; there will be regulations in place that cover not only the materials currently being transported but also all materials relevant to a nuclear power programme (and for which international conventions apply, e.g. transport by air and sea and, for some States, by land). In such States, there may also be a regulatory body in charge of the oversight of safety in the transport of nuclear material.

3.104. IAEA Safety Standards Series No. SSG-33, Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition) [56], presents the different provisions for the safe transport of radioactive material according to the assigned UN number. There are essentially two sets of UN numbers; the set for fissile material is especially relevant to the conduct of a nuclear power programme. The different UN numbers for fissile and non-fissile material indicate that additional controls are required in the transport of fissile material. The regulatory body should be competent in ensuring that appropriate controls are in place. The transport of spent nuclear fuel is an especially demanding task that is likely to require new types of arrangement to be made.

3.105. While a nuclear power programme will typically result in a small percentage increase in the number of shipments of radioactive material, it will increase by several orders of magnitude the total quantity of radioactive material transported. The degree of protection that is necessary for this small number of additional packages should be significantly higher than that for the majority of packages being transported.

3.106. To prepare for the transport of radioactive material from the nuclear power programme, it should be ensured that new regulatory bodies are familiar with the existing regulatory framework.

3.107. The key functions of a regulatory body in relation to the transport of radioactive material are set out in IAEA Safety Standards Series No. TS-G-1.5, Compliance Assurance for the Safe Transport of Radioactive Material [57]. Each of these functions should be examined, and the available resources and skills to fulfil these functions should be assessed. Some functions might be initially carried out in other States; however, the regulatory body for the transport of radioactive material in a State with a nuclear power programme should develop domestic competence in all areas, for example:

(a) Design assessment: In many cases, this function will be limited in terms of scope and resources (or might not exist at all) until a nuclear power programme is established.
(b) Witnessing of testing: The level of testing in relation to the transport of radioactive material in a nuclear power programme is significantly different from that required for the majority of shipments of radioactive material. The testing might involve skills that are not available in the regulatory body if there is no nuclear power programme.
(c) Witnessing of manufacture: It is possible that the regulatory body for the transport of radioactive material need not witness any manufacturing until a

nuclear power programme is established. Although it is the responsibility of the packaging owner to witness manufacturing, the regulatory body should periodically witness the manufacture of packaging as a part of compliance assurance.

(d) Examination of maintenance and servicing arrangements: The complexity of packages, types of material, hostile environments and length of operating lifetime of components all introduce issues that are specific to the transport of radioactive material in a nuclear power programme. In some cases, packages used in a State will be serviced and maintained in another State until a nuclear power programme decision is made.

(e) Monitoring of transport operations: Since the number of shipments remains reasonably constant, the monitoring of transport operations is unlikely to be of concern, either in terms of competence or in terms of resources.

(f) Enforcement actions and investigation of incidents: Most States will have adequate capabilities in this area.

(g) Interdepartmental liaison and cooperation: The key issue with regard to interdepartmental liaison and cooperation is that any new regulatory body that is proposed should fit into the existing regulatory framework without any overlaps or gaps.

(h) Issuing of approvals: The issuing of approvals might be a new process for the regulatory body. The approval system may be modelled on other industries within the State (e.g. aircraft certification) or on other systems identified through networking and interactions with other States.

(i) Regulatory review and maintenance of an effective legal framework: The area of regulatory review and maintenance of an effective legal framework might increase resource requirements, but the necessary skills should be available in one of the existing regulatory bodies. Some new legislation might be necessary.

(j) Staff training and distribution of information: Staff training and the distribution of information on how the regulatory body works are likely to be among the first requirements in Phase 3. An advantage of globally harmonized regulations for the transport of radioactive material is that information and training can be imported from other States and adapted as necessary.

(k) Emergency planning and exercises: Since the quantity of radioactive material being transported will increase considerably, there should be effective planning for an emergency response. Prior to a nuclear power programme, in most cases the radioactive material being transported is most likely to pose a secondary risk in a serious transport accident. However, with the development of a nuclear power programme, there could be cases in which the radioactive material could give rise to the primary risk in an

accident. This could have wide ranging implications, depending on the national infrastructure and arrangements for emergency preparedness and response.

(l) Audits of management systems: Most States will have adequate capability in the area of audits of management systems.

Phase 2

3.108. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 7 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Requirement 2 of GSR Part 7 [13];
(d) Provisions of SSR-6 (Rev. 1) [17] as a whole.

Action 190. All relevant organizations should prepare a plan on how to meet the relevant international safety requirements and should start to fill the gaps identified in Phase 1.

Action 191. The regulatory body and the organizations in charge of the transport of radioactive material should participate in international activities and networks to provide mutual support.

3.109. The arrangements for the transport of fresh fuel and spent fuel should be assessed. The possible routes and modes of fuel transport should be tentatively identified on the basis of this assessment (including the assessment of security). The feasibility of the plans should be evaluated, with account taken of the access routes to the nuclear power plant site and the points of entry to and exit from the State.

3.110. An evaluation should also be made of the expected needs for the transport of low level and intermediate level radioactive waste generated during plant operation. This applies if a national storage or disposal site is under consideration, as opposed to the storage of radioactive waste in a location on the nuclear power plant site.

3.111. Owing to the internationally harmonized requirements for the transport of radioactive material, it should be possible to obtain assistance from another State. There are several international groups or associations of regulatory bodies for the

transport of radioactive material that can offer mutual support. The regulatory body should consider joining such a group or association.

Phase 3

3.112. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 7 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 2 of GSR Part 3 [9];
(c) Requirement 2 of GSR Part 7 [13];
(d) Provisions of SSR-6 (Rev. 1) [17] as a whole.

Action 192. The regulatory body and the organizations in charge of the transport of radioactive material should fully implement the changes to the national requirements and arrangements for the transport of radioactive material in accordance with the plan developed in Phase 2.

3.113. The first transport of radioactive material to be conducted as part of the new nuclear power programme will be the transport of fresh nuclear fuel to the nuclear power plant site. Requirements for such transport should be established before planning the transport. While other types of transport are not expected to take place during Phase 3, it is expected that operating organizations of nuclear power plants should have contingency plans in place for the transport of radioactive material from nuclear power plants prior to their operation. As a result, the transport of all radioactive material should be considered by the regulatory body during Phase 3, even though such transport may not start until some years later.

ACTIONS 193–197: INTERFACES WITH NUCLEAR SECURITY

General

3.114. Paragraph 1.10 of SF-1 [1] states:

> "Safety measures and security measures 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."

This section refers to the interfaces between safety aspects and nuclear security aspects that are to be taken into account in the development of a nuclear power programme.

3.115. Relevant guidance with regard to the establishment of a nuclear security regime is provided in the IAEA Nuclear Security Series. Specific guidance is provided in IAEA Nuclear Security Series No. 19, Establishing the Nuclear Security Infrastructure for a Nuclear Power Programme [58].

