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IAEA SAFETY STANDARDS

For protecting people and the environment

Establishing the Safety Infrastructure for a Nuclear Power Programme

Revision 03

Status: Step 7 – Approval by the relevant safety review committees for submission to Member States for comments

Please be informed that the document is in track changes mode for Member States' convenience. The changes are the outcome of the Agency review of the document

DRAFT SPECIFIC SAFETY GUIDE

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 at the IAEA Internet site

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

The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at 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 and protection 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 **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

ESTABLISHING THE SAFETY INFRASTRUCTURE FOR A NUCLEAR POWER PROGRAMME

SPECIFIC SAFETY GUIDE

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FOREWORD

by Yukiya Amano
Director General

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

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

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

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

Safety is not an end in itself but a prerequisite for the purpose of the protection of people in all States and of the environment — now and in the future. The risks associated with ionizing radiation must be assessed and controlled without unduly limiting the contribution of nuclear energy to equitable and sustainable development. Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used

NOTE BY THE SECRETARIAT

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. The process of developing, reviewing and establishing the IAEA standards involves the IAEA Secretariat and all Member States, many of which are represented on the four IAEA safety standards committees and the IAEA Commission on Safety Standards.

The IAEA standards, as a key element of the global safety regime, are kept under regular review by the Secretariat, the safety standards committees and the Commission on Safety Standards. The Secretariat gathers information on experience in the application of the IAEA standards and information gained from the follow-up of events for the purpose of ensuring that the standards continue to meet users' needs. The present publication reflects feedback and experience accumulated until 2010 and it has been subject to the rigorous review process for standards.

Lessons that may be learned from studying the accident at the Fukushima Daiichi nuclear power plant in Japan following the disastrous earthquake and tsunami of 11 March 2011 will be reflected in this IAEA safety standard as revised and issued in the future.

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 is necessary to take the measures recommended (or equivalent alternative measures). The Safety

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

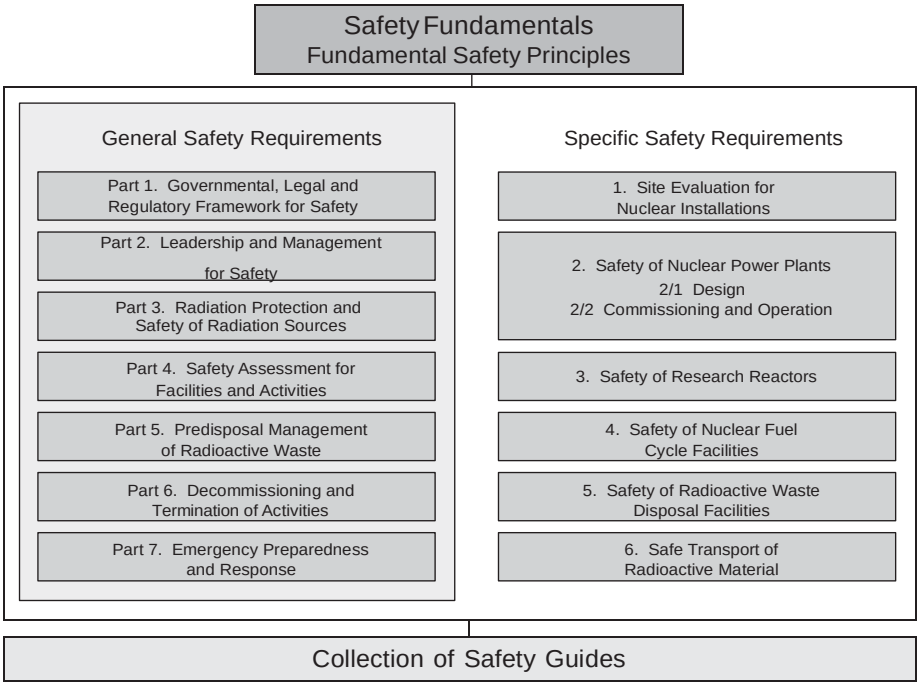

FIG. 1. The long term structure of the IAEA Safety Standards Series.

Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

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

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

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

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

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

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

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

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

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

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

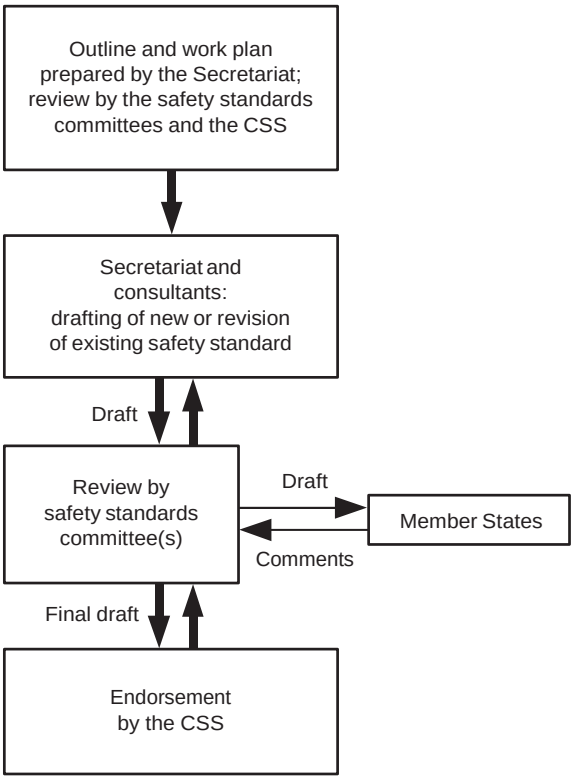

FIG. 2. The process for developing a new safety standard or revising an existing standard.

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.asp~~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. The IAEA General Conference encouraged the Secretariat to develop approaches to supporting the development of infrastructure for nuclear power in States either considering the introduction of nuclear power or expanding an existing nuclear power programme. A number of States have requested guidance on how to apply the IAEA Safety Standards in the development of a nuclear power programme.

1.2. The IAEA Safety Fundamentals publication on 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 may be more or less important in relation to particular circumstances, the appropriate application of all relevant principles is required. 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; ~~and~~ Principle 4, Justification of facilities and activities and Principle 9 on Emergency preparedness and response ,~~—~~are crucial to preparing properly for the future safe operation of nuclear power plants.

1.3. A considerable period of time is necessary to acquire the necessary competences and a strong safety culture before construction and operating a nuclear power plant. While prime responsibility for safety must rest with the operating organization, the State has the responsibility, upon committing itself to a nuclear power programme that demands significant investment, to create a robust framework for safety. This responsibility is incumbent on those who live and work within the State and it cannot be outsourced. Establishing a sustainable safety infrastructure is a long process, and it has been internationally acknowledged that a period of 15 years under optimum conditions would generally be needed between the consideration of nuclear power as part of the national energy strategy and the commencement of operation of the first nuclear power plant.

1.4. In 2007, the IAEA published a brochure entitled Considerations to Launch a Nuclear Power Programme [2] and a report entitled Milestones in the

Safety

Infrastructure for a National Nuclear Power Programme Supported by the IAEA Fundamental Safety Principles (INSAG-22) [4]. This INSAG report defines 'nuclear safety infrastructure' as "the set of institutional, organizational and technical elements and conditions established in a State to provide a sound foundation for ensuring a sustainable high level of nuclear safety".

1.5. In 2010, the IAEA Board of Governors approved for publication an IAEA Safety Requirements publication on the Governmental, Legal and Regulatory Framework for Safety [5], which establishes requirements in respect of the infrastructure for safety. Reference [5] 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, from the use of a limited number of radiation sources to a nuclear power programme. This framework for safety is essentially the governmental part of the 'nuclear safety infrastructure'.

1.6. In INSAG-22 [4], consistent with Refs [2, 3], the lifetime of a nuclear power plant is divided into five phases from a nuclear safety standpoint and indicative average durations are provided for each of these phases. The present Safety Guide uses the same approach in considering Phases 1, 2 and 3:

- Phase 1 is 'Safety infrastructure before deciding to launch a nuclear power programme' (average duration: 1–3 years);
- Phase 2 is 'Safety infrastructure preparatory work for construction of a nuclear power plant after a policy decision has been taken' (average duration: 3–7 years);
- Phase 3 is 'Safety infrastructure during implementation of the first nuclear power plant' (average duration: 7–10 years);
- Phase 4 is 'Safety infrastructure during the operation phase of a nuclear power plant' (average duration: 40–60 years);
- Phase 5 is 'Safety infrastructure during the decommissioning and waste management phases of a nuclear power plant' (average duration: 20 to more than 100 years), as shown in Fig.1.

1.7. This Safety Guide provides recommendations, presented in the form of sequential actions, on meeting safety requirements progressively during Phases 1, 2 and 3 of the development of the safety infrastructure (see Fig. 2).

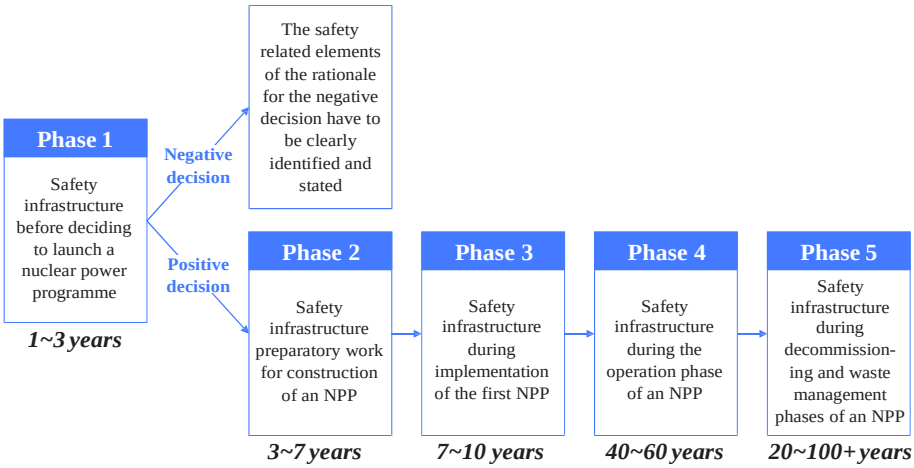

FIG. 1. Main phases of safety infrastructure development over the lifetime of a nuclear power plant (based on INSAG-22 [4]). NPP: nuclear power plant.

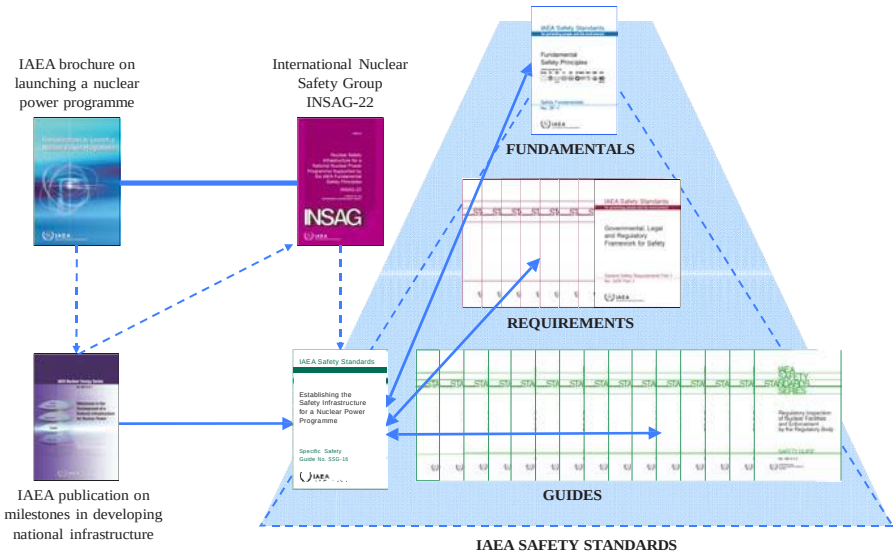

FIG. 2. This Safety Guide provides guidance on the progressive implementation of the IAEA safety standards.

1.8. The use of the IAEA Safety Requirements publications alone is not considered sufficient to understand the need for or to develop a safety infrastructure. It is expected that the organizations or persons using this Safety Guide will understand and use the recommendations provided in the Safety Guides supporting the Safety Requirements publications in the respective subject areas. The IAEA promotes national 'self-assessments' and provides for the application of its safety standards through safety review services such as the Integrated Regulatory Review Service (IRRS), ~~or~~ the Operational Safety Review Team service (OSART) or the Emergency Preparedness Review service (EPREV) upon request by the State, to guide and/or to peer review a national self- assessment in specific areas.

1.9. 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'.

1.10. 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. The 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 the associated Safety Guides.

1.11. 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 may have few or no nuclear activities already established, others may have extensive experience from 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 no regulatory body and no 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 a future revision of this Safety Guide.

1.12. This Safety Guide is intended for use by any 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'. This includes:

— Governmental officials;

— Organizations that are given an explicit governmental mandate to assess the feasibility of or to coordinate the development of a nuclear power programme[1];
— Regulatory bodies;
— Operating organizations;
— External expert support entities, including technical and scientific support organizations[2];
— Industrial organizations, including plant vendors, manufacturers, designers and constructors;
— Organizations for radioactive waste management and spent fuel management;
— Organizations involved in preparedness for and response to a nuclear or radiological emergency;
— Organizations involved in the transport of nuclear material;
— Competent authorities for matters relating to nuclear security;
— Education and training organizations;
— Research centres[3].

1.13. International organizations may use this Safety Guide to help 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.

1.14. Any 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. They 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 properly managing the radioactive waste generated during plant operation and decommissioning.

1.15. 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 (the government as a whole, executive body, the legal system, regulatory body, etc.) is responsible for a given action. In such cases, the general term ‘State’ or ‘government’ is used.

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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. For the purpose of this Safety Guide, such

organizations are referred to by the general term ‘the government’.

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

OBJECTIVE

1.16. The objective of this Safety Guide is to provide guidance on the establishment of a framework for safety in accordance with the IAEA safety standards for States deciding on and preparing to embark on a nuclear power programme. In this regard, it proposes ~~200~~ 197 safety related actions to be taken in the first three phases of the development of the nuclear power programme, to achieve the foundation for a high level of safety throughout the entire lifetime of the nuclear power plant, including safety in the associated management of radioactive waste and spent fuel, and safety in decommissioning.