3.116. Safety and nuclear security have a common purpose — to protect people and the environment from harmful effects of ionizing radiation, including those effects arising from a nuclear security event — and are therefore complementary. Incidents give rise to risks, whether the initiating event for a given radioactive release follows a natural event, an equipment failure or a nuclear security event. Nuclear security is concerned with the prevention of, detection of and response to criminal or intentional unauthorized acts involving or directed at nuclear and other radioactive material, associated facilities and associated activities (see IAEA Nuclear Security Series No. 20, Objective and Essential Elements of a State's Nuclear Security Regime [59]).

3.117. During each phase in the development process of a nuclear power programme, nuclear security and safety infrastructures should be developed in a coordinated manner as far as possible.

3.118. All organizations involved in a nuclear power programme should be made aware of the commonalities and differences between safety and nuclear security to be able to factor both into development plans. The interfaces between safety and nuclear security have to be recognized, and safety and nuclear security infrastructures should be developed in a manner that complements and enhances both disciplines.

Phase 1

3.119. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 12 of GSR Part 1 (Rev. 1) [5];

(b) Requirement 6 of GSR Part 2 [8].

Action 193. The government should foster both safety culture and nuclear security culture, taking into account their commonalities and differences.

3.120. A safety culture and a nuclear security culture that govern the attitudes and behaviour of individuals should be developed and fostered within the management system.

3.121. Safety culture and nuclear security culture are based on similar concepts. However, there are also some concepts that are unique to nuclear security culture, such as trustworthiness and confidentiality (see IAEA Nuclear Security Series No. 7, Nuclear Security Culture [60]).

Phase 2

3.122. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 12 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 6 of GSR Part 2 [8];
(c) Requirement 5 of GSR Part 5 [11];
(d) Requirements 2 and 23 of GSR Part 7 [13];
(e) Requirement 8 of SSR-2/1 (Rev. 1) [16];
(f) Requirement 17 of SSR-2/2 (Rev. 1) [14].

Action 194. All relevant organizations should coordinate safety and nuclear security aspects from the early stages of development, establishing maximum synergy and, where necessary, integration.

3.123. Relevant structures, systems and components and procedures should be examined with regard to both nuclear security and safety aspects so as to ensure that an optimal balance is achieved.

3.124. A single regulatory body may be responsible for both safety and nuclear security, or the regulatory body may consist of separate competent authorities covering the areas of safety and nuclear security. A consultation and coordination mechanism is required between these authorities to ensure that any potential conflicts in implementing different regulatory requirements are avoided.

3.125. With respect to the degree to which nuclear safety and nuclear security are to be integrated, special attention should be paid to the degree of government involvement. Typically, a larger number of authorities are concerned with nuclear security than with safety; consequently, there are more interfaces to handle and a greater need for cooperation and coordination.

Phase 3

3.126. The following actions should be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

(a) Requirement 12 of GSR Part 1 (Rev. 1) [5];
(b) Requirement 6 of GSR Part 2 [8];
(c) Requirement 5 of GSR Part 5 [11];
(d) Requirements 2 and 23 of GSR Part 7 [13];
(e) Requirement 8 of SSR-2/1 (Rev. 1) [16];
(f) Requirement 17 of SSR-2/2 (Rev. 1) [14].

Action 195. The regulatory body (possibly consisting of several authorities) should ensure that nuclear security regulations do not compromise safety and that safety regulations do not compromise nuclear security.

Action 196. All relevant organizations should ensure that emergency preparedness and response plans in the field of safety and contingency and response plans in the field of nuclear security are complementary, coherent and well coordinated among all the entities involved.

Action 197. The operating organization and the regulatory body should continue to foster safety culture and nuclear security culture in their respective organizations.

3.127. Major decisions with regard to safety enhancements and nuclear security enhancements require the consultation of each discipline. For example, enhancements such as barriers, locks and fences, which are designed to improve physical protection, could have the unintended consequence of delaying or preventing plant operators from taking actions to safely shut down and cool down the reactor. The arrangements for clear delineation of responsibilities with regard to safety aspects and nuclear security aspects should include coordination and communication processes as well as mechanisms for resolving potential conflicts between safety aspects and nuclear security aspects.

3.128. If safety and nuclear security regulatory bodies are separate, there should be consultation and coordination mechanisms between them.

Appendix

OVERVIEW OF ACTIONS TO BE TAKEN IN EACH PHASE FOR THE ESTABLISHMENT OF THE SAFETY INFRASTRUCTURE

PHASE 1

Action No.	Responsible entities (main)			Actions to be taken to implement the IAEA Safety Requirements in Phase 1, and the basis for these actions
	Government, legislative bodies	Regulatory body	Operating organization	
Implementing the IAEA General Safety Requirements for the safety infrastructure				
1. National policy and strategy for safety				
Basis	Requirement 1 of GSR Part 1 (Rev. 1) [5] Requirements 10 and 29 of GSR Part 3 [9] Requirement 2 of GSR Part 5 [11] Requirement 2 of GSR Part 7 [13]			
1				The government should consider the necessary elements of a national policy and strategy for safety to meet the fundamental safety objective and safety principles established in SF-1 [1].
2				The government should provide for the coordination of all activities to establish the safety infrastructure.
3				The government should ensure that the status of the safety infrastructure in relevant areas is assessed and that radiation protection considerations are adequately taken into account.
4				The government should take due account of the assessment of the elements of the safety infrastructure and of the fundamental principle of justification when making a decision on whether to introduce a nuclear power programme.

2. Global nuclear safety regime				
Basis	Requirements 1, 14 and 36 of GSR Part 1 (Rev. 1) [5] Requirements 7 and 17 of GSR Part 7 [13]			
11				The government should prepare for participation in the global nuclear safety regime.
12				The government should begin a dialogue with neighbouring States with regard to its projects for establishing a nuclear power programme.
13				The government and relevant organizations (if such organizations exist) should establish contact with organizations in other States and international organizations to seek advice on safety related matters.
3. Legal framework				
Basis	Requirements 1–4 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Requirement 1 of GSR Part 5 [11] Requirement 4 of GSR Part 6 [12] Requirements 2 and 20 of GSR Part 7 [13]			
20				The government should identify all necessary elements of a legal framework for the safety infrastructure and should plan how to structure and develop this framework.
21				The government should consider the process that should be employed to license nuclear facilities in the later stages of the programme.
4. Regulatory framework				
Basis	Requirements 1, 3, 4, 7 and 11 of GSR Part 1 (Rev. 1) [5] Requirements 2 and 3 of GSR Part 3 [9] Requirement 1 of GSR Part 5 [11]			
24				The government should recognize the need for an effectively independent and competent regulatory body and should consider the appropriate position of the regulatory body in the State's governmental and legal framework for safety.
25				The government should seek advice from the regulatory body on radiation safety issues relating to a nuclear power programme.

26				The government should identify the prospective senior managers of the regulatory body.
5. Transparency and openness				
Basis	Requirements 1 and 36 of GSR Part 1 (Rev. 1) [5] Requirements 5 and 12 of GSR Part 2 [8] Requirement 1 of GSR Part 5 [11]			
39				The government should establish a policy and guidance to inform the public and other interested parties of the benefits and risks of nuclear power to facilitate their involvement in the decision making process on a prospective nuclear power programme.
40				The government should establish a process to ensure that the comments arising from consultation with the public and other interested parties are considered, and it should communicate the results of these considerations to the interested parties.
6. Funding and financing				
Basis	Requirements 1, 3, 10 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 9 of GSR Part 2 [8] Requirement 1 of GSR Part 5 [11] Requirement 9 of GSR Part 6 [12] Requirement 2 of GSR Part 7 [13] Requirements 1, 3 and 4 of SSR-2/2 (Rev. 1) [14]			
48				The government should plan funding for education and training, and for research centres and other national infrastructure, to support the safe operation of nuclear power plants, including on-site and off-site emergency arrangements.
49				The government should require that the operating organization allocate the necessary financial resources to ensure the safety of its nuclear power plants until the end of their planned operating lifetime.
50				The government should consider the various possible sources for the funding of the regulatory body.
51				The government should consider the various possible sources and mechanisms of funding for radioactive waste management and spent fuel management, the decommissioning of nuclear power plants and the disposal of radioactive waste.

7. External support organizations and contractors				
Basis	Requirements 4, 11, 13 and 20 of GSR Part 1 (Rev. 1) [5] Requirements 3 and 11 of GSR Part 2 [8] Requirement 2 of GSR Part 3 [9] Requirement 3 of SSR-2/2 (Rev. 1) [14]			
61				The government should consider the availability of expertise, industrial capability and technical services that could support the safety infrastructure in the long term.
62				The government should assess the need to create or enhance national organizations to provide technical support to the regulatory body and the operating organization for the safe operation of nuclear power plants.
8. Leadership and management for safety				
Basis	Requirements 1 and 19 of GSR Part 1 (Rev. 1) [5] Requirements of GSR Part 2 [8] as a whole Requirement 5 of GSR Part 3 [9] Requirement 2 of SSR-1 [15]			
72				The government should take into account the essential role of leadership and management for safety to achieve a high level of safety and to foster a strong safety culture within organizations.
73				The government should ensure that all the activities conducted are included within the framework of an effective integrated management system.
74				The government, when identifying senior managers for the prospective organizations to be established, should look for people with leadership capabilities and an attitude that emphasizes safety culture.

9. Human resources development				
Basis	Requirements 1, 11 and 18 of GSR Part 1 (Rev. 1) [5] Requirement 9 of GSR Part 2 [8] Requirement 2 of GSR Part 3 [9] Requirements 21 and 25 of GSR Part 7 [13] Requirement 4 of SSR-2/2 (Rev. 1) [14]			
85				The government should consider a strategy for attracting, recruiting, training and retaining an adequate number of experts to meet the needs of all organizations involved in ensuring safety in a prospective nuclear power programme.
86				The government should identify competences required in areas relating to nuclear safety and the approximate number of experts needed.
87				The government should identify national institutions and institutions in other States that could provide education and training and could start training in key areas relating to nuclear safety.
88				The government should identify gaps in safety related training at existing training institutions and should plan to strengthen existing training institutions or to establish new training institutions to fill these gaps.
89				The government should ensure that prospective senior regulators identified by the government and prospective safety experts to be involved in the nuclear power programme gain an understanding of the principles and criteria of nuclear safety.
10. Research for safety and regulatory purposes				
Basis	Requirements 1 and 11 of GSR Part 1 (Rev. 1) [5]			
99				The government should consider in which areas in-depth knowledge is necessary for assessing and analysing safety related aspects of a nuclear power plant project and should identify research centres that can start research programmes in safety related areas of knowledge.
100				The government should identify the capabilities of domestic research centres to meet needs in core areas of knowledge and should plan to establish new research centres for such areas as necessary.

11. Radiation protection				
Basis	Requirement 7 of GSR Part 1 (Rev. 1) [5] Requirements 2 and 43 of GSR Part 3 [9] Requirements 25–27 of SSR-1 [15]			
105				The government should consider the additional radiation risks and special needs associated with the operation of nuclear power plants.
106				The government should ensure that an initial radiological environmental impact assessment is conducted, as appropriate, on the basis of a defined set of criteria, at a regional scale and with the use of available data.
107				The government should recognize the need to integrate radiation protection regulations and new safety regulations for nuclear power plants.
12. Safety assessment				
Basis	Requirements 5, 6 and 8 of GSR Part 4 (Rev. 1) [10]			
117				The government should familiarize itself with the IAEA safety standards and with practices in other States, as appropriate, to gain an understanding of the resources and competences needed for the safety assessment.
13. Safety of radioactive waste management, spent fuel management and decommissioning				
Basis	Requirements 7 and 10 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Requirements 1 and 2 of GSR Part 5 [11] Requirements 1, 4, 5 and 9 of GSR Part 6 [12]			
122				The government should recognize the long term nature of the safety requirements for, and the cost implications of, radioactive waste management (including disposal of waste), spent fuel management and decommissioning.
123				The government should consider the feasible options for radioactive waste management (including disposal of waste), spent fuel management and decommissioning on the basis of a comprehensive long term policy and strategy.

14. Emergency preparedness and response				
Basis	Requirements 7 and 8 of GSR Part 1 (Rev. 1) [5] Requirement 43 of GSR Part 3 [9] Requirements 1 and 2 of GSR Part 7 [13]			
133				The government should develop awareness of the need for the early establishment of emergency plans.
134				The government should identify response organizations and new arrangements for supporting emergency preparedness and response.
Implementing the IAEA Specific Safety Requirements for the safety infrastructure				
15. Operating organization				
Basis	Requirements 5, 6 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 4 of GSR Part 3 [9] Requirements 1 and 4 of SSR-2/2 (Rev. 1) [14]			
146				If the operating organization has already been established or identified in Phase 1 (which is not the scenario developed in this Safety Guide, in which the operating organization is established at the beginning of Phase 2), it should be involved together with the government in activities for the development of the safety infrastructure from the beginning.
147				The government should consider the financial resources and the necessary competences and staffing that are expected from an organization operating a nuclear power plant so as to ensure long term safety.
148				The government should consider the different ways of establishing an operating organization so as to ensure long term safety.
16. Site survey and site evaluation				
Basis	Requirement 31 of GSR Part 3 [9] Requirements 1–27 of SSR-1 [15]			
160				The government should ensure that potential sites are identified and candidate sites are selected on the basis of a set of defined criteria, at a regional scale and with the use of available data.