1.17. This Safety Guide is intended to contribute to the building of leadership and management for safety and of a safety culture. It is intended for use as guidance for self-assessment by all organizations involved in the development of a safety infrastructure.

1.18. The government, through the legal system, establishes national policy for safety by means of different instruments, statutes and laws. The regulatory body, as designated by the government, is charged with the implementation of policies through a regulatory programme or a strategy set forth in its regulations or standards. The government, through the legal system, 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 plans and promulgates regulations in execution of such laws or 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 for effective coordination. The recommendations made in this Safety Guide are to be understood in the context of these respective functions, although some flexibility may be necessary in following them, depending on the particular national circumstances.

SCOPE

1.19. The scope of 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 ~~200~~ 197 actions.

1.20. This Safety Guide addresses the gradual application of IAEA safety standards during the development of the ~~necessary~~ safety infrastructure during the first 3 phases of a nuclear power programme.
During Phase 1, the country will analyse all issues that would be involved in introducing nuclear power, so that at the end of Phase 1, it is in a position to make a knowledgeable decision on whether or not to introduce nuclear power. ~~In phase 1, the government is preparing to take before a decision on whether or not to launch a nuclear power programme .is taken~~
During Phase 2, the country will carry out the work required to prepare for the regulating, contracting, financing and construction of a nuclear power plant.~~In p~~(Phase 21), ~~the government/operating organization is preparing to select the safety infrastructure for preparatory work for the construction of a~~the nuclear ~~power plant~~ design and vendor.~~.~~
For countries 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 countries, 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.
~~1.20. In (Pphase 32), , the operating organization is anengaged in procurement, construction and licensingd the safety infrastructure during construction activities and preparing for the commissioning of the first nuclear power plant. The regulatory body is performing review and assessment of licensing applications, conducting inspections and issuing licenses.(Phase 3) (see Fig. 3)~~
~~1.21.~~
1.21. Figure 3 provides an indicative time frame ~~with some steps~~and some important milestones expected in each one of the phases. At ~~T~~the end of phase 1, the country is ready to make a knowledgeable commitment to a nuclear power programme~~, is reached when the decision about the nuclear power programme is taken~~. At the end of phase 2, the country is ready ~~to select the nuclear power plant design and vendor. This selection could be taken through a competitive bidding process or by direct negotiations through intergovernmental agreements or the use of alternative contracting and ownership arrangement.~~to invite bids/negotiate a contract for the first nuclear power plant. At the end of ~~The end~~

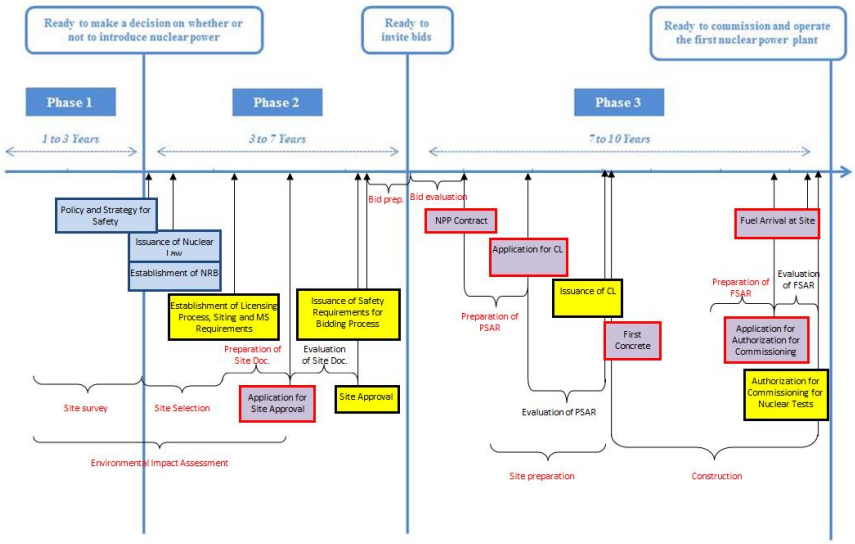
~~safety in establishing a safety infrastructure for a nuclear power programme.~~

1.22. Figure 4 utilizes this time-frame to provide insights on 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 organizations involved in emergency preparedness and response. This also reflects the development of sufficient human resources with the competence to perform the necessary activities. In addition, Fig. 4 identifies, for each relevant IAEA Safety Requirements publication, at which stages, respectively:

— There should be awareness of the requirements;
— Implementation of the requirements should be started;
— Requirements should be fully implemented.

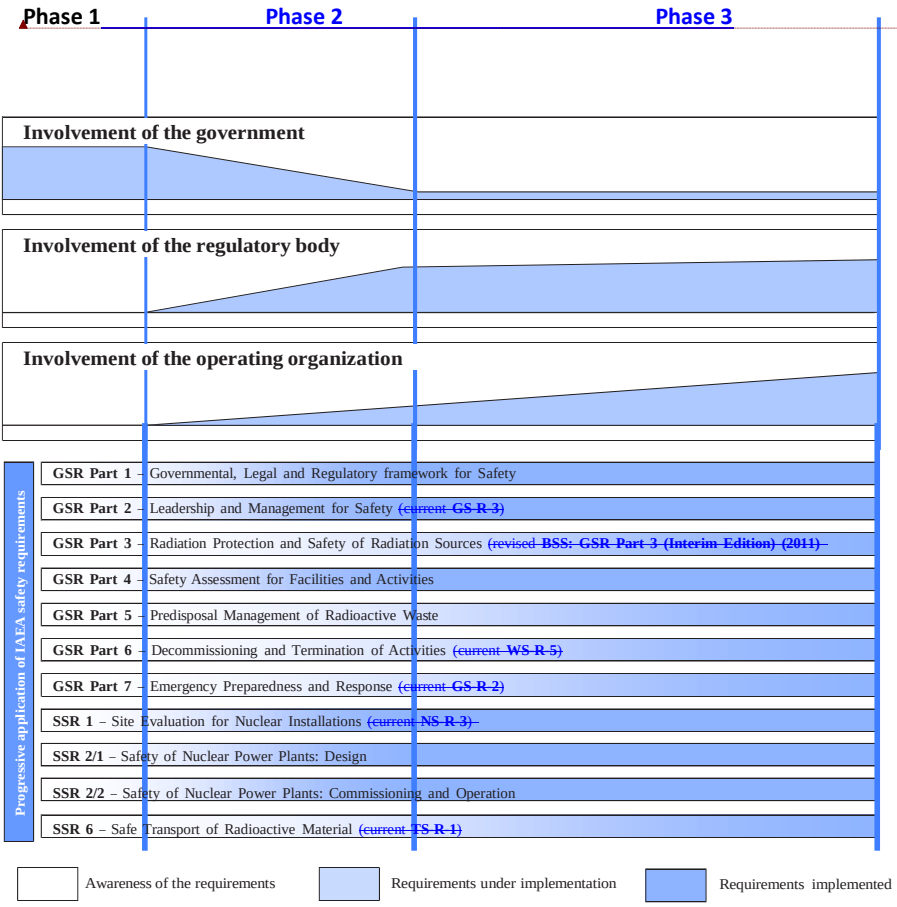
1.23. Research reactors and nuclear fuel cycle facilities are not explicitly covered in this Safety Guide, which concentrates on the nuclear power programme.

The Fundamental Safety Principles [1] state 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 the INSAG report on The Interface Between Safety and Security at Nuclear Power Plants [7].



New Figure 3

FIG. 3. Indicative time frame and some important milestones for the development of a nuclear safety infrastructure.



The initial degree of application of these requirements may vary from State to State depending on the use of radioactive sources and/or nuclear installations (other than NPPs) before considering the nuclear power option.

FIG. 4. Progressive involvement of the main organizations in a nuclear power programme and progressive application of the IAEA Safety Requirements (indicative only, to be used with flexibility).

1.24. The IAEA's statutory mandate concerns risks associated with ionizing radiation. Conventional risks such as risks associated with chemical hazards are not within the purpose and scope of this Safety Guide; however, they also have to be regulated by the State.

STRUCTURE

1.25. Sections 2 and 3 provide guidance on the development of a nuclear safety infrastructure in line with the IAEA safety standards during Phases 1, 2 and 3. Section 2 addresses the 'general safety requirements' of this infrastructure (elements 1–14), while Section 3 addresses the 'specific safety requirements' of the infrastructure (elements 15–20), in accordance with the structure of the IAEA Safety Standards Series (see Fig. 5). 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 to be complied with.

1.26. In the text, for each of the elements considered, numbered actions appear as 'should' statements, and then the following paragraphs provide the user with further background on, and the rationale for, these numbered actions.

1.27. This Safety Guide specifies, for each phase, the IAEA Safety Requirements publications that serve as a basis for the actions.

1.28. The appendix consists of a summary of all the actions (as 'should' statements) which should be taken in Phases 1, 2 and 3, respectively, as well as the bases for these actions.

1.29. The IAEA's web sites provide a comprehensive list of relevant IAEA Safety Requirements and Safety Guides, as well as other key safety related publications such as INSAG reports (http://www-ns.iaea.org/standards, http://www-pub.iaea.org/books).

	20 ELEMENTS OF THE SAFETY INFRASTRUCTURE	MAIN SUPPORTING IAEA SAFETY REQUIREMENTS IDENTIFIED	CORRESPONDING NUMBER IN THE LONG-TERM STRUCTURE
SECTION 2 General Safety Requirements	1 - National policy and strategy	GSR Part 1	GSR Part 1
	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		
	8 - Leadership and management for safety	GS-R-3	GSR Part 2
	9 - Human resources development		
	10 - Research for safety and regulatory purposes		
	11 - Radiation protection	~~Current BSS (~~GSR Part 3 ~~(Interim) 2011)~~	GSR Part 3
	12 - Safety assessment	GSR Part 4	GSR Part 4
	13 - Safety of radioactive waste, spent fuel management and decommissioning	GSR Part 5 GSR Part 6~~WS-R-5~~	GSR Part 5 GSR Part 6
	14 - Emergency preparedness and response	GS-R Part 7~~-2~~	GSR Part 7
SECTION 3 Specific Safety Requirements	15 - Operating organization	~~NS-R-2 (being revised)~~SSR 2/2	SSR 2/2
	16 - Site survey, site selection and evaluation	NS-R-3	SSR 1
	17 - Design safety	~~NS-R-1 (being revised)~~SSR 2/1	SSR 2/1
	18 - Preparation for commissioning	~~NS-R-2 (being revised)~~SSR 2/2	SSR 2/2
	19 - Transport safety	SSR- 6~~TS-R-1~~	SSR- 6
	20 - Interfaces with nuclear security	GSR Part 1	GSR Part 1

FIG. 5. Structure of Sections 2 and 3 of this Safety Guide, in accordance with the structure of the IAEA Safety Standards Series.

1.30. The IAEA web site provides a listing of current IAEA safety standards as well as downloadable files for all standards and information on IAEA safety standards being drafted or reviewed: http://www-ns.iaea.org/downloads/standards/status.pdf

1.31. The IAEA ~~has set~~is setting up a web site for this Safety Guide to provide users with hyperlinks to the applicable Safety Requirements (http://www-ns.iaea.org/tech- areas/safety-infrastructure).

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 ~~justification~~ for embarking on a ~~NPP~~nuclear power programme needs to recognize the possibility of a nuclear emergency, including one resulting from a severe accident ~~more than those considered in the design~~ and the country's ability to deal with the consequences of such an accident.

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.

~~2.3~~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 may 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 handling of radioactive material in large amounts. In this Safety Guide, for the sake of generality, 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 that could present its findings to the government's highest level decision makers.

~~2.4~~2.5 From the earliest phase of the development of safety infrastructure, the prime responsibility for safety will rest with the prospective facility operating

governmental, legal and regulatory framework to support a high level of safety [5]. The prime responsibility for safety cannot be delegated or outsourced [1]; it must be discharged by the operating organization through leadership, adequate funding, sufficient expertise, and legal responsibility, training and education. Regulatory oversight will be a is important to verify ensure that the operating organization discharges its responsibility for safety completely and effectively and to enforce compliance with applicable safety standards. driving force.

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

2.7 The implementation of safety improvements cannot detract NPP operators and regulatory bodies 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 developing a specific new design. Nevertheless, the choice will be made from among various available technologies. Such a choice may be made at different times depending on the overall policy, but in any case, the policy should emphasize the effective transfer of competence in safety to the State. If there is a strategy of the State to establish an early partnership with a certain other State, the selection of a technology can take place in Phase 1 as part of the decision process to move forward with the nuclear option, or early in Phase 2. In such a case, the partnership between the State providing the technology and the State embarking on a nuclear power programme should include agreements at the governmental level to establish the framework for and objectives of such cooperation. An alternative strategy — the strategy that is described in this Safety Guide — would be first to develop a national knowledge base through a large network of international contacts during Phase 2, and then to open a bidding process.

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 required competence to manage the nuclear technology and to safely conduct nuclear activities is an essential requisite for a sustainable programme. This development programme for the

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 1 of GSR Part 1 [5];
— Requirements 10 and 29 of GSR Part 3 [8];
— Requirement 2 of GSR Part 5 [9].
— Requirement 2 of GSR Part 7 [26].
—

Action 1. The government should consider the necessary elements of a national policy and strategy for safety to meet the fundamental safety objective and the principles established in the IAEA Safety Fundamentals [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 radiological 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 or not to introduce a nuclear power programme.

2.10 In a national policy and strategy for safety, the fundamental safety objective and the fundamental safety principles established in the IAEA Fundamental Safety Principles [1] apply:

— Principle 2 of the IAEA Fundamental Safety Principles [1], 'Role of government', 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…".
— The national position should reflect an understanding of the principles expressed in the IAEA's Fundamental Safety Principles [1], in particular Principle 4: Justification of facilities and activities, which states that "Facilities and activities that give rise to radiation risks must yield an

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.

2.11 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 needed to facilitate a knowledgeable decision regarding a prospective nuclear power programme, it may be appropriate for the government to appoint a project organization that is given an explicit governmental mandate.

2.12 The government should also take into account:

- Binding international instruments and other international instruments (see also paras ~~2.18–2.32~~ 2.20-2.36 on the global nuclear safety regime);
- The necessary scope and elements of the governmental, legal and regulatory framework for safety (see also paras ~~2.33–2.47~~ 2.37-2.52 on the legal framework and paras ~~2.48–2.83~~ 2.53-2.90 on the regulatory framework);
- The need for and provision for a vigorous competence building programme and the associated human and financial resources (see also paras ~~2.158–2.177~~ 2.173-2.189 on human resources development and paras ~~2.97–2.106~~ 2.106-2.115 on funding and financing);
- The provisions and framework for research and development (see also paras ~~2.178–2.189~~ 2.190-2.201 on research for safety and regulatory purposes);
- The promotion of leadership and management for safety, including safety culture (see also paras ~~2.142–2.157~~ 2.152-2.172 on leadership and management for safety);
- The need for and provision for spent fuel management and radioactive waste management, including disposal of radioactive waste (see also paras ~~2.222–2.238~~ 2.236-2.252 on safety of radioactive waste management, spent fuel management and decommissioning’); ~~and~~
- Potential environmental, social and economic impacts of a prospective nuclear power ~~programme~~programmer; and~~.~~
- The need for upgrade or for establishment of all supporting infrastructure, including for example the infrastructure necessary to support emergency preparedness and response arrangements.

2.13 Although the State may already have experience in the management of research reactors or radioactive sources, there are new activities that should be commenced in a timely manner, and that will require the corresponding resources

2.14 In most States, major projects are subject to environmental restrictions and their promoters have the obligation to demonstrate the impacts of their project (including the impacts of the different alternatives considered) by means of a document generally called the 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. Interfaces, roles and coordination among other organizations involved in the environmental impact assessment should also be taken into consideration. For a nuclear power plant project, such a report is very broad and the radiological environmental impact analysis is only a part of the 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 (all types, i.e. water, air and soil pollution, noise, vibration, light, heat, radiation). This Safety Guide deals only with the radiological impacts, in accordance with the statutory mandate of the IAEA[3]. Principle 7 of the IAEA Fundamental Safety Principles [1] states that

[3] Although non-radiological aspects of safety (e.g. industrial safety, fire safety) and environmental protection are not explicitly considered in this Safety Guide, States are expected to fulfil their international undertakings and obligations in relation to these.

"People and the environment, present and future, must be protected against radiation risks". The radiological environmental impact analysis (which in most States constitutes one section of the environmental impact assessment) is further addressed in paras ~~2.190–2.201~~ 2.190-2.201 on radiation protection and paras ~~3.24–3.48~~ 3.26-3.53 on site survey and site evaluation. In the event that the State already has a regulatory body for radiation protection and nuclear safety, this body should contribute to the review of the environmental impact assessment in its field of responsibility.

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

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 1 of GSR Part 1 [5];
— Requirements 10 and 29 of GSR Part 3 [8];
— Requirement 2 of GSR Part 5 [9].
— Requirement 2 of GSR Part 7 [26]..
—

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 the IAEA Safety Fundamentals [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.

that their development is adequately coordinated.

2.16 After the State has decided to introduce a nuclear power programme, the implementation of activities begins in Phase 2. In Phase 2, 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.

2.17 The government should establish 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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 1 of GSR Part 1 [5];
— Requirements 10 and 29 of GSR Part 3 [8];
— Requirement 2 of GSR Part 5 [9].
— Requirement 2 of GSR Part 7 [26]..

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 are fulfilling their responsibilities.

2.18 The government should ensure that the coordination mechanisms put in place are efficient and effective, and should improve them as necessary.

2.19 Other actions to be taken by the government are described in the following sections of this Safety Guide.

ACTIONS 11–19: GLOBAL NUCLEAR SAFETY REGIME

General

2.20 A nuclear power programme in any State cannot be treated in isolation.~~,~~ A nuclear accident could have health and safety effects beyond national borders due to potential transboundary radioactive releases, and impact on the worldwide public opinion.~~owing to the potential transboundary effects of a radioactive release. A nuclear accident could have consequences anywhere through the impact on public opinion.~~ States have a shared need for universal safe operation of nuclear facilities and safe conduct of activities. The national safety policy and the strategy adopted by the government should therefore take full benefit of effective participation in the global nuclear safety regime. However, the prime responsibility for safety rests within each State and with the licensed operators of nuclear facilities.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, ~~and~~ 14 and 36 of GSR Part 1 [5].

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 regarding its projects for establishing a nuclear power programme.

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

2.21 Specific considerations 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.

~~2.5~~2.22 States embarking on a nuclear power programme should cooperate

(i.e. States with territories within emergency planning zones and distances [~~GSR Part 7~~26]) towards ensuring exchange of information relevant to EPR in relation to the nuclear power programme. Such a coordination and cooperation should be done on all levels from local authorities and response organizations to national authorities and response organizations including regulatory body, as necessary

~~2.21~~2.23 International cooperation and assistance is an opportunity to share and benefit from the experience of States that have already implemented, or are also in the process of implementing, a nuclear power programme. In 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 derive benefit from international operating experience and regulatory experience and from the dissemination of lessons learned. Liaising with other States with similar objectives for nuclear power programmes should also be considered.

~~2.22~~2.24 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:

— The international conventions that establish robust common principles and obligations for ensuring safety in the use of radiation, radioactive material and nuclear energy, and to provide an effective coordinated response to emergencies;
— Codes of conduct that promote good practices in the relevant operations;
— Internationally agreed IAEA safety standards that support the development of harmonized national safety requirements, guides and practices;
— International peer reviews of safety levels that aim for mutual learning by participating Member States;
— Knowledge networks and expert networks;
— Multinational and bilateral cooperation in safety matters that is aimed at enhancing safety by means of harmonized approaches and the increased quality and effectiveness of safety reviews and inspections.

~~2.23~~2.25 In this phase, the government gives consideration to becoming party to international conventions and codes of conduct such as:

— The Convention on Nuclear Safety[4] [10];
— The Convention on Early Notification of a Nuclear Accident [11];
— The Convention on Assistance in the Case of a Nuclear Accident or

Safety of Radioactive Waste Management [13];

— The Convention on the Physical Protection of Nuclear Material and the Amendment thereto [14];

— The Code of Conduct on the Safety and Security of Radioactive Sources [15].

[4] The Convention on Nuclear Safety, which was developed to promote and harmonize nuclear safety, is a legally binding international agreement that was ratified by all States with operating nuclear power plants. The Convention sets up a system of national reporting and peer reviews to ensure that States are complying with their obligations to meet recognized international safety standards and to apply good practices.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 14 of GSR Part 1 [5];
— Requirements 6.3–6.6 of GS-R-3 [16],
— Requirement 24 of SSR 2/2 [17]

Action 14. All the 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 with advanced nuclear power programmes.

~~2.24~~2.26 One important consideration in the successive decision processes in a nuclear power programme is the interdependence of activities relating to nuclear power between all States. In Phase 2, activities that are required in the international agreements and conventions identified in Phase 1 should therefore be commenced. This will help to promote safety nationally and globally, as well as enhancing international confidence and trust. The consent of a State to be bound by international instruments may be expressed by means of signature, ratification, acceptance, approval or accession in accordance with the provisions of the respective instrument.

~~2.25~~2.27 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 participate, although for different reasons, in their respective international networks. An important part of international cooperation and assistance would be the exchange of construction ~~experience and~~ operating and emergency management experience. The regulatory body should assess whether experience indicates that modifications are needed in the regulatory requirements or whether more attention will be given to certain safety issues in assessment and inspections. The operating organization should participate to be alerted to experience that may indicate the need for design changes or the reconsideration

~~2.6~~2.28 Effective participation in international activities and networks promotes the transfer of knowledge on lessons learned and best practices from other States. This includes reporting operating and regulatory experience to the networks in timely manner. It also facilitates the provision of support by States with advanced nuclear power programmes. Such support could include two way long term assignments of experts: whether consultants from other States coaching the developing organizations or experts sent to other States for on the job training.

~~2.27~~2.29 Commitment to complying with the IAEA safety standards and to participation in international safety reviews and safety services on the basis of 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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 14 of GSR Part 1 [5];
— Requirements 6.3–6.6 of GS-R-3 [16];
— Requirement 24 of SSR-2/2 ~~Ref.~~ [17].

Action 17. All the 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.

~~2.28~~2.30 The State should participate in the review meetings of the relevant international conventions to which it has become a party.

~~2.29~~2.31 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.

~~2.30~~2.32 To gain feedback from regulatory bodies in other States, the regulatory body should extend its contacts, in particular through its participation in bilateral, multilateral and international cooperation and assistance on the subject of a nuclear power programme.

~~2.31~~2.33 Assistance from the regulatory body of the supplier State, as well as from other regulatory bodies that have oversight experience with other nuclear power plants of the same type as that selected, including temporary assignments of staff, should be sought to the extent possible.

~~2.32~~2.34 Exchange of results of safety reviews, peer reviews and joint inspections with regulatory bodies in other States having oversight experience with nuclear power plants of the type selected could be used for increasing the understanding of important safety issues, for experience sharing and for transparency among interested parties and the public–.

~~2.33~~2.35 The operating organization should establish professional cooperation arrangements with operating organizations in other States, as well as with international operator organizations such as the World Association of Nuclear Operators (WANO).

~~2.34~~2.36 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

~~2.35~~2.37 Principle 2 of the IAEA's Fundamental Safety Principles [1], 'Role of government', states that "An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained."

~~2.36~~2.38 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

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 2, 3 and 4 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirement 1 of GSR Part 5 [9];
— Requirements ~~3.3 and 3.~~4 of ~~WS-R-5~~GSR Part 6 [18],
— Requirements 2 and 20 of GSR Part 7 [26].

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

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

2.39 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 may have been met in respect of other activities. The State should therefore perform a complete assessment of the need for legislation and a regulatory framework to support the safe operation and effective oversight and licensing of a nuclear power plant as well as to support the establishment and maintenance of emergency arrangements.

~~2.37~~2.40 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. The IAEA's Handbook on Nuclear Law [19] provides detailed guidance on this subject.

~~2.38~~2.41 A nuclear law, which should ensure transparency and should be clearly understandable, is prepared in Phase 1 so as to be enacted ~~as a starting point of~~early in Phase 2. As established in GSR Part 1 [5], para. 2.5, a governmental, legal and regulatory framework for safety is required to set out the following:

(1) 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 ~~2.190–2.201~~ 2.202-2.214 on radiation protection);

(3) The type of authorization[5] that is required for the operation of facilities and the conduct of activities, in accordance with a graded approach;
(4) The rationale for the authorization of new facilities and activities and the applicable decision making process;
(5) Provision for the involvement of interested parties and for their input in decision making (see also paras ~~2.84–2.96~~ 2.91-2.105 on transparency and openness);
(6) 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 3.1–3.2~~3~~5 on the operating organization);
(7) The establishment of a regulatory body (see also paras ~~2.48–2.83~~ 2.53-2.90 on the regulatory framework);
(8) Provision for the review and assessment of facilities and activities, in accordance with a graded approach (see also paras ~~2.202–2.221~~ 2.215-2.235 on safety assessment);
(9) The authority and responsibility of the regulatory body for promulgating (or preparing for enactment) regulations and preparing guidance for their implementation (see also paras ~~2.48–2.83~~ 2.53-2.90 on the regulatory framework);
(10) Provision for the inspection of facilities and activities and for the enforcement of regulations, in accordance with a graded approach (see also paras ~~2.48–2.83~~ 2.53-2.90 on the regulatory framework);
(11) Provision for appeal against decisions of the regulatory body;
(12) Provision for preparedness for and response to a nuclear or radiological emergency (see also paras ~~2.239–2.250~~ 2.253-2.269 on emergency preparedness and response);
(13) Provision for the interface with nuclear security (see also paras ~~3.94–3.108~~ 3.102-3.112 on interfaces with nuclear security);
(14) Provision for the interface with the system of accounting for and control of nuclear material (this is not further addressed in this Safety Guide);
(15) Provision for acquiring and maintaining the necessary competence nationally for ensuring safety (see also paras ~~2.158–2.177~~ 2.173-2.189 on human resources development and paras ~~2.178–2.189~~ 2.190-2.201 on research for safety and regulatory purposes);

[5] 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.

(16) Responsibilities and obligations in respect of financial provision for the management of radioactive waste and of spent fuel, and for decommissioning of facilities and termination of activities (see also paras ~~2.222–2.238~~ 2.236-2.252 on safety of radioactive waste management, spent fuel management and decommissioning, and paras ~~2.97–2.106~~ 2.106-2.115 on funding and financing);
(17) The criteria for release from regulatory control;
(18) The specification of offences and the corresponding penalties;
(19) Provision for controls on the import and export of nuclear material and radioactive material and for their tracking within and, to the extent possible, outside national boundaries, such as tracking of the authorized export of radioactive sources (this is not further addressed in this Safety Guide).

~~2.39~~2.42 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. Firstly, it reduces the amount of new legal texts to be drafted. Secondly, it takes advantage of the technical or legal expertise of experienced organizations or States. Thirdly, in the case of incorporation of IAEA models, it can help a State to comply with the requirements of the IAEA and to receive IAEA technical assistance.

~~2.40~~2.43 These advantages are accompanied by difficulties that should be given careful consideration, however. Firstly, there are concerns about whether and how international requirements or requirements of another State will fit into a State's legal structure. Secondly, standards or guidelines prepared elsewhere may contain provisions that are inconsistent with or contradictory to important features of a State's legal structure. Thirdly, translation might raise other concerns, since terms relating to nuclear energy that are derived from another language may be meaningless or confusing to persons expected to apply the national law or to comply with it. In addition, difficulties may arise from the fact that the external requirements (e.g. international instruments) may be subject to change, even on a regular basis.

~~2.41~~2.44 There is a relationship between the development of nuclear legislation and the consideration of becoming party to the international conventions in the field of nuclear energy. The State should therefore ensure that the nuclear law is consistent and reflects the provisions of the relevant international instruments.