17. Design safety				
Basis	Requirements of SSR-2/1 (Rev. 1) [16] as a whole			
170				The government should understand the objectives for nuclear safety and how they are taken into account in nuclear power plants of various designs.
171				The government should consider the availability of the technical infrastructure and the reliability of the national power grid and should consider their potential impact on the design requirements for the safety of the nuclear power plant.
18. Preparation for commissioning				
No action in Phase 1.				
19. Transport safety				
Basis	Requirement 7 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Provisions of SSR-6 (Rev. 1) [17] as a whole			
189				The government should consider the implications for the legal and regulatory framework of the transport of nuclear fuel and radioactive waste, in addition to the existing transport of other radioactive material.
20. Interfaces with nuclear security				
Basis	Requirement 12 of GSR Part 1 (Rev. 1) [5] Requirement 6 of GSR Part 2 [8]			
193				The government should foster both safety culture and nuclear security culture, taking into account their commonalities and differences.

PHASE 2

Action No.	Responsible entities (main)			Actions to be taken to implement the IAEA Safety Requirements in Phase 2, and the basis for these actions
	Government, legislative bodies	Regulatory body	Operating organization	
Implementing the IAEA General Safety Requirements for the safety infrastructure				
1. National policy and strategy for safety				
Basis	Requirement 1 of GSR Part 1 (Rev. 1) [5] Requirements 10 and 29 of GSR Part 3 [9] Requirement 2 of GSR Part 5 [11] Requirement 2 of GSR Part 7 [13]			
5				The government should establish a clear national policy and strategy for meeting safety requirements in order to achieve the fundamental safety objective and to apply the fundamental safety principles established in SF-1 [1].
6				The government should establish a policy for knowledge transfer for ensuring safety by means of contracts and agreements with organizations in other States that may be involved in the nuclear power programme.
7				The government should ensure identification of responsibilities and their progressive allocation to the relevant organizations involved in the development of the safety infrastructure.
8				The government should ensure that all the necessary organizations and other elements of the safety infrastructure are developed efficiently and that their development is adequately coordinated.

2. Global nuclear safety regime				
Basis	Requirements 1 and 14 of GSR Part 1 (Rev. 1) [5] Requirement 13 of GSR Part 2 [8] Requirements 7 and 17 of GSR Part 7 [13] Requirement 24 of SSR 2/2 (Rev. 1) [14]			
14				All relevant organizations should participate in the global nuclear safety regime.
15				The State should become a Party to the relevant international conventions, as identified in Phase 1.
16				All relevant organizations should strengthen their cooperation on safety related matters with States that have advanced nuclear power programmes.
3. Legal framework				
Basis	Requirements 1–4 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Requirement 1 of GSR Part 5 [11] Requirement 4 of GSR Part 6 [12] Requirements 2 and 20 of GSR Part 7 [13]			
22				The government should enact and implement the appropriate elements of the legal framework for the safety infrastructure.
4. Regulatory framework				
Basis	Requirements 1, 3, 4, 7, 11, 15–19, 21–26, 30 and 32 of GSR Part 1 (Rev. 1) [5] Requirement 3 of GSR Part 2 [8] Requirements 2 and 3 of GSR Part 3 [9] Requirements 1 and 3 of GSR Part 5 [11] Requirement 5 of GSR Part 6 [12] Requirement 2 of GSR Part 7 [13]			
27				The government should establish an effectively independent regulatory body and should empower it with adequate legal authority and ensure it has the technical and managerial competence, and the human and financial resources, to discharge its responsibilities in the nuclear power programme.
28				The government should appoint senior managers and key experts to the regulatory body and should assign to them the responsibility for developing the organization.

29				The regulatory body should consider the various regulatory approaches that are applied for nuclear power programmes of the same size and should decide on its approach, taking into account the State's legal and industrial practices and the guidance provided in IAEA safety standards.
30				The regulatory body should establish a process for developing and issuing regulations and guides specifying the documentation and procedures necessary in the various steps of the licensing process and inspections to be conducted.
31				The regulatory body should develop and issue those safety regulations that are needed for the bidding process or contract negotiations.
32				The regulatory body should begin establishing a suitable working relationship with the operating organization and with other relevant national and international organizations.
5. Transparency and openness				
Basis	Requirements 1, 21, 34 and 36 of GSR Part 1 (Rev. 1) [5] Requirements 5 and 14 of GSR Part 2 [8] Requirement 3 of GSR Part 3 [9] Requirements 1 and 3 of GSR Part 5 [11] Requirements 10 and 13 of GSR Part 7 [13] Requirement 2 of SSR-2/2 (Rev. 1) [14]			
41				The government should inform the public and other interested parties about the safety implications of the decision on the implementation of a nuclear power programme.
42				All relevant organizations should continue to inform the public and other interested parties about safety issues, including the expected health and environmental impacts of a nuclear power programme.

6. Funding and financing				
Basis	Requirements 1, 3, 10 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 9 of GSR Part 2 [8] Requirement 1 of GSR Part 5 [11] Requirement 9 of GSR Part 6 [12] Requirement 2 of GSR Part 7 [13] Requirements 1, 3 and 4 of SSR-2/2 (Rev. 1) [14]			
52				The government should make provision for long term funding for education and training, and for research centres and other national infrastructure, to support the safe operation of nuclear power plants, including on-site and off-site emergency arrangements.
53				The government should decide on the mechanism for sustainable funding of the regulatory body.
54				The operating organization should establish a policy for ensuring adequate funding so as not to compromise safety at any stage of the nuclear power programme.
55				The government should enact legislation that requires financial provision for the funding of long term radioactive waste management, spent fuel management and decommissioning.
7. External support organizations and contractors				
Basis	Requirements 4, 11, 13, 17 and 20 of GSR Part 1 (Rev. 1) [5] Requirements 3 and 11 of GSR Part 2 [8] Requirements 2 and 3 of GSR Part 3 [9] Requirements 3 and 31 of SSR-2/2 (Rev. 1) [14]			
63				The operating organization and the government should encourage industrial organizations in the State to develop their capabilities with the objective of participating in the construction of nuclear power plants and supporting their safe long term operation.
64				The government, and the operating organization if applicable, should establish organizations to provide expertise and engineering support or other external support for regulatory oversight and for the safe operation of nuclear power plants, as identified in Phase 1.
65				External support organizations and potential contractors should begin to build competence and quality management systems for ensuring safety.