~~2.42~~2.45 After preparation of a reasonably detailed initial draft, many governments have found it useful to subject the draft nuclear law to an independent review, to assess its adequacy and public acceptability.

~~2.43~~2.46 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 safety related. Such laws concern: radiation 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.

~~2.44~~2.47 States usually have specific laws for the management of crisis/emergencies such as: earthquakes, floods, CBRN (chemical, biological, radiological, nuclear materials) and to provide for protection of the public. They are referred to as civil protection authorities and have the responsibility to protect and rescue the public in any type of emergency. For a nuclear emergency, they will also take a role into implementing public protective actions but this may require some amendments in the law to cover this in line with the nuclear law too.

~~2.45~~2.48 In Phase 1, the government should recognize that effective licensing requires a sound legal and governmental infrastructure, including a regulatory body with well-defined responsibilities and functions. To conduct licensing effectively, the general process to be utilized 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. Further information on this topic is given in Ref. [20].

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 2, 3 and 4 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirement 1 of GSR Part 5 [9];
— Requirement~~s 3.3 and 3.~~4 of ~~WS-R-5~~GSR Part 6 [18],
— Requirements 2 and 20 of GSR Part 7 [26]

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

~~2.46~~2.49 During Phase 2, all essential legislation identified during the assessment process of Phase 1 should be enacted.

~~2.47~~2.50 To ensure consistency of legislation, the State should also complement or amend the related laws identified in Phase 1.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 2, 3 and 4 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirement 1 of GSR Part 5 [9];
— Requirements ~~3.3 and 3.~~4 of ~~WS-R-5~~GSR Part 6 [18],
— Requirements 2 and 20 of GSR Part 7 [26].
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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.

~~2.48~~2.51 In 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.

~~2.49~~2.52 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 regulatory bodies or audits conducted under an appropriate quality management system are examples in this regard.

ACTIONS 24–38: REGULATORY FRAMEWORK

General

~~2.50~~2.53 Principle 2 of the IAEA's Fundamental Safety Principles [1], 'Role of government', states that "An effective legal and governmental framework for safety, including an independent regulatory body, must be

~~2.51~~2.54 In a nuclear power programme, the regulatory body should verify that site evaluation, design, construction, commissioning, operation and decommissioning comply with the relevant safety standards. The core functions of the regulatory body, as allocated in the legislation, include the following:

— Preparation of regulations and guides;
— Authorization of facilities and activities;
— Review and assessment of information relevant to safety;
— Inspection of facilities and activities;
— Enforcement of compliance with regulations and standards.

~~2.52~~2.55 The regulatory body's responsibilities also include:

— Ensuring that on site emergency ~~preparedness~~ arrangements including ~~and~~ emergency plans and procedures are in place ~~to protect workers, the public and the environment~~and provide assurance of an effective response and that they are integrated with emergency arrangements of other response organizations and other plans as appropriate (see Ref. ~~[20]~~[26];
— Establishing appropriate means of providing information to interested parties in a transparent manner;
— Promoting safety culture;
— Promoting the necessary coordination with other national and international bodies.

~~2.53~~2.56 The regulatory structures and approaches currently in use 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. Also, the approaches in States with a nuclear power plant vendor may differ from those in States that import nuclear power plants.

~~2.54~~2.57 To be effective, the regulatory body should have adequate authority, (including the right to suspend operation and/or to impose penalties on licensees), independence, financial resources and technically competent staff. The regulatory body should make use of the services of external support organizations (see actions 61–71) in areas where it needs additional expertise. Requirements for an effective regulatory body are provided in GSR Part 1 [5], and the implementation of the requirements is supported by Safety Guides [21–25].

~~2.72~~2.58 Development of human resources of the regulatory body and

~~2.177~~ 2.173-2.189 on human resources development and paras ~~2.142-2.157~~2.152-2.172 on leadership and management of safety, respectively.

~~2.55~~2.59 The national regulatory bodies should determine safety objectives to be achieved by the licensees and ensure implementation of the necessary safety measures. The required safety measures need to be implemented by licensees within stipulated deadlines and subject to regulatory verification. Inadequate regulatory verification may have a negative impact on safety particularly, if the licensee fails to take the required safety actions in a timely manner.

~~2.8~~

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 3, 4, 7 and 11 of GSR Part 1 [5];
— Requirements 2 and 3 of GSR Part 3 [8];
— Requirement 1 of GSR Part 5 [9].

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.

~~2.56~~2.60 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, then clarity of their respective roles and responsibilities should be ensured**, while avoiding any conflict of interest**. In any case, emphasis should be given to assessing and understanding the appropriate position of the regulatory body in the governmental structure of the State.

knowledge of nuclear regulatory matters.

2.582.62 The development of the regulatory framework involves maintaining a balance between prescriptive approaches and more flexible goal setting approaches. This balance might depend upon 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, ~~and the decision on the approach should be made in Phase 2,~~ the persons expected to be in charge of the regulatory body should start learning and considering various regulatory approaches in Phase 1. A strategy is envisioned to determine which regulatory approach will be chosen.

2.592.63 IAEA Safety Standards Series No. GS-G-1.4, Documentation for Use in Regulating Nuclear Facilities [24], presents some advantages and disadvantages of different regulatory approaches and provides further guidance on this topic.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 3, 4, 7, 11, 15, 16, 17, 18, 21, 22, 23, 24, 25, 26, 30 and 32 of GSR Part 1 [5];
— Requirements 2 and 3 of GSR Part 3 [8];
— Requirements 1 and 3 of GSR Part 5 [9];
— Requirement~~s 3.~~5 ~~and 3.6~~ of ~~WS-R-5~~GSR Part 6 [18];
— Requirement 3.7 of GS-R-3 [16].
— Requirement 2 of GSR Part 7 [26].

Action 27. The government should establish an effectively independent regulatory body and should empower it with adequate legal authority, technical and managerial competence, and 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,

State's legal and industrial practices and the guidance provided in the IAEA safety standards.

Action 30. The regulatory body should establish a process and ~~should~~ issue 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 ~~specify~~ develop and issue those ~~the safety requirements~~safety regulations that ~~should be known~~are needed for the bidding process.

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

2.64 The regulatory body's core functions should be clearly defined in the legislation, and as stated in GSR Part 1 [5]. Specific guidance to assist the regulatory body in establishing its regulatory framework can be found in Safety Guides Nos GS-G-1.1 to GS-G-1.5 [21–25].

~~2.60~~2.65 The regulatory body should be effectively independent of all entities — including parts of the government — 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.

~~2.61~~2.66 In establishing the regulatory body, a knowledgeable decision should be made on whether to expand the existing regulatory body or whether to create a new regulatory body. If the regulatory body consists of 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.

~~2.62~~2.67 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.

through various stages in Phase 2, starting with its early organization and 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 therefore develops competences in managing growth and change.

~~2.64~~2.69 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 understanding all relevant safety issues of the nuclear power programme. The regulatory approach also has implications for the need for external expert support for the regulatory body.

2.70 In 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 performance, function and outcome oriented approach. Each regulatory approach has benefits and disadvantages associated with it, 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 ~~be ready to~~ adopt ~~-~~ the approach that best suits the State's needs. 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 *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 set detailed technical requirements, or could identify issues that the operating organization and its suppliers should address and present for assessment by the regulatory body. Specific technical requirements can then be taken from relevant international industrial standards (including nuclear specific standards) or industrial standards of other States, as agreed by the regulatory body at an early stage of the licensing process for nuclear power plants. Issuing detailed regulations places a high demand on the regulatory body's resources for

— A *performance based regulatory approach* allows the operating organization more flexibility in determining how to meet the established safety goals and may require fewer, 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 may 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 for each topic are met.

~~2.65~~2.71 Besides the general alternatives just described, the approaches in different States vary with respect to the scope and depth of safety assessment and inspection. The scope of issues that are under regulatory control may include all structures, systems and components classified as safety relevant or may be limited to the most safety relevant parts only. The targets of the comprehensive and systematic regulatory control and inspections are 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, 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 comprehensive independent analyses and inspections of its own.

~~2.66~~2.72 Throughout Phase 2, the regulatory body should have a firm strategy for prioritizing the development of regulations. Regulations governing management ~~system~~of safety, site evaluation, design, construction and manufacturing should be prepared ~~early in Phase 2~~ so as to be taken into account in the bidding process. In setting its requirements, the regulatory body should adopt as a reference the IAEA safety standards, which express an international consensus and are neutral towards different vendors. The regulatory body may complement these 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 so as to avoid conflicts, inconsistencies or incompleteness.

~~2.67~~2.73 Regulations that could have an impact on the choice of technology should be established early in the process. The plan and schedule for

information from the feedback of experience and comments from interested parties.

~~2.68~~2.74 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 what documents are required for a licence application, as well as the depth of review for each document submitted in support of a licence application. Separate hold points should be specified for certain steps in design, manufacturing, construction and commissioning, as necessary, for the purpose of verifying the results of work and the preparedness to proceed. Whichever process is chosen, it should be established in Phase 2.

~~2.69~~2.75 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 basic guidance on the content of documents to be submitted in support of a licence application could be further specified and supplemented in more detail.

~~2.70~~2.76 Further guidance on this topic is provided in Ref. [20].

~~2.71~~2.77 The relation between the regulatory body and the operating organization should be based on mutual understanding and respect as well as frank and open communication. The relation should apply 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.

~~2.72~~2.78 The regulatory body should establish links with the regulatory bodies of other States whose expertise is well established and recognized, and also with regional and international forums and networks. The regulatory body should have staff capable of absorbing the knowledge that should be transferred.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 3, 4, 7, 11, 16, 17, 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 and 33 of GSR Part 1 [5];
— Requirements 2 and 3 of GSR Part 3 [8];

— Requirements 3.5 and 3.6 of WS-R-5GSR Part 6 [18];
— Requirement 3.7 of GS-R-3 [16],
— Requirement 2 of GSR Part 7[26].
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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 to be conducted during the licensing process, including 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 safety related components.

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

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

2.742.80 In many cases, it is helpful to accept the use of technical standards of the vendor State or of a State having oversight experience with a reactor of the type 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 for better focusing of the auditing and evaluation of these organizations.

regulations and standards of the supplier State. This had an advantage in that the supplier knew in detail which requirements it had to meet, and it was easier for the regulatory body because of the criterion that such a plant was licensed in the supplier 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 these 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.

~~2.76~~2.82 If the option chosen by the State is to use and/or further to develop its own system, the State could continue to base its regulatory framework on the approach found most suitable ~~in Phase 2~~. 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.

~~2.77~~2.83 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.

~~2.78~~2.84 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 both the operating organization and the various suppliers. In some States, it is the practice for the regulatory body to approve 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 license is issued and possible other pre-approvals are given by the regulatory body, ~~the regulatory body issues the construction licence,~~ construction starts, including the manufacture of important safety (and safety related) systems and components. The construction should proceed in a manner that ensures quality and safe operation. In this phase, the operating organizations, and the regulatory body as applicable, should monitor

components, both at the site and at 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 the procurement and infrastructure needed for training** .

~~2.79~~2.85 The regulatory body's management system should cover the activity of production of regulation 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 these up to date. Too 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 Ref. [24].

~~2.80~~2.86 Licensing, a major regulatory activity in Phase 3, should be based on independent regulatory review and assessment of the documents that are submitted by the operating organization. It is the practice in many States to issue a construction licence and an operation licence in this phase. Next to the procedure for granting a licence, a procedure for any subsequent amendment, suspension or revocation of the licence is therefore also issued.

~~2.81~~2.87 As the regulatory body should 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 applies during the construction phase also.

~~2.82~~2.88 The regulatory body should develop a comprehensive inspection programme to carry out its inspection duties. Consideration should be given to obtaining support from States that have oversight experience with the selected reactor type. The overall inspection programme may comprise three aspects:

— Routine inspections of the plant status and operations conducted by resident or non-resident inspectors;
— Topical inspections conducted by inspectors with relevant expertise, in accordance with a scheduled programme;
— Reactive inspections conducted after abnormal events.

~~2.83~~2.89 The extent to which the regulatory body does its own testing

of the qualification 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.

~~2.84~~2.90 A list of programmes that the operating organization should have in place before and during operation is contained in reference [20]. The regulatory body should review, assess, inspect and, as appropriate, approve such programmes.

ACTIONS 39–47: TRANSPARENCY AND OPENNESS

General

~~2.85~~2.91 Societal acceptance is a prerequisite for the implementation of a nuclear power programme. Societal acceptance should be confirmed before major investments and organizational arrangements are made. For gaining 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 the risks involved, and of the environmental impacts of the operation of the nuclear power plant and the associated activities (such as activities in radioactive waste management, spent fuel management and emergency preparedness). Involvement of the public and stakeholders is a continuous process.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 36 of GSR Part 1 [5];
— Requirements 3.6 and 5.26 of GS-R-3 [16];
— Requirement 1 of GSR Part 5 [9].

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 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 ~~relevant~~ interested parties are considered, and it should communicate the results of

~~2.86~~2.92 Principle 4 of the IAEA Fundamental Safety Principles [1], on Justification of facilities and activities, 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 acceptance in society 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. **Involving the public in the early stages of decision making regarding nuclear power should be prioritized.**

~~2.87~~2.93 The government should ensure that ~~all~~ 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. This range of audiences 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 to the process that is intended to lead to a decision on launching a nuclear power programme.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 21, 34 and 36 of GSR Part 1 [5];
— Requirements 3.6, 5.26 and 5.27 of GS-R-3 [16];
— Requirement 3 of GSR Part 3 [8];
— Requirements 1 and 3 of GSR Part 5 [9];
— Requirement 2 of SSR-2/2 [17];
— Requirement 10 of GSR Part 7 [26].

Action 41. The government should inform ~~all~~ the public and other interested parties regarding 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 on safety issues, including the expected health and environmental impacts of a nuclear power programme.

benefits to the public and other interested parties in a clear and transparent manner.

~~2.89~~2.95 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 the operating organization to disseminate public information on the planned facilities and their safety features and their expected environmental impacts.