66				The regulatory body and the operating organization should plan arrangements for overseeing the activities performed by their respective external support organizations and contractors.
8. Leadership and management for safety				
Basis	Requirements 1, 19 and 35 of GSR Part 1 (Rev. 1) [5] Requirements of GSR Part 2 [8] as a whole Requirement 5 of GSR Part 3 [9] Requirement 7 of GSR Part 5 [11] Requirement 2 of SSR-1 [15] Requirement 2 of SSR-2/2 (Rev. 1) [14] Paragraph 306 of SSR-6 (Rev. 1) [17]			
75				The regulatory body and the operating organization should start developing and implementing effective integrated management systems in their respective organizations and should foster a strong safety culture.
76				The regulatory body and the operating organization should develop competences in managing the growth of and change in the organization.
77				The regulatory body and the operating organization should make appropriate arrangements for measurement, assessment (both self-assessment and independent assessment) and continual improvement of their integrated management systems.
9. Human resources development				
Basis	Requirements 1, 11 and 18 of GSR Part 1 (Rev. 1) [5] Requirement 9 of GSR Part 2 [8] Requirements 2–4 and 26 of GSR Part 3 [9] Requirements 21 and 25 of GSR Part 7 [13] Requirements 4 and 7 of SSR-2/2 (Rev. 1) [14] Paragraphs 311–315 of SSR-6 (Rev. 1) [17]			
90				All relevant organizations should implement a strategy to attract and retain high quality trained personnel.
91				All relevant organizations should support the safety related training of their prospective staff in nuclear organizations in other States.
92				The regulatory body and the operating organization should actively recruit staff so as to ensure capability in areas relevant to safety in a timely manner.

93				The government and relevant organizations should establish new institutes or new curricula relevant to safety, as identified in Phase 1.
94				All relevant organizations should commence the education and training in academic and vocational institutions of the number of persons necessary for ensuring safety.
10. Research for safety and regulatory purposes				
Basis	Requirements 1 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 3 of GSR Part 5 [11]			
101				The operating organization and the regulatory body should be involved in identifying areas for safety research.
102				The government should implement plans to establish new institutions for research relating to safety as necessary.
103				Research centres should begin conducting research relating to safety in areas in which in-depth knowledge is essential to support the safe long term operation of nuclear power plants.
11. Radiation protection				
Basis	Requirement 7 of GSR Part 1 (Rev. 1) [5] Requirements 1–4, 6–16, 18–32 and Schedule III of GSR Part 3 [9] Requirements 25–27 of SSR-1 [15] Requirements 78 and 79 of SSR-2/1 (Rev. 1) [16] Paragraphs 301–303 of SSR-6 (Rev. 1) [17]			
108				The regulatory body and/or the government should amend the legislation and/or regulations, as appropriate, for the purposes of regulating radiation protection to include specific aspects of the nuclear power programme.
109				The regulatory body should establish or approve, as appropriate, the limits and constraints with regard to workers and the public both for normal operation and for potential exposures in a nuclear power plant.
110				The operating organization should update the radiological environmental impact assessment for the site selected, as appropriate.

111				The regulatory body should review and assess the radiological environmental impact assessment for the site selected, as appropriate.
112				The operating organization should commence a radiological environmental monitoring programme.
113				The operating organization should use all appropriate safety principles and requirements and regulatory requirements with regard to radiation protection in preparing the bid specifications or contract negotiations for the nuclear power plant.
12. Safety assessment				
Basis	Requirements 24–26 of GSR Part 1 (Rev. 1) [5] Requirement 13 of GSR Part 3 [9] Requirements 1–6, 8 and 14–16 of GSR Part 4 (Rev. 1) [10]			
118				The operating organization, the regulatory body and external support organizations, as appropriate, should start to develop the expertise to conduct or review the safety assessments.
13. Safety of radioactive waste management, spent fuel management and decommissioning				
Basis	Requirements 7 and 10 of GSR Part 1 (Rev. 1) [5] Requirements 2 and 31 of GSR Part 3 [9] Requirements 1–12 and 17 of GSR Part 5 [11] Requirements 1, 4–6, 8 and 9 of GSR Part 6 [12] Requirement 15 of GSR Part 7 [13] Requirements 35, 36 and 38 of SSR-2/1 (Rev. 1) [16] Requirement 21 of SSR-2/2 (Rev. 1) [14]			
124				The government and other interested parties, as appropriate, should establish the national policy and strategy for radioactive waste management, spent fuel management and decommissioning and should set the goals for its implementation to an appropriate schedule, including site investigations for the purposes of radioactive waste disposal.
125				The government, together with the operating organization, should consider the need to establish a national organization responsible for radioactive waste management or to extend the organization for radioactive waste management if one already exists in the State.

126				The regulatory body should establish the necessary regulatory requirements on radioactive waste management, spent fuel management and decommissioning, as necessary for bid specifications or contract negotiations.
127				The operating organization should consider the arrangements that are necessary for ensuring the safety of radioactive waste management, the safety of spent fuel management and safety in decommissioning, and for minimizing the generation of radioactive waste.
14. Emergency preparedness and response				
Basis	Requirements 7 and 8 of GSR Part 1 (Rev. 1) [5] Requirements 43 and 44 of GSR Part 3 [9] Requirements 1, 2, 4, 5 and 20–23 of GSR Part 7 [13] Requirements 18 and 19 of SSR-2/2 (Rev. 1) [14] Paragraphs 304 and 305 of SSR-6 (Rev. 1) [17]			
135				The government should determine the national response organizations with responsibilities for emergency preparedness and response.
136				The government should specify the general approach for emergency preparedness and response on the basis of the probability and severity of the emergency.
137				The government should start implementing new arrangements as identified in Phase 1 for strengthening the infrastructure for emergency preparedness and response.
138				The regulatory body should develop the regulations on emergency preparedness and response, as necessary for the development of infrastructure.
139				The operating organization should start developing a general emergency preparedness programme for nuclear power plants.

Implementing the IAEA Specific Safety Requirements for the safety infrastructure				
15. Operating organization				
Basis	Requirements 5, 6 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 4 of GSR Part 3 [9] Requirements 1–5 of SSR-2/2 (Rev. 1) [14]			
149				The operating organization should be formed, if it has not already been formed, and it should be expressly assigned its prime responsibility for safety.
150				The operating organization should appoint managers and key experts, should specify its organizational structure and should establish its policy for human resources development for discharging its responsibility for safety.
151				The operating organization should establish an integrated management system in which safety is the overriding priority.
152				The operating organization should establish a constructive working relationship with the regulatory body and with relevant national and international organizations, consistent with governmental policy.
153				The operating organization should establish a process for bidding or contract negotiations and should specify the safety requirements to be included, consistent with national regulations.
154				The operating organization should make provision to include matters relating to the transfer of safety knowledge in the bid specifications or contract negotiations, consistent with governmental policy.
16. Site survey and site evaluation				
Basis	Requirement 31 of GSR Part 3 [9] Requirements 1–27 of SSR-1 [15]			
161				The regulatory body should establish specific safety requirements for site evaluation, including requirements for the process of authorizing the site selected, in compliance with the relevant IAEA safety standards.