~~2.90~~2.96 The government should inform ~~all~~ the public and other interested parties regarding decisions on the implementation of a nuclear power programme, including the long term national and international commitments to maintain nuclear safety~~-~~ and adequate preparedness to effectively respond to emergencies in relation to the nuclear power programme (including ~~very low probability~~ severe accidents conditions 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, ~~-~~ **incorporating the transport of nuclear materials.** Information should be provided to the public, local governments, committees representing local interests, industry, news media, non-governmental organizations and neighbouring States.

~~2.91~~2.97 The involvement of the public and other interested parties, including public hearings, and resolution of the issues expressed in those hearings, should be made part of the licensing process.

~~2.92~~2.98 The regulatory body should communicate on its activities and its role with interested parties, explaining the following:

— Its responsibility for the establishment and enforcement of regulations and requirements on nuclear safety;
— Its authority to give binding orders for ensuring safety;
— Its independence from undue influences in decision making;
— Its technical competence and the available human resources;
— Its neutrality (without bias).

~~2.93~~2.99 The operating organization should explain to the public and other interested parties its responsibility for safety, its competence and its compliance with regulatory requirements.

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 21, 34 and 36 of GSR Part 1 [5];
— Requirements 3.6, 5.26 and 5.27 of GS-R-3 [16];
— Requirement 3 of GSR Part 3 [8];
— Requirements 1 and 3 of GSR Part 5 [9];
— Requirements 4.53 to 4.54, 4.82 to 4.84 of ~~GS-R-2~~ GSR Part 7 [26];
— Requirement 2 of SSR-2/2 [17].

Action 43. All relevant organizations should seek to establish and maintain the confidence and trust of the public and other interested parties~~, including the public,~~ 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~~ 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 ~~all~~ the public and other interested parties involved in the construction programme, including suppliers, regarding the problems and difficulties encountered.

~~2.94~~2.100 Communication should be continued on a regular basis and in a structured manner.

~~2.95~~2.101 The regulatory body and the operating organization should inform the public about the possible radiation risks arising from operational states and accidents including events with a very low probability of occurrence but with high consequences that are associated with the operation of a facility.

technology that is deployed in its nuclear power plants and the expected environmental impacts. This could be done in a permanent public centre near the nuclear power plant and occasionally in other locations. The operating organization should also inform the news media on the progress of construction activities, including possible problems of general interest.

~~2.97~~2.103 ~~Likewise, the regulatory body should keep the public and the news media informed on experience from construction and commissioning.~~ The regulatory body should communicate with the public and other interested parties ~~on abnormal events and~~ on safety concerns that may arise during construction and commissioning.

2.104 The regulatory body, the operating organization and response organizations should provide, particularly to the public who may be potentially affected by an emergency associated with the nuclear power programme, ~~with~~ information on emergency preparedness and response arrangements. This should ~~to~~ include information on the potential for an emergency and associated hazards~~,~~ on how the public will be warned and notified and on the actions to be taken [26].

~~2.98~~2.105 Both the regulatory body and the operating organization should learn how to use the International Nuclear Event Scale before the commissioning stage [27].

ACTIONS 48–60: FUNDING AND FINANCING

General

~~2.99~~2.106 Sustainable funding of safety related activities including emergency arrangements of respective response organizations. should be provided for the entire lifetime of a nuclear power plant. After the initial investment for construction of the plant, investments are needed for its regular refurbishment, because most equipment is of limited lifetime and should be replaced with new equipment as part of the ageing management ~~programme~~programme or as a result of enhanced regulatory requirements resulting from safety research or operating experience. Also, technologies 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, costs for decommissioning and waste and spent fuel management represent a significant part of the total costs of a

from the beginning of operation of a plant.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 3, 10 and 11 of GSR Part 1 [5];
— Requirement 4.1 of GS-R-3 [16];
— Requirement 1 of GSR Part 5 [9];
— Requirements 9 of GSR Part 6 ~~6.1 to 6.5 of WS-R-5~~ [18];
— Requirements 1, 3 and 4 of SSR-2/2 [17],
— Requirement 2 of GSR Part 7[26].
—

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 consider the long term economic conditions of nuclear power plant operation, to ensure that the operating organization is able 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.

~~2.100~~2.107 Means of ensuring funding 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 in relation to the nuclear power programme.

nuclear power programme for its entire duration, which should not compromise safety at any stage.

~~2.102~~2.109 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 nuclear safety, and for nuclear regulation. **A systematic approach to training is highly encouraged as the structured training programme at nuclear power plants.**

~~2.103~~2.110 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 transport considerations. Funding should be well secured to avoid its depletion for other purposes or through monetary inflation. In 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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 3, 10 and 11 of GSR Part 1 [5];
— Requirement 4.1 of GS-R-3 [16];
— Requirement 1 of GSR Part 5 [9];
— Requirement 9 of GSR Part 6~~s 6.1 to 6.5 of WS-R-5~~ [18];
— Requirements 1, 3 and 4 of SSR-2/2 [17],
— Requirement 2 of GSR Part 7 [26].
—

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.

2.111 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.

2.1042.112 The funding mechanism should be decided on for the oversight of the safety of nuclear facilities by the regulatory body. 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 rendered 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 to accommodate variations in the workload of the regulatory body.

2.1052.113 The mechanism and timing for funding for the long term management and disposal of radioactive waste, decommissioning and the management of spent fuel should be planned with account taken into account of the fact that the plant might be forced to stop operation before the end of its design lifetime.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 3, 10 and 11 of GSR Part 1 [5];
— Requirement 4.1 of GS-R-3 [16];
— Requirement 1 of GSR Part 5 [9];
— Requirement 9 of GSR Part 6 Requirements 6.1 to 6.5 of WS-R-5 [18];
— Requirements 1, 3 and 4 of SSR-2/2 [17],
— Requirement 2 of GSR Part 7 [26].

Action 56. The government should provide appropriate sustainable

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.

~~2.106~~2.114 By the end of Phase 3, the operating organization should establish rates for electricity generated, as allowed by the national tariff structure. The rate fixed should be set to provide funding for the sustainable safe operation of the nuclear power plant.

~~2.107~~2.115 Funding for decommissioning and for the disposal of radioactive waste and spent fuel as necessary is established as per requirements in the legislation or regulations. Provision should be made to ensure that these funds are not depleted by unauthorized use or by monetary inflation. In the early stage of operation, adequate funds should be secured until the full amount has been raised.

ACTIONS 61–71: EXTERNAL SUPPORT ORGANIZATIONS AND CONTRACTORS

General

~~2.108~~2.116 The operating organization and the regulatory body should have full competence to understand the basis of all safety related decisions that they are responsible for making. However, it may not be feasible to conduct within these organizations all detailed assessments of design information and inspection results or verification of the correctness of safety analyses. Such assessments and verification are necessary to ensure that sound decisions are taken. Technical or other expert professional support may

organization and the regulatory body with ready access to scientists, engineers and other experts.

~~2.109~~2.117 As an example, the regulatory body may need services such as those for developing ~~some~~ safety analysis tools, conducting independent safety ~~analysis~~ analyses and assessments, and conducting experimental research. The operating organization should liaise with various suppliers, both for 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 hire or deploy a full time plant employee.

~~2.110~~2.118 Organizations from which the regulatory body may obtain support typically include:

— Advisory bodies;
— Dedicated external support organizations;
— Research centres;
— Academic institutions;
— Regulatory bodies of other countries;
— ~~IAEA and~~ international and regional organizations;
— Consultants with experience in specific technical or scientific topics.

~~2.111~~2.119 Further guidance on this topic is provided in Ref. [28].

~~2.112~~2.120 Organizations and contractors with which the operating organization should liaise typically include:

— Plant vendors;
— Suppliers of equipment and services;
— External maintenance organizations;
— Organizations conducting material testing and inspections;
— Dedicated external support organizations;
— Research centres;
— Academic institutions;
— Consultants with experience in specific technical or scientific topics.

~~2.113~~2.121 Further information about this topic can be found in Ref. [29].

~~2.114~~2.122 The roles and functions of universities and other academic institutions may differ from those of external support organizations, as the

safety related research, and support in the development of longer term regulatory approaches.

~~2.115~~2.123 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 supported. The external support organizations should be flexible enough to allow changes over time, as the needs of the organizations supported will evolve.

~~2.116~~2.124 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 based independent advice to the regulatory body over the long term on all issues relevant to the regulatory decision making process. Advisory bodies would confirm and advise that the regulatory body has properly addressed relevant safety issues in licensing reviews. They could also support the development of regulations. Moreover, they could bring broad perspectives to bear on the formulation of regulatory policy and regulations. Members of advisory bodies should be independent, highly experienced, and respected by their peers in their respective fields.

~~2.117~~2.125 Short term external support could suitably be provided by 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 on.

~~2.118~~2.126 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 instance, 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 system.**

body, it should be ensured that such support is independent of the support provided to the operating organization.

~~2.120~~2.128 The roles and responsibilities of external support organizations should be clearly defined and understood. ~~Where external support organizations play a significant role in the operation or regulatory control of a plant~~When the work of external support organizations can affect the safety of the plant~~,~~ the management system of the operating organization or the regulatory body should provide for the proper supervision of their activities.

~~2.121~~2.129 Regulatory bodies and licensees need to keep a questioning attitude on safety matters and avoid over-reliance on experts' advice in particular in cases of conflicting ~~information~~conclusions ~~,~~regarding 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.

~~2.9~~

~~2.122~~2.130 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 that there are an adequate number of personnel having the knowledge and experience necessary to supervise and to evaluate the work of contractors. Adequate contractual arrangements should be made to specify the roles and responsibilities of external support organizations.

~~2.123~~2.131 Domestic organizations should participate in the construction of nuclear power plants, since competences will be needed within the State to ensure adequate support for safe long term operation.

~~2.124~~2.132 Certain technical services, such as dosimetry services and environmental monitoring services, in-service testing and inspection, and metrological activities, are needed within a State introducing a nuclear power programme. Such services could be set up within the operating organization taking into account the need to avoid apparent or real conflict of interest related to such services, or they could be outsourced.

Phase 1

The following actions are recommended to be completed in this phase as a step

— Requirements 4, 11, 13 and 20 of GSR Part 1 [5];
— Requirements 3.14 and 5.23 of GS-R-3 [16];
— Requirement 2 of GSR Part 3 [8];
— Requirement 3 of SSR-2/2 [17].

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 to enhance national organizations to provide technical support to the regulatory body and the operating organization for the safe operation of nuclear power plants.

~~2.125~~2.133 Expertise may, at the beginning of the nuclear power programme, 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.

~~2.126~~2.134 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.

~~2.127~~2.135 The government should start to identify and encourage industrial organizations that possibly could participate both in civil construction and in supplying structures, systems and components. During operation, these organizations could provide support in maintenance of the plant and of the equipment that they have supplied. This would ensure the availability in the State of professional and high quality maintenance over the lifetime of the plant.

~~2.128~~2.136 Even though there may 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 organizations. For the coordinated development of industry in the State and for training the industry to deal with nuclear projects, the means for building a dedicated engineering organization **adopting a systematic approach to training** should be considered. Such an organization should acquire broad knowledge in the nuclear field and should subsequently support manufacturers

~~2.129~~2.137 Operation of a nuclear power plant may require the provision of external technical services such as:

— Personal radiation dosimetry and environmental radiation monitoring;
— In-service testing and inspection;
— Maintenance of special technical equipment;
— Metrological activities.

~~2.130~~2.138 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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 4, 11, 13, 17 and 20 of GSR Part 1 [5];
— Requirements 3.14, 5.14, 5.23 and 5.24 of GS-R-3 [16];
— Requirements 2 and 3 of GSR Part 3 [8];
— Requirements 3 and 31 of SSR-2/2 [17].

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.

~~2.131~~2.139 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 for providing 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.

~~2.132~~2.140 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 business. 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 preserve and informed to the general public.**

~~2.133~~2.141 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.

~~2.134~~2.142 Application of quality standards for nuclear equipment and services is generally more stringent than for other industrial operations. If the national policy supports industrial involvement in construction or support

systems should be prepared. Compliance with requirements for quality management and the safety of future nuclear power plants should then be ensured.

~~2.135~~2.143 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 may 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 to the vendor or to 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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 4, 11, 13, 17 and 20 of GSR Part 1 [5];
— Requirements 3.14, 5.14, 5.15–5.20, 5.23, 5.24 and 5.25 of GS-R-3 [16];
— Requirements 2 and 3 of GSR Part 3 [8];
— Requirements 3 and 31 of SSR-2/2 [17].

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

Action 70. All the 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

~~2.136~~2.144 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.

~~2.137~~2.145 External personnel providing a service or providing advice to the operating organization cannot have direct authority over plant personnel, although they may be responsible for the quality of the service or advice provided. As the operating organization retains the prime responsibility for 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 the training system.**

~~2.138~~2.146 Areas in which the operating organization should be supported by the vendor include:

— Training of operating staff;
— Preparation of documentation, including that required for licensing;
— Commissioning of the plant;
— Maintenance and in-service inspection;
— Technical assistance during operation;
— Preparation of normal operating procedures and emergency operating procedures.

~~2.139~~2.147 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.

~~2.140~~2.148 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'[6] and 'super turnkey'[7] projects).

~~2.141~~2.149 The operating organization should reassess the capabilities

services for the nuclear facility. 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.

~~2.142~~2.150 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.

~~2.143~~2.151 The operating organization has prime responsibility for the quality (and thus the safety) of the products of 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

2.152 Principle 3 of the IAEA's Fundamental Safety Principles [1], on Leadership and Management for Safety, 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."

2.153 ~~The organization (regulatory body, operating organization and other relevant organizatyons)~~ In all the~~All~~ relevant organizations ~~need to ensure that~~ an integrated management system [16] is implemented. ~~and that s enior management and~~ The managers at all levels demonstrate leadership~~,~~ which gives ~~giving~~ an overriding priority to safety and foster~~ings~~ a strong safety culture.

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

~~2.10~~

2.155 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" [30].

~~2.144~~2.156 An integrated management system needs to integrate all elements of management including safety, health, environmental, security, quality, ~~social~~ societal and economic elements so that safety is not compromised.

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[6] In a turnkey project, a single contractor or a consortium of contractors takes the overall technical responsibility for the entire works.

[7] In a super turnkey project, a single contract is placed for the entire nuclear power plant. This implies that the prime responsibility for the technical success of the project, and therefore for the design of the plant, is placed upon the contractor

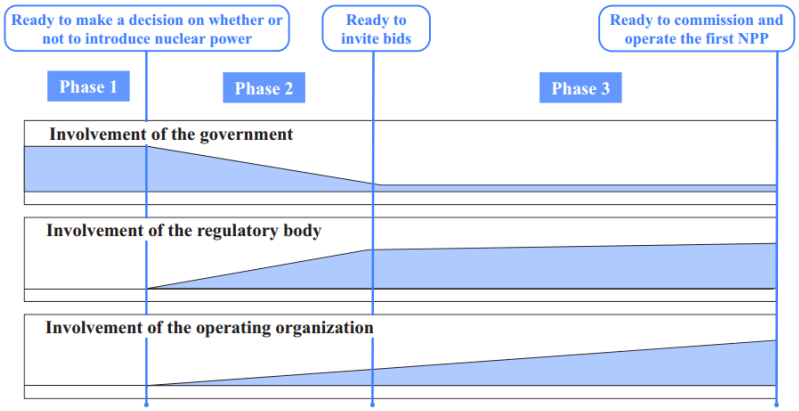

FIG. 6. Progressive involvement of the main organizations in the nuclear power programme (indicative only, to be used with flexibility).

~~2.145~~2.157 Efficient and effective ~~management system~~integrated 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. 6, the extent of involvement of the different organizations will vary considerably during the different phases of implementation of the nuclear power programme. While the government is the major player in Phase 1, the regulatory body may not be created before Phase 2, and Phase 3 is the main phase for the implementation of the operating organization's programmes.

2.158 All the actions taken by the relevant organizations should be included in the framework of an effective ~~management system~~integrated management system. In this regard, the requirements stated in GS-R-3 [16] should provide the basis for the management systems, which should be established before the actions are conducted by the applicable organizations in the applicable phase.

~~2.11~~2.159 All organizations should avoid ~~self-~~complacency and maintain the overall ~~focus~~attention on ~~public health and~~ safety.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 19 of GSR Part 1 [5];
— Requirements of GS-R-3 [16] as a whole;
Requirement 5 of GSR part 3 [8]
— Requirements 6.1–6.9 of NS-R-3 [31].
—

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 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.

leadership capabilities and an attitude emphasizing safety culture.

~~2.146~~2.160 Selection of the senior managers should be accorded great importance in establishing an effective management focused on keeping safety paramount. The senior managers will define the mission, strategies, objectives and policies of the organizations and will make decisions accordingly. In identifying persons for top positions in the prospective operating organization and regulatory body, priority should be given to persons with leadership capabilities and attitudes emphasizing safety culture.

~~2.147~~2.161 In particular, 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 to be implemented made by the regulatory body are likely to be respected. Organizations headed by persons who are perceived as lacking competence or as holding their positions for political reasons will have difficulty in maintaining confidence internally and externally.

2.162 Leadership in safety should be demonstrated at all levels in organizations. Safety should be achieved and maintained by means of an effective ~~management system~~integrated management system. An effective ~~management system~~integrated management system 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 promotion of a safety culture at all levels of the organization, the regular assessment of safety performance, and the application of lessons learned from experience, including the recognition and treatment of potential precursors to accidents. 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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 19 and 35 of GSR Part 1 [5];
— Requirements of GS-R-3 [16] as a whole;
— Requirement 5 of GSR Part 3 [8];
— Requirement 7 of GSR Part 5 [9];

— Requirement 306 of ~~TS-R-1~~SSR-6 [32].

Action 75. The regulatory body and the operating organization should start developing and implementing effective integrated management systems in their respective organizations and should promote 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 continuous improvement of their integrated management systems.

2.163 Early in Phase 2, all top positions in the operating organization and 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 GS-R-3 [16].

2.164 Regulatory bodies should develop a safety culture policy, incorporate safety culture into their regulatory processes ~~by developing a safety culture policy~~, and train~~ing~~ its ~~senior~~ management and staff in their respective roles and responsibilities in its implementation.

~~2.12~~2.165 Regulatory bodies should also implement a ~~more specific~~ regulatory oversight of safety culture of the licensees.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 19 and 35 of GSR Part 1 [5];
— Requirements of GS-R-3 [16] as a whole;
Requirement 7 of GSR Part 5 [9];
— Requirements 5.37–5.39 of GS-R-2 [26];
— Requirements 6.1–6.9 of NS-R-3 [31];

— Requirements 2, 8, 9 and 15 of SSR-2/2 [17];
— Requirement 306 of ~~TS-R-1~~SSR-6 [32].

Action 78. The senior management of all the 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 the 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 ~~management system~~integrated management systems is monitored and measured, and that self-assessments as well as independent assessments are conducted regularly for continuous improvement.

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

Action 82. All the 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 prepare a safety management programme as well as 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.

~~2.148~~2.166 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.

promoted at all levels of the organization.

~~2.150~~2.168 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.

~~2.151~~2.169 To sustain the effectiveness of the ~~management system~~integrated management system, it should be measured and monitored on a periodic basis. Self-assessment has been identified as an important mechanism that organizations should use to improve their performance.

~~2.152~~2.170 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. In this phase, processes for self-assessment should be established for continuous monitoring of the effectiveness of the operating organization and the regulatory body.

~~2.153~~2.171 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.

~~2.154~~2.172 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

~~2.155~~2.173 Requirement 11 of GSR Part 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 organizations covered by this requirement include the regulatory body, the operating organization, research organizations and external support organizations, industrial organizations and organizations providing technical services.

~~2.156~~2.174 Requirement 4.3 of GS-R-3 [16] states that "Senior

all levels and shall provide training or take other actions to achieve the required level of competence". This requirement applies to all organizations involved in safety related activities.

~~2.157~~2.175 Recommendations on human resources development for the regulatory body and the operating organization are provided in GS-G-1.1 [21] and NS-G-2.8 [34].

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 11 and 18 of GSR Part 1 [5];
— Requirements 4.1, 4.3 and 4.5 of GS-R-3 [16];
— Requirement 2 of GSR Part 3 [8];
— Requirement 4 of SSR-2/2 [17].
— Requirement 21 and 25 of GSR Part 7 [26].
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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.

assessment of education and training 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.

2.175 The assessment process for education and training should include the development of a list of the areas of expertise necessary to support the development of the legal and regulatory framework, site evaluation, design assessment, construction and regulatory oversight, together with estimates of the number of individuals necessary in those functional areas. In later phases, expertise should be available for commissioning, operation, maintenance, ~~and~~ radioactive waste management and emergency preparedness and response. **These should be managed by the operating organization through a systematic approach to training.**

~~2.158~~2.176 The assessment process should also include examination of the current capabilities of existing academic facilities and research and development centres as well as 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 lead to conclusions on the adequacy of the current capabilities to meet the needs identified in areas such as reactor physics, thermal hydraulics, chemistry, radiation protection, materials science, strength analysis, reliability technology, mechanical engineering, civil engineering, earth sciences, radiological environmental impact, electrical engineering, instrumentation and control engineering, human behavioural science, testing of materials, project management, ~~and~~ organizational management and emergency management.

~~2.159~~2.177 On the basis of the assessment of education and training, 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.

~~2.160~~2.178 Experience shows that, before education and training curricula are put in place, it could be useful to utilize 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.

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

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 11 and 18 of GSR Part 1 [5];
— Requirements 4.1, 4.3, 4.4 and 4.5 of GS-R-3 [16];
— Requirements 2, 3, 4 and 26 of GSR Part 3 [8];
— Requirements 4 and 7 of SSR-2/2 [17];
— Requirements 311 to 315 of ~~TS-R-1~~SSR-6 [32],
— Requirement 21 and 25 of GSR Part 7 [26].

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 necessary number of persons for ensuring safety.

~~2.162~~2.180 A strategy to attract and retain trained high quality personnel

institutions in other States, sufficient salaries, good working conditions and career positions. The government should also verify that all organizations with crucial safety related tasks, especially the regulatory body, have been able to attract high quality staff.

~~2.163~~2.181 Early in Phase 2, a policy decision should be made regarding 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 so 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.

~~2.164~~2.182 Where the assessment in Phase 1 has shown the need for new institutions or extended curricula, such new institutions should be established and curricula should be revised. **The operating organization should manage their training programme through a systematic approach to training.**

~~2.165~~2.183 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. The objective is to have early in Phase 2 staff of the regulatory body who are able to specify and understand safety requirements. The safety requirements are for use by the operating organization in the bidding process and for its own use in the review of the site and the application for the construction license. The staff also has to be able to make other safety related decisions at the time when such decisions are needed. 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 assessing compliance and the achievement of safety objectives, are identified in Phase 2.

~~2.166~~2.184 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 for a nuclear power plant, and to evaluate the safety relevant parts of the bids to be received early in Phase 3. Even if the support of consultants may be available internationally for this purpose, the operating organization should start early enough to recruit experts with a good overall understanding of the safety issues, the site specific safety features and the nuclear power plant designs. Recruitment should be conducted, with the

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1, 11 and 18 of GSR Part 1 [5];
— Requirements 4.1, 4.3, 4.4 and 4.5 of GS-R-3 [16];
— Requirements 2, 3, 4 and 26 of GSR Part 3 [8];
— Requirements 4 and 7 of SSR-2/2 [17];
— Requirements 311–315 of ~~TS-R-1~~SSR-6 [32].
— Requirement 21 and 25 of GSR Part 7 [26].
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Action 95. The operating organization, the regulatory body, ~~and~~ external support organizations and all other 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.

~~2.167~~2.185 A sustainable level of expertise in nuclear power technology and safety should be maintained by means of the continuous 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 ~~2.178–2.189~~2.190-2.201-on research for safety and regulatory purposes).

~~2.168~~2.186 The operating organization should recruit and train its staff to support construction, preparation for operation and licensing. **The operating organization should manage their training programme through a systematic approach to training.** At the beginning of this phase, staff should be recruited with experience of project management, civil

management. The operating organization should use integrated competences from early in construction 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 promote a strong safety culture in the other organizations involved throughout the construction project. The need for customer's verification of quality is not diminished, even in the 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 component manufacturing. The control room operating personnel 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 ~~in due time before commissioning of the plant,~~early during the construction phase and in consideration of the relevant regulatory requirements.

~~2.169~~2.187 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.

~~2.170~~2.188 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 curriculums that are appropriate to meeting the needs of the nuclear power ~~programme~~programmer, including safety culture.

~~2.171~~2.189 All organizations involved in the nuclear power programme should have a systematic way of categorizing, disseminating and retaining all knowledge (including training material) obtained through international cooperation and— assistance and contracted commercial services. This approach should be sustainable for the continuous development of human resources and institutional knowledge.

General

~~2.172~~2.190 Vendors can provide technical advice and support to the operating organization in the licensing stages and in the early years of operation, but these in-depth 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 which it cannot be assumed will continue to exist throughout the lifetime of the nuclear power plant.

~~2.173~~2.191 Research in States commencing a nuclear power programme should be focused on the safety features and core areas 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 (i.e. computer programs) and models that can be used for plant specific safety analyses in later stages. The accumulated knowledge could then be used for deterministic safety analysis and probabilistic safety analysis as well as for 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 and for planning potential power upgrades or other modifications, or 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 for addressing safety related concerns that can arise when indications of cracking are found in pressure retaining components and piping.

~~2.174~~2.192 In addition to providing an increased understanding of the key characteristics of the prospective nuclear power plant and the safety issues relating to them, the research should serve the general development of knowledge of and competence in nuclear science and technology in the State. Research and development in the State should be directed at building competence in certain areas, and research constitutes good training in or preparation for all interested parties of what is to come with a nuclear power plant project.

~~2.175~~2.193 Beyond the technical core areas, attention should be given to aspects relating to research into management systems and human factors.

~~2.176~~2.194 If a decision is made to utilize a research reactor for supporting safety related research or for developing human resource capacity for

Reactors [35], and should give due consideration to the associated Safety Guides. However, these issues are not explicitly covered in this Safety Guide.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 11 of GSR Part 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 ~~gaps in~~ the capabilities of domestic research centres to meet needs in core areas, and should plan to establish new research centres for core areas as necessary.

~~2.177~~2.195 National research activities should be considered and initiated as early as possible when considering launching a nuclear power programme. The areas of science and technology in which research and development are of vital importance for every State with a nuclear power plant in operation include reactor physics, thermal hydraulics, material sciences, strength analysis and probabilistic safety assessment. Examples of other areas in which research could be considered are fire safety, human performance, seismic analyses, consequence analysis for severe accidents, assessment for beyond design basis accidents and management of organizations.

~~2.178~~2.196 In establishing new research programmes, consideration should be given to whether the research can best be conducted within the existing institutions in which the necessary structures and scientific and academic networks are already in place, or whether a new institution should be set up. Both approaches have been used by States in the past.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 11 of GSR Part 1 [5];

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~~, as identified in Phase 1~~.

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

~~2.179~~2.197 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 in gaps in knowledge. An integrated research plan should be developed that consolidates all the current and planned activities for identifying long term gaps in knowledge and needs for research.

~~2.180~~2.198 The national knowledge base should be strengthened by means of research groups 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 is aimed at creating an independent knowledge base within the State, which will be necessary to support the contracting and licensing process, and later to support safe plant operation and regulatory oversight of safety.

~~2.181~~2.199 If vital research on nuclear safety cannot be conducted within existing research organizations, a dedicated nuclear research organization should be established.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 1 and 11 of GSR Part 1 [5];
— Requirement 3 of GSR Part 5 [9].

Action 104. Research centres and other relevant organizations should focus

plant site.

~~2.182~~2.200 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 its safety analyses. Plant specific models should be incorporated into the generic tools. Comprehensive analysis 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[8]. 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.