162				The operating organization should complete the investigations relating to the acceptability of the candidate sites and should select the preferred candidate site for the first nuclear power plant, making use of specific data, information and studies, as well as assessments conducted on the fullest possible temporal and spatial scales of investigation.
163				The operating organization should prepare the site evaluation report and should submit it to the regulatory body on the basis of a full assessment of the site selected and including the confirmation of site acceptability and the characterization of the site for the definition of the site related design basis parameters.
164				The regulatory body should review and assess the site evaluation report and should make a decision with regard to the acceptability of the site selected and the site related design basis.
165				The operating organization should use all the appropriate information relevant to safety and to regulatory control that relates to or is derived from the site characterization to prepare the bid specifications or to negotiate a contract for the first nuclear power plant.
166				The operating organization should start to evaluate and modify the site and the radiological environmental monitoring programme, as necessary, after the site evaluation report has been approved.
17. Design safety				
Basis	Requirements 5, 15, 16 and 29 of GSR Part 3 [9] Requirements of SSR-2/1 (Rev. 1) [16] as a whole Requirements 15 and 16 of SSR-4 [42]			
172				All relevant organizations should obtain an in-depth understanding of the safety principles and safety requirements applicable in the design of a nuclear power plant.
173				The operating organization should conduct a thorough market survey of the available nuclear power technologies and should investigate their safety features.
174				The regulatory body should prepare and enact national safety regulations on design that are necessary for bid specification or contract negotiations.

175				The government and the operating organization, as applicable, should start to implement plans for improving the national technical infrastructure, as necessary, to fill in previously identified gaps in the capabilities necessary for ensuring safety.
176				The operating organization should include in the bid specification or contract negotiations all the safety and regulatory aspects that should be considered in the design, with account taken of the status of the national technical infrastructure.
18. Preparation for commissioning				
No action in Phase 2.				
19. Transport safety				
Basis	Requirement 7 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Requirement 2 of GSR Part 7 [13] Provisions of SSR-6 (Rev. 1) [17] as a whole			
190				All relevant organizations should prepare a plan on how to meet the relevant international safety requirements and should start to fill the gaps identified in Phase 1.
191				The regulatory body and the organizations in charge of the transport of radioactive material should participate in international activities and networks to provide mutual support.
20. Interfaces with nuclear security				
Basis	Requirement 12 of GSR Part 1 (Rev. 1) [5] Requirement 6 of GSR Part 2 [8] Requirement 5 of GSR Part 5 [11] Requirements 2 and 23 of GSR Part 7 [13] Requirement 8 of SSR-2/1 (Rev. 1) [16] Requirement 17 of SSR-2/2 (Rev. 1) [14]			
194				All relevant organizations should coordinate safety and nuclear security aspects from the early stages of development, establishing maximum synergy and, where necessary, integration.

PHASE 3

Action No.	Responsible entities (main)			Actions to be taken to implement the IAEA Safety Requirements in Phase 3, and the bases for these actions
	Government, legislative bodies	Regulatory body	Operating organization	
Implementing the IAEA General Safety Requirements for the safety infrastructure				
1. National policy and strategy for safety				
Basis	Requirement 1 of GSR Part 1 (Rev. 1) [5] Requirements 10 and 29 of GSR Part 3 [9] Requirement 2 of GSR Part 5 [11] Requirement 2 of GSR Part 7 [13]			
9				The government should continue to implement the national policy and strategy for safety.
10				The government should ensure that the regulatory body and the operating organization fulfil their responsibilities.
2. Global nuclear safety regime				
Basis	Requirements 1 and 14 of GSR Part 1 (Rev. 1) [5] Requirement 13 of GSR Part 2 [8] Requirements 7 and 17 of GSR Part 7 [13] Requirement 24 of SSR-2/2 (Rev. 1) [14]			
17				All relevant organizations should ensure continued participation in international activities and international networks for strengthening safety.
18				The operating organization should implement a cooperation programme with the vendor and with other organizations operating nuclear power plants of the same type as that selected, for the purpose of strengthening safety.
19				The regulatory body should implement a cooperation programme with the vendor State and with other regulatory bodies that have experience of oversight of nuclear power plants of the same type as that selected.

3. Legal framework				
Basis	Requirements 1–4 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Requirement 1 of GSR Part 5 [11] Requirement 4 of GSR Part 6 [12] Requirements 2 and 20 of GSR Part 7 [13]			
23				The government should ensure that the legal framework for the safety infrastructure is fully in place and that the legislation is complied with by the relevant organizations.
4. Regulatory framework				
Basis	Requirements 1, 3, 4, 7, 11, 16–18 and 21–33 of GSR Part 1 (Rev. 1) [5] Requirement 3 of GSR Part 2 [8] Requirements 2 and 3 of GSR Part 3 [9] Requirements 1 and 3 of GSR Part 5 [11] Requirement 5 of GSR Part 6 [12] Requirement 2 of GSR Part 7 [13]			
33				The regulatory body should maintain suitable working relationships with the operating organization.
34				The regulatory body should plan and conduct all the required licensing and oversight activities during the licensing process, including during siting, construction, commissioning and operation, consistent with the regulatory approach that was selected.
35				The regulatory body should establish a consistent procedure for issuing, revising and revoking regulations and guides.
36				The regulatory body should ensure that a full and comprehensive set of regulations and guides is in place for regulating construction, commissioning and operational activities at the appropriate time.
37				The regulatory body should implement its programme for inspection and enforcement during construction including, as applicable, the design and manufacture of items important to safety.
38				The regulatory body should review and assess programmes to be implemented by the operating organization, as appropriate.

5. Transparency and openness				
Basis	Requirements 1, 21, 34 and 36 of GSR Part 1 (Rev. 1) [5] Requirements 5 and 14 of GSR Part 2 [8] Requirement 3 of GSR Part 3 [9] Requirements 1 and 3 of GSR Part 5 [11] Requirements 10 and 13 of GSR Part 7 [13] Requirement 2 of SSR-2/2 (Rev. 1) [14]			
43				All relevant organizations should seek to establish and maintain the confidence and trust of the public and other interested parties on safety issues.
44				All relevant organizations, as appropriate to their role, should continue to explain to the public and other interested parties the risks and benefits of the introduction of nuclear power and the measures taken to limit the risks.
45				The regulatory body should communicate with the public and other interested parties about the licensing process, safety requirements and regulatory oversight.
46				The operating organization and the regulatory body should communicate with the public and other interested parties about safety issues in construction and the commissioning programme.
47				The operating organization and the regulatory body should maintain a transparent approach on safety issues with the public and other interested parties with regard to any problems and difficulties encountered in the construction programme, including the problems and difficulties of suppliers.
6. Funding and financing				
Basis	Requirements 1, 3, 10 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 9 of GSR Part 2 [8] Requirement 1 of GSR Part 5 [11] Requirement 9 of GSR Part 6 [12] Requirement 2 of GSR Part 7 [13] Requirements 1, 3 and 4 of SSR-2/2 (Rev. 1) [14]			
56				The government should provide sustainable funding for the efficient and effective conduct of the regulatory body's activities and for the emergency arrangements of the respective response organizations.
57				The operating organization should ensure that funding is sufficient for ensuring the safe operation of the nuclear power plant.