~~2.183~~2.201 Arrangements to maintain close contacts with academic research and educational establishments should be ensured. 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 expertise, which can only be maintained through an active national commitment to education and research on safety.

ACTIONS 105–116: RADIATION PROTECTION

General

~~2.184~~2.202 Humans have always been exposed to ionizing radiation (termed 'natural background radiation'), because of the radioactivity of material contained in rocks that form the Earth's crust and the exposure of the Earth's surface to cosmic rays. The fundamental safety objective stated in the IAEA's Fundamental Safety Principles [1] is to protect people and the environment from harmful effects of ionizing radiation.

~~2.185~~2.203 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.

~~2.186~~2.204 Facilities and activities that give rise to radiation risks must yield an overall benefit (Principle 4 of the IAEA's Fundamental Safety Principles [1], 'Justification of facilities and activities'). Protection must be optimized to provide the highest level of safety that can reasonably be achieved (Principle 5 [1], 'Optimization of protection'). Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm (Principle

[8] 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.

~~2.187~~2.205 This Safety Guide addresses the protection of people and the environment from harmful effects of ionizing radiation, as the fundamental safety objective of the IAEA's Fundamental Safety Principles [1]. 'People' in the context of this Safety Guide includes workers and the public.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 7 of GSR Part 1 [5];
— Requirements 2 and 43 of GSR Part 3 [8];
— Requirements 4.1–4.15 of NS-R-3 [31].

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 ~~analysis~~assessment[9] 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 for integrating radiation protection regulations and new safety regulations for nuclear power plants.

~~2.188~~2.206 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 ~~require the establishment of~~ legislation and other provisions for radiation protection have been established. However, the implementation of a nuclear power programme would

give rise to additional hazards resulting from the expansion of activities. This would necessitate amending or complementing the existing national framework.

~~2.189~~2.207 Preparation of a radiological environmental impact ~~analysis~~ 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 the section on a national policy and strategy for safety of this Safety Guide, is 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 the IAEA's Fundamental Safety Principles [1].

~~2.190~~2.208 A Safety Guide on radiological environmental impact analysis for the verification of radiological protection is being prepared to provide guidance on how to produce such a radiological environmental impact ~~analysis~~assessment. ~~The radiological environmental impact analysis is part of both the environmental impact assessment.~~

~~2.191~~

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 7 of GSR Part 1 [5];
— Requirements 1–4, 6-16, 18-32~~6–42 and~~ Schedule III ~~and Schedule IV~~ of GSR Part 3 [8];
— Requirements 4.1–4.15 of NS-R-3 [31];
— Requirements 78 and 79 of SSR-2/1 [33];
— Requirements 301–303 of ~~TS-R-1~~SSR-6 [32].

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 regarding workers and the public both for normal and potential exposure situations in a nuclear power plant.

environmental impact ~~analysis~~ assessment for the site selected, as appropriate.

Action 111. The regulatory body should review and assess the radiological environmental impact ~~analysis~~ 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 for the nuclear power plant.

~~2.192~~2.209 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 determine dose limits (established 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 Ref. [8].

~~2.193~~2.210 The regulatory body and the operating organization also should give consideration to Refs [36, 37] for the issuing of regulations and for the preparation of bid specifications.

~~2.194~~2.211 The radiological environmental monitoring programme should be ~~developed~~ 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 organizations' systematic approach to training**. Non-radiological impacts may be addressed in separate documentation and may be submitted to a separate authority, as appropriate. The environmental monitoring should be commenced early in order to obtain accurate reference information on natural conditions with regard to radiation and other conditions in the ~~neighbourhood~~neighborhood of the nuclear power plant.

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 7 of GSR Part 1 [5];
— Requirements 1–4, 6–33, ~~43–46,~~and Schedule III ~~and Schedule IV~~ of GSR Part 3 [8];
— Requirements 4.1–4.15 of NS-R-3 [31];
— Requirements 78 and 79 of SSR-2/1 [33];
— Requirement 21 of SSR-2/2 [17];
— Requirements 301–303 of ~~TS-R-1~~SSR-6 [32].

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 ~~releases~~ discharges from the nuclear power plant to the environment.

~~2.195~~2.212 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 occupational radiation doses. 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 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, and to the accuracy and reliability of the measuring equipment used for radiation monitoring.

~~2.196~~2.213 The earlier estimates for the releases of radioactive material in normal operational states as well as in ~~accident conditions~~design basis accident and design extension conditions should be confirmed when the final configuration of the plant is known.

programmes.

ACTIONS 117–121: SAFETY ASSESSMENT

General

~~2.198~~2.215 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 as specified by the plant designer, the operating organization and the regulatory body have been met.

~~2.199~~2.216 Safety assessment plays an important part throughout the lifetime of a nuclear power plant whenever decisions are made on safety issues.

~~2.200~~2.217 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 severe accidents). The aim of 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 Ref. [41].

~~2.201~~2.218 The operating organization should have 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.

~~2.202~~2.219 A general understanding of safety features of nuclear power plants 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 plant operators on the design and operation of the plant. A safety assessment is also required by the regulatory body before issuing authorizations for the construction, commissioning and ~~commissioning~~ operation of the plant.

~~2.203~~2.220 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

— The aim of the *deterministic approach* is to specify and apply, for anticipated operational occurrences and postulated accident conditions, a set of conservative deterministic rules and requirements for the design and operation of facilities or for the planning and conduct of activities. These rules and requirements, when they are met, are expected to provide a high degree of confidence that the level of radiation risks to workers and the public arising from the facility or activity will be acceptably low. This conservative approach provides a way of compensating for uncertainties in the performance of equipment and the performance of personnel.

— 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 the safety of a nuclear power plant, probabilistic safety analysis uses a comprehensive, structured approach to identifying failure scenarios. It constitutes a conceptual and mathematical tool for deriving numerical estimates of risk. The probabilistic approach uses realistic assumptions wherever possible and provides a framework for addressing explicitly many of the uncertainties. Probabilistic approaches may provide insights into the reliability of system performance, 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.

~~2.204~~2.221 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.

2.222 The safety assessment may be supported by a programme of research and development. ~~Paragraphs 2.178–2.189 cover research for safety and regulatory purposes.~~

~~2.13~~

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 5, 6 and 8 of GSR Part 4 [41].

Action 117. The government should familiarize itself with the IAEA safety

~~2.205~~2.223 The ~~State~~ government should recognize the need to develop expertise in nuclear safety and safety assessment.

~~2.206~~2.224 The government should engage in a dialogue with governmental organizations in other States so as to take account of developments in nuclear safety and safety assessment.

~~2.207~~2.225 The government should consider the optimum ways of utilizing safety assessments that have already been carried out by designers, operating organizations and regulatory bodies in other States, and by international organizations.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 24, 25 and 26 of GSR Part 1 [5];
— Requirement 13 of GSR Part 3 [8];
— Requirements 1–6, 8, 14–16 of GSR Part 4 [41].

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

~~2.208~~2.226 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.

~~2.209~~2.227 The development and use of the safety assessment should provide the framework for production of the necessary information to demonstrate compliance with the relevant safety requirements and for the radiological environmental impact analysis that is carried out to support site evaluation and plant selection.

~~2.210~~2.228 The operating organization, which has the prime responsibility for safety, should recruit and train personnel with the skills and expertise necessary 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 may serve as an input to the operating organization's systematic approach to safety.

~~2.211~~2.229 The operating organization and the regulatory body may need support from external support organizations which have, or individuals who have, the specialist skills in particular areas. External expert support is addressed in paras ~~2.107–2.141~~ 2.116-2151.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 24, 25 and 26 of GSR Part 1 [5];
— Requirement 13 of GSR Part 3 [8];
— Requirements 1–24 of GSR Part 4 [41];
— Requirements 5 and 39 of SSR-2/1 [33];
— Requirement 12 of SSR-2/2 [17].

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.

~~2.212~~2.230 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 all radiation risks to workers, the public and the environment from the

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 safety margins have been incorporated. 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 be used also for preparing emergency management plans.

2.231 The operating organization should conduct an assessment of the safety information and analyses provided by the vendor for its (the operating organization's) preparation of the safety analysis report before submitting it to the regulatory body. This requires the use of proper 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.

~~2.213~~2.232 Where practicable, the safety assessment ~~shall~~ confirms that there are adequate margins to avoid cliff-edge effects ~~having unacceptable consequences.~~

If facilities share resources (whether human or material) in accident conditions the safety assessment ~~shall~~ demonstrates that the required safety functions can nevertheless be fulfilled at each facility during such conditions.

2.233 The regulatory body should carry out a comprehensive review and independent verification of the safety analysis report to ~~determine evaluate~~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.

~~2.214~~2.234 In the design and construction phase, the contacts established between the vendor, the operating organization and the regulatory body with other organizations in the nuclear field should be used to identify improvements to determine which of them are applicable to the plant being built. Such improvements include any safety related improvements to fulfil national safety requirements as well as improvements that are being made at other plants (in particular at plants of the same design) and

emerging nuclear safety issues.

~~2.215~~2.235 An example of the format and content of the safety analysis report can be found in Ref. [42].

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

General

~~2.216~~2.236 Principle 7, para. 3.29, of the IAEA's Fundamental Safety Principles [1], 'Protection of present and future generations', states that "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."

~~2.217~~2.237 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) which require arrangements for the predisposal management and disposal of low level and intermediate level radioactive waste.

~~2.218~~2.238 Implementation of a nuclear power programme will cause a significant increase in the volume and activity of the waste that should be safely managed and disposed of. High level radioactive waste with a very long lifetime poses a new 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.

~~2.219~~2.239 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 fuel cycle is closed or open (i.e. whether the fuel cycle requires the reprocessing or the disposal of the spent fuel). In either case, storage of the spent fuel will be required. The time period for storage will be a significant factor in determining the provisions required for safety.

~~2.220~~2.240 In some States, a dedicated organization is established for radioactive waste management. In other States, the operating organization takes

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.

~~2.221~~2.241 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 of NS-R-5 [43] and the recommendation of the supporting Safety Guides would apply.

~~2.222~~2.242 Financial aspects relating to the safety of radioactive waste management and of spent fuel management are addressed in paras ~~2.97–2.106~~ 2.106-2.115 on funding and financing in this Safety Guide.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 7 and 10 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirements 1 and 2 of GSR Part 5 [9];
— Requirements 1,4,5 and 9 of GSR Part 6 [18].
~~Requirements 2.1, 3.1–3.4, 6.1–6.5 of WS-R-5 [18].~~

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 strategy.

~~2.223~~2.243 The availability of alternative options for managing high level radioactive waste, including its ~~final~~ disposal, should be considered before making a decision on launching a nuclear power programme. The possibility of ensuring long term safety by means of alternative options and the uncertainty of cost estimates in each option should be taken into account. It should be recognized that dependence on services in other States for spent fuel

~~2.224~~2.244 An important issue that should be considered in making a decision on the approach to radioactive waste management is the choice of option for the nuclear fuel cycle. The question is whether to have an open fuel cycle with direct disposal of spent fuel or whether instead to have a closed fuel cycle in which the spent fuel is reprocessed and the high level waste arising from its reprocessing has to be disposed of. Which alternative 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 nuclear power as a global energy source. There is no easy answer to the question of which alternative is the best. The decision to select a particular alternative depends on many factors, some being cost based and others of a technical nature or matters of policy, including security. Regardless of the alternative selected, cost estimates for ~~final~~ 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 ~~2.98–2.107~~2.106-2.115 on funding and financing).

~~2.225~~2.245 Radiological impacts and the costs of decommissioning a nuclear power plant should also be factored into the consideration of whether or not to implement a nuclear power programme. In addition to the type of waste being generated during operation, large amounts of solid waste of low and very low specific activity are produced in decommissioning activities. Specific requirements for decommissioning are addressed in ~~WS-R-5~~GSR Part 6 [18].

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 7 and 10 of GSR Part 1 [5];
— Requirements 2 and 31 of GSR Part 3 [8];
— Requirements 1–12 and 17 of GSR Part 5 [9];
— Requirements ~~2.1–2.3, 2.5, 3.1–3.8, 4.1–4.8, 6.1–6.5 of WS-R-5~~1, 4, 5, 6, 8 and 9 of GSR Part 6 [18];
— Requirement 22 of SSR-2/2 [17];
— Requirements 35, 36 and 38 of SSR-2/1 [33];
— Requirement 15 of GSR Part 7 [26].

Action 124. The government and other interested parties as appropriate

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 for establishing a national organization responsible for radioactive waste management, or for extending the organization for radioactive waste management if this 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.

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.

~~2.226~~2.246 Alternative ~~interim~~ storage and disposal strategies for low level, intermediate level and high level radioactive waste and for spent fuel should be studied in Phase 2. The studies should focus on the safety, feasibility and costs of alternative strategies. As concerns 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 ~~central final repository~~disposal facility, and possibly a dedicated organization to operate such a facility. This should be decided early enough that the ~~treatment~~ processing facilities and ~~interim~~ 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.

~~2.227~~2.247 For managing long lived radioactive waste and high level radioactive waste and spent fuel, the government and the waste management organization should assess whether the ~~final~~ disposal of radioactive waste can be provided by means of national arrangements or whether assistance from other States is necessary. In general, national arrangements are feasible in an open fuel cycle with direct disposal of spent fuel. However, the use of a closed fuel cycle in a small nuclear power programme would require services to be rendered by a reprocessing organization in another State.

~~2.228~~2.248 Although the disposal solutions with respect to low level, intermediate level and high level radioactive waste will probably not have been

would be essential for an informed decision to be made on the funds to be allocated for the purposes of radioactive waste management.