58				The operating organization should ensure that arrangements are in place for the funding of radioactive waste management and decommissioning.
59				The regulatory body should verify, as part of the licensing process, that the operating organization has sufficient financial resources.
60				The government or the regulatory body should verify that a system for the funding of decommissioning activities, radioactive waste management and spent fuel management, including disposal, is in place.
7. External support organizations and contractors				
Basis	Requirements 4, 11, 13, 17 and 20 of GSR Part 1 (Rev. 1) [5] Requirements 3, 10 and 11 of GSR Part 2 [8] Requirements 2, 3 and 20 of GSR Part 3 [9] Requirements 3 and 31 of SSR-2/2 (Rev. 1) [14]			
67				The regulatory body should establish a framework for the qualification of technical services that are significant for nuclear safety.
68				External support organizations should continue the recruitment of staff and the building of competence in safety related matters.
69				All relevant organizations should ensure clarity in specifying the roles and responsibilities of external support organizations.
70				All relevant organizations should make appropriate arrangements to avoid conflicts of interest when obtaining external support.
71				The regulatory body and the operating organization should oversee the activities performed by their respective external support organizations and contractors, and should assess the quality of the services provided, in accordance with their management systems.

8. Leadership and management for safety				
Basis	Requirements 1, 19 and 35 of GSR Part 1 (Rev. 1) [5] Requirements of GSR Part 2 [8] as a whole Requirement 5 of GSR Part 3 [9] Requirement 7 of GSR Part 5 [11] Requirement 26 of GSR Part 7 [13] Requirement 2 of SSR-1 [15] Requirement 2 of SSR-2/1 (Rev. 1) [16] Requirements 2, 8, 9 and 15 of SSR-2/2 (Rev. 1) [14] Paragraph 306 of SSR-6 (Rev. 1) [17]			
78				The senior management of all relevant organizations should provide effective leadership and effective management for safety to ensure a sustainable high level of safety and a strong safety culture.
79				All relevant organizations should continue the implementation of a management system that promotes the concept that requirements for safety are paramount within the organization, overriding all other demands.
80				The operating organization and the regulatory body should ensure that the effectiveness of their integrated management systems is monitored and measured, and that self-assessments as well as independent assessments are conducted regularly for continual improvement.
81				All relevant organizations should ensure that appropriate arrangements for the management of safety related knowledge (including record management and report management) and knowledge transfer are in place.
82				All relevant organizations should ensure that leadership and succession development programmes are in place to develop future leaders with a strong emphasis on safety.
83				The operating organization should describe the provisions for management for safety in the corresponding chapter of the safety analysis report.
84				The regulatory body should review and assess the operating organization's programme on safety management.

9. Human resources development				
Basis	Requirements 1, 11 and 18 of GSR Part 1 (Rev. 1) [5] Requirement 9 of GSR Part 2 [8] Requirements 2–4 and 26 of GSR Part 3 [9] Requirements 21 and 25 of GSR Part 7 [13] Requirements 4 and 7 of SSR-2/2 (Rev. 1) [14] Paragraphs 311–315 of SSR-6 (Rev. 1) [17]			
95				The operating organization, the regulatory body, external support organizations and relevant response organizations should ensure the availability of sufficient competent human resources for the efficient and effective conduct of all activities at the appropriate time.
96				The operating organization should prepare a human resources management programme (including staffing, qualification and training) as well as the corresponding parts of the safety analysis report.
97				The regulatory body should review and assess the operating organization's programme with regard to human resources management.
98				The government should continue promoting the development of education in the nuclear field so as to continue providing a flow of qualified people in areas relevant to safety.
10. Research for safety and regulatory purposes				
Basis	Requirements 1 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 3 of GSR Part 5 [11]			
104				Research centres and other relevant organizations should focus their research on the features and safety aspects of the nuclear power plant that will be constructed, including features and aspects specific to the actual plant site.

11. Radiation protection				
Basis	Requirement 7 of GSR Part 1 (Rev. 1) [5] Requirements 1–4, 6–16, 19–32 and Schedule III of GSR Part 3 [9] Requirements 25–27 of SSR-1 [15] Requirements 5, 78 and 79 of SSR-2/1 (Rev. 1) [16] Requirement 21 of SSR-2/2 (Rev. 1) [14] Paragraphs 301–303 of SSR-6 (Rev. 1) [17]			
114				The operating organization should establish a radiation protection programme, should continue implementing an environmental radiological monitoring programme and should prepare the corresponding chapters of the safety analysis report.
115				The regulatory body should review and assess the operating organization's programmes with regard to radiation protection and relevant environmental protection and should verify compliance with the regulatory requirements.
116				The regulatory body should ensure that arrangements are in place for the monitoring of all discharges from the nuclear power plant to the environment.
12. Safety assessment				
Basis	Requirements 24–26 of GSR Part 1 (Rev. 1) [5] Requirement 13 of GSR Part 3 [9] Requirements 1–24 of GSR Part 4 (Rev. 1) [10] Requirements 5 and 10 of SSR-2/1 (Rev. 1) [16] Requirement 12 of SSR-2/2 (Rev. 1) [14]			
119				The operating organization should perform comprehensive safety assessments of the nuclear power plant and should produce safety analysis reports to demonstrate that all relevant safety requirements have been met.
120				The regulatory body should carry out a comprehensive review and an independent verification of the safety analysis reports submitted by the operating organization to verify compliance with the regulatory requirements.
121				The operating organization and/or the regulatory body should obtain support from external support organizations or individual experts in performing or reviewing safety assessments, as necessary.

13. Safety of radioactive waste management, spent fuel management and decommissioning				
Basis	Requirements 7 and 10 of GSR Part 1 (Rev. 1) [5] Requirements 2 and 31 of GSR Part 3 [9] Requirements 1–20 of GSR Part 5 [11] Requirements 1, 4–6 and 8–10 of GSR Part 6 [12] Requirement 15 of GSR Part 7 [13] Requirements 35, 36 and 38 of SSR-2/1 (Rev. 1) [16] Requirements 21 and 33 of SSR-2/2 (Rev. 1) [14]			
128				The operating organization should prepare a programme for radioactive waste management and spent fuel management, as well as a programme for decommissioning management, in accordance with the national policy and strategy, and should prepare the corresponding chapters of the safety analysis report.
129				The regulatory body should review and assess the operating organization's programmes for waste management and spent fuel management and for decommissioning and should verify their compliance with the regulatory requirements.
130				The operating organization, and the radioactive waste management organization if applicable, should make their respective storage facilities fully operational and ready to receive radioactive waste and spent fuel from the nuclear power plant.
131				The regulatory body should implement its regulatory oversight programme for facilities and activities for radioactive waste management and spent fuel management.
132				All relevant organizations should be aware of international efforts and progress with regard to the disposal of radioactive waste.
14. Emergency preparedness and response				
Basis	Requirements 7 and 8 of GSR Part 1 (Rev. 1) [5] Requirement 43–46 and Schedule IV of GSR Part 3 [9] Requirements 1–26 and appendices I and II of GSR Part 7 [13] Requirement 18 of SSR-2/2 (Rev. 1) [14] Paragraphs 304 and 305 of SSR-6 (Rev. 1) [17]			
140				The regulatory body should establish detailed regulations on emergency preparedness and response.

141				The operating organization should develop and implement an emergency plan and emergency procedures for the nuclear power plant and should put in place adequate arrangements to support preparedness for an effective response.
142				The government and the regulatory body should develop and implement emergency plans and emergency procedures and should put in place adequate arrangements to support preparedness for an effective response at the local, national and, as appropriate, international levels.
143				The government and the regulatory body should establish arrangements for coordination between the emergency plan of the nuclear power plant and the plans of the relevant response organizations that would be involved in emergency response.
144				The regulatory body should review and assess the emergency plan and procedures for nuclear power plants to the extent necessary to verify compliance with the regulatory requirements.
145				The government, the regulatory body and the operating organization should demonstrate their emergency response capabilities by conducting appropriate exercises that include all the organizations concerned, the people who are potentially affected and representatives of the news media.
Implementing the IAEA Specific Safety Requirements for the safety infrastructure				
15. Operating organization				
Basis	Requirements 5, 6 and 11 of GSR Part 1 (Rev. 1) [5] Requirement 3 of GSR Part 2 [8] Requirement 4 of GSR Part 3 [9] Requirement 2 of GSR Part 7 [13] Requirement 1 of SSR-2/1 (Rev. 1) [16] Requirements 1–32 of SSR-2/2 (Rev. 1) [14] Requirements 58, 63 and 68 of SSR-4 [42]			
155				The operating organization should implement, as part of its integrated management system, a safety policy that includes goals and objectives that give safety matters the highest priority.
156				The operating organization should give primary consideration to safety aspects during the evaluation of bids or contract negotiations.

157				The operating organization should, in coordination with the vendor as necessary, prepare all the safety documentation as required in the licensing process for submission to the regulatory body.
158				The operating organization should develop all necessary programmes for operational management (including programmes for operations, maintenance and training) and should submit them to the regulatory body, as appropriate.
159				The operating organization should ensure completion of the construction of the nuclear power plant in accordance with the design basis licence conditions, and with primary consideration given to safety aspects.
16. Site survey and site evaluation				
Basis	Requirement 31 of GSR Part 3 [9] Requirements of SSR-1 [15] as a whole			
167				The operating organization should prepare the chapter on site evaluation in the safety analysis report and then update it, taking into account the specificities of the nuclear power plant selected and the data and information gathered during the pre-operational stage.
168				The operating organization should implement necessary safety improvements to the site, as site protection measures determined as a result of the external hazard assessment.
169				The operating organization should continue to implement the environmental programme and the site monitoring programme.
17. Design safety				
Basis	Requirements 5, 15, 16 and 29 of GSR Part 3 [9] Requirements of SSR-2/1 (Rev. 1) [16] as a whole Requirements 10 and 11 of SSR-2/2 (Rev. 1) [14] Requirements 15 and 16 of SSR-4 [42]			
177				The operating organization should establish a ‘design authority’ that will maintain the knowledge of the safety design and its configuration management over the lifetime of the plant.

178				The operating organization should conduct an adequate safety review of the designs proposed by the vendors in the submitted bids or contract negotiations, including an assessment of the associated sets of codes and standards.
179				The operating organization should establish proper interaction with the selected vendor for the preparation of the safety documents.
180				The government and the operating organization should ensure the completion of all the required improvements of the national technical infrastructure consistent with the plant design.
181				The operating organization should prepare and provide to the regulatory body the safety documents required in the licensing process.
182				The regulatory body should review and assess the safety documentation, such as the safety analysis report, and should verify the compliance of the design with regulatory requirements.
183				The operating organization should ensure the adequate validation and verification of the design of the nuclear power plant and its structures, systems and components, and the regulatory body should review this validation and verification.
184				The operating organization and the regulatory body should implement their respective processes to address modifications made to the design during construction and afterwards.
18. Preparation for commissioning				
Basis	Requirement 25 of SSR-2/2 (Rev. 1) [14]			
185				The regulatory body should issue requirements on commissioning, including the establishment of a severe accident management programme.
186				The operating organization should establish a comprehensive commissioning programme, should prepare the corresponding chapter of the safety analysis report, as appropriate, and should ensure that there are a sufficient number of competent operating staff to be involved in commissioning activities.

187				The operating organization should establish mechanisms for the transfer of responsibilities for safety with the constructor at the end of Phase 3.
188				The regulatory body should review and assess the commissioning programme, should verify compliance with requirements and should prepare a programme to oversee the commissioning of systems important to safety in the next phase.
19. Transport safety				
Basis	Requirement 7 of GSR Part 1 (Rev. 1) [5] Requirement 2 of GSR Part 3 [9] Requirement 2 of GSR Part 7 [13] Provisions of SSR-6 (Rev. 1) [17] as a whole			
192				The regulatory body and the organizations in charge of the transport of radioactive material should fully implement the changes to the national requirements and arrangements for the transport of radioactive material in accordance with the plan developed in Phase 2.
20. Interfaces with nuclear security				
Basis	Requirement 12 of GSR Part 1 (Rev. 1) [5] Requirement 6 of GSR Part 2 [8] Requirement 5 of GSR Part 5 [11] Requirements 2 and 23 of GSR Part 7 [13] Requirement 8 of SSR-2/1 (Rev. 1) [16] Requirement 17 of SSR-2/2 (Rev. 1) [14]			
195				The regulatory body (possibly consisting of several authorities) should ensure that nuclear security regulations do not compromise safety and that safety regulations do not compromise nuclear security.
196				All relevant organizations should ensure that emergency preparedness and response plans in the field of safety and contingency and response plans in the field of nuclear security are complementary, coherent and well coordinated among all the entities involved.
197				The operating organization and the regulatory body should continue to foster safety culture and nuclear security culture in their respective organizations.

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