~~2.229~~2.249 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 such areas as the transport and ~~interim~~ storage of radioactive waste.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 7 and 10 of GSR Part 1 [5];
— Requirements 2 and 31 of GSR Part 3 [8];
— Requirements 1–20 of GSR Part 5 [9];
— Requirements 1,4,5,6,8, 9 and 10 of GSR Part 6 [18]~~Requirements 2.1–2.5, 3.1–3.8, 4.1–4.8, 5.1–5.14, 6.1–6.5 of WS-R-5 [18];~~
— Requirements 22 and 33 of SSR-2/2 [17];
— Requirements 35, 36 and 38 of SSR-2/1 [33],
— Requirement 15 of GSR Part 7 [26].
—

Action 128. The operating organization should prepare a programme for radioactive waste management and spent fuel management, as well as a decommissioning management programme, in accordance with the national 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 ~~interim~~ 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

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

~~2.230~~2.250 Work should be started by the operating organization, and by the radioactive waste management organization, if applicable, to determine and to evaluate the arrangements and sites that would be viable for the ~~final~~ disposal of low level and very low level radioactive waste.

~~2.231~~2.251 The ~~treatment~~ 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 arrangements for reduction of the volume of waste and arrangements for the packaging of waste are in accordance with the radioactive waste management strategy. The facilities should be fully operational at the time of startup of the first reactor.

~~2.232~~2.252 The mechanism for funding the decommissioning costs and the costs for radioactive waste management ~~and the~~ (including disposal of ~~radioactive~~ waste) should be established by legislation before the startup of the first reactor (see also paras ~~2.98–2.107~~2.106-2.115 on funding and financing).

ACTIONS 133–145: EMERGENCY PREPAREDNESS AND RESPONSE

General

2.253 ~~Good design~~Safety features incorporated in the design of nuclear power plants and effective management system with a strong management commitment to safety and a strong safety culture are to ensure the practical elimination of plant event sequences that could result in high radiation doses or radioactive releases, ~~and safety culture as well as safe operation of a nuclear power plant should make the probability of a large radioactive release extremely low.~~ However, ~~the~~ despite the high level of confidence that the occurrence of such sequences is extremely unlikely the application of the concept of defence in depth requires additional barriers to mitigate the consequences of radioactive releases that could potentially result from accident conditions.~~probability is not zero.~~

2.254 Emergency ~~planning~~ preparedness and response for the protection of human life, health, property ~~plant personnel, emergency workers, the public~~ and the environment is an essential element of ~~plant~~ the overall nuclear safety, as stated in Principle 9 of the IAEA's Fundamental Safety Principles [1], on

~~incidents~~emergencies.

~~2.233~~2.255 Emergency arrangements need to be developed and implemented for an adequate preparedness to effectively respond 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 [26], [GS-G-2.1].

~~2.234~~2.256 In addition to specific roles and responsibilities of the regulatory body and the operating organizations in relation to the plant safety in general and in on-site emergency arrangements specifically, considerations of overall emergency preparedness and response will include respective response organizations at local, regional and national levels. Recognition of the need for their engagement as early as possible in the overall consideration of the nuclear power programme is essential. In Phase 1 these organizations will be involved in evaluation of their existing capabilities in emergency preparedness and response, in identification of needs for further strengthening in the light of the nuclear power programme, and in development of an action plan to do so. In Phase 2 and Phase 3 they will be increasingly involved in development of adequate arrangements in accordance with the action plan and their respective roles and responsibilities.

~~2.235~~2.257 The full emergency arrangements in relation to the nuclear power programme ~~need~~should ~~to~~ be established and tested in an exercise by the time the fuel is brought to the site.

~~2.14~~2.258 The IAEA Safety Standards in emergency preparedness and response [GSR Part 7, GS-G-2.1 and GS-G-2] provide detailed requirements, recommendations and guidance for ensuring an adequate preparedness and response for a nuclear or radiological emergency irrespective of the cause. Another publication in the Emergency Preparedness and Response Series provides considerations in emergency preparedness and response for States embarking on a nuclear power programme [EPR-Embarking 2012] supporting, consistently with IAEA Safety Standards, the development of adequate level of emergency preparedness and response in relation to the nuclear power programme.

Phase 1

The following actions are recommended to be completed in this phase as a step

— Requirements 7 and 8 of GSR Part 1 [5];
— Requirement 43 of GSR Part 3 [8];
— Requirements 1-2 of GSR part 7 [26].

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

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

~~2.236~~2.259 An appreciation of the need for emergency planning should be developed with involvement of 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 require complex interactions between the organizations — largely non-nuclear organizations. During Phase 1, the need should be recognized for agreement on the allocation of responsibilities in developing arrangements for emergency preparedness and response and how these arrangements would be coordinated. ~~–~~ A close examination of emergency planning options and costs should also be considered at this stage.

~~2.237~~2.260 Due consideration should be given at the national level to the steps by which a State becomes a party to and ratifies the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 7 and 8 of GSR Part 1 [5];
— Requirements 43–4~~6 and Schedule IV~~ of GSR Part 3 [8];
— Requirements ~~2.1–2.6, 3.1–3.20, 5.2–5.30 of GS-R-2~~1, 2, 4, 5 and 20-23 of GSR part 7 [26];
— Requirements 18 and 19 of SSR-2/2 [17];
— Requirements 304 and 305 of ~~TS-R-1~~SSR-6 [32].

Action 135. The government should ~~specify specify~~determine the national institutions 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 ~~basic~~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.

~~2.238~~2.261 During Phase 2, implementation details 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. This covers, inter alia:

— Basic legislation and regulations for emergency planning;
— ~~Threat~~ Hazard assessment;
— Emergency response plans, procedures and concepts of operations;
— Procedures for protecting emergency workers and helpers;
— Demographic characteristics of the site or sites selected;
— Procedures for provisions for public notification, information and instruction;
— Procedures for the implementation of urgent protective actions and other response actions;
— Procedures for medical response;
— Procedures for the implementation of ~~longer term~~early protective actions and other response actions ;
— Procedures for dealing with non-radiological consequences.

2.262 The gaps identified in existing emergency arrangements and capabilities of institutions and communication networks at all levels should be filled, or else the filling of these gaps should be realized through an action plan which implementation should be 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.**

~~2.15~~

~~2.239~~2.263 The establishment of an emergency organization and of the associated interactions and provisions should be commenced in Phase 2 as it can take a long time.

2.264 There needs to be a sufficient number of emergency responders to respond to simultaneous emergencies on all units. The operating organization, response organizations and the regulatory body should give due consideration to the requirements for emergency preparedness for and response to a nuclear or radiological emergency, as established in ~~GS-R-2~~GSR Part 7 [26] and the respective guidance and recommendations provided in GS-G-2.1 and GSG-2 [GS-G-2.1, GSG-2]

~~2.240~~2.265 National activities with the intention of ratifying of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency should be continued and should be completed as early as possible.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 7 and 8 of GSR Part 1 [5];
— Requirements 43–46 and Schedule IV of GSR Part 3 [8];
— Requirements ~~2.1–2.6, 3.1–3.20, 4.1–4.100, 5.2–5.39~~1-26 and Appendices I and II of ~~of GS-R-2~~GSR part 7 [26];
— Requirement 18 of SSR-2/2 [17];
— Requirements 304 and 305 of ~~TS-R-1~~SSR-6 [32].

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 preparedness programme and emergency plans and procedures for nuclear power plants, and should prepare the corresponding chapter of the safety analysis report.

Action 142. The government and the regulatory body should develop and implement emergency preparedness programmes at the local, national and international levels.

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

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

Action 145. The government, the regulatory body and the operating organization should demonstrate emergency response capabilities by conducting appropriate exercises that include local authorities and local

~~2.241~~2.266 In Phase 3, by the time the nuclear fuel first arrives on the site, the development of emergency arrangements should be completed and the testing and/or exercising of the emergency arrangements with local and national organizations and their demonstration to the regulatory body should be performed. Scenarios including possible disruption of local and regional infrastructure should also be considered.

~~2.242~~2.267 Programmes, plans and procedures for preparedness for a nuclear or radiological emergency should be implemented at the international, national, regional , ~~–~~local and ~~plant~~ 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 response plan of the nuclear power plant, the plans of the relevant national institutions involved in emergency response at all levels, and other States, consistent with the relevant IAEA safety standards [26] and conventions [Early Notification, Assistance, Nuclear Safety Conventions and Joint Convention].~~conventions~~.

~~2.243~~2.268 The procedures for communication channels and protocols for chains of command and control between the various emergency centres of the operating organization, local, regional -and national authorities and the regulatory body should be developed, put in place and tested.

~~2.244~~2.269 At this stage, the regulatory body should have reviewed and, if required, approved the on-site emergency response plans and the government through the coordination mechanisms should have reviewed and approved, as necessary, respective emergency response plans at local, regional and national levels. The government through the coordination mechanism and the regulatory body . ~~It~~ should also have verified the adequacy and consistency of these 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

General

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

- 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.
- Ensuring the quality of structures, systems and components of the plant.
- Ensuring that a knowledgeable workforce is acquired and maintained at all times, including the plant operators and other plant staff.
- 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 minimize and address interface issues, including interfaces between safety, security, maintenance and operations, etc.
- Establishing safety policies and implementing management programmes for safe operation and verifying their effectiveness.
- Establishing and implementing a policy for personnel qualification, as well as programmes for staff continual training ~~and retraining~~.
- 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.
- Establishing liaison with the regulatory body ~~public authorities~~ and other public authorities ~~the regulatory body~~ for the purposes of considering, understanding and ensuring compliance with regulatory requirements.
- 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.
- Providing resources, services and facilities to plant management and adequately supervising safety related work performed by contractors.
- Providing adequate information for the purposes of liaison and public relations.
- Ensuring the collection, evaluation, implementation and dissemination of operating experience.
- Ensuring that the decision making process gives adequate consideration to the selection of priorities and the organization of activities.

3.2. Principle 1 of the IAEA's Fundamental Safety Principles [1] on 'responsibility for safety' states that "the prime responsibility for safety

organization that has to meet the fundamental safety objective "To protect people and the environment from harmful effects of ionizing radiation", by taking the following measures addressed in para 2.1 of Ref.[1]:

"(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. It is incumbent on the operating organization to specify safety criteria and to assure itself that the design, construction and operation of nuclear power plants meet the applicable safety criteria. 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 utilized or generated. These responsibilities should be discharged in accordance with applicable safety objectives and the requirements established by or approved by the regulatory body.

3.4. The IAEA Safety Requirements publication SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation [17] establishes requirements, and IAEA Safety Guide NS-G-2.4, The Operating Organization for Nuclear Power Plants [29], provides 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 ~~2.159–2.177~~ 2.173-2.189 on human resources development and paras ~~2.142–2.157~~ 2.152-2.172 on leadership and management for safety of this Safety Guide.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 5, 6 and 11 of GSR Part 1 [5];

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 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 to ensure long term safety.

3.6. 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 bear 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 provisions, structures and procedures that are necessary. The first goal is preparation for the bidding process to take place at the end of Phase 2. An appropriate programme for human resource development for achieving this goal, and for continuing further with preparations for construction, should be planned in Phase 1.

3.7. Considerations in Phase 1 include topics such as:

— The capabilities and resources of existing electrical power producing companies to enter into the nuclear field;
— The safety implications of various contract options for nuclear power plants, such as turnkey[10], super turnkey[11], split package[12] or multicontract[13] approaches;
— The possibilities of joint ventures with operating organizations in other States to strengthen safety capabilities;
— The possibilities of ownership by other States;
— The legal implications of the former two issues concerning other States;
— The design authority function (see paras ~~3.49–3.69~~ 3.54-3.75 on design safety);
— The preliminary environmental impact ~~analysis~~ assessment (both

3.8. These topics should be assessed together with the financial arrangements and the staff numbers and competences expected from the operating organization

[10] In a turnkey project, a single contractor or a consortium of contractors takes the overall responsibility for the entire technical works.

[11] In a super turnkey project, a single contract is placed for the entire nuclear power plant. This implies that the prime responsibility for the technical success of the project, and therefore for the design of the plant, is placed upon the contractor.

[12] 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.

[13] 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.

at all stages of the preparation and implementation of construction projects, as well as during operation, to provide for long term safety.

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

— *Policy making functions*, such as making investment decisions, setting management objectives, establishing a policy for nuclear safety and for quality, human resources development, allocating resources, approving the contents of management programmes, and setting policies on fitness for duty;
— *Operating functions*, which include executive decision making and actions for the operation of the plant, both in operational states and in accident conditions;
— *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;
— *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

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 5, 6 and 11 of GSR Part 1 [5];
— Requirement 4 of GSR Part 3 [8];
— Requirements 1–5 of SSR-2/2 [17].

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 has the overriding priority.

Action 152. The operating organization should establish a suitable 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 bidding process and should specify the safety requirements to be included in the call for bids, 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, consistent with governmental policy.

3.10. The operating organization should recognize its prime responsibility for safety. Key management positions of the operating organization, or of a separate project organization for nuclear power plants 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.

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

— To implement the project management on its own;
— To train and maintain its staff to ensure safe plant operation;
— 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;
— To gain an understanding of how to meet all safety requirements and to incorporate the safety requirements properly into the call for bids;
— To specify the evaluation process for bids, giving due importance to safety criteria;
— 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 safety assessment to the regulatory body;
— 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, and their experience in managing large construction projects;
— To verify the preparedness of potential vendors to implement the project, including maturity of the detailed design;
— To develop the operating organization's own effective and efficient management system, including quality control, for construction and manufacturing, on the basis of good knowledge of national and international standards and requirements;
— To consider approaches to spent fuel management and radioactive waste management.

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

3.13. 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.

3.14. 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 clarity of the roles and responsibilities of each organization should be ensured. However, the prime responsibility for safety rests with the authorized party that becomes the operating organization of the nuclear power plant.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 5, 6 and 11 of GSR Part 1 [5];
— Requirement 3.7 of GS-R-3 [16];
— Requirement 4 of GSR Part 3 [8];
— Requirement 1 of SSR-2/1 [33];
— Requirements 1–32 of SSR-2/2 [17];
— Requirements 9.4, 9.49–9.53 of NS-R-5 [43].
Requirement 2 of GSR Part 7 [26].

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

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

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.

3.15. 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.

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

3.17. Progressively in Phase 3, the operating organization should grow larger in size and complexity. The organization should plan for the rapid change in its size, its functions, its responsibilities, its organization and its 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.

3.18. The description of the structure and of the functions to be performed by the individual departments in the operating organization, on and off the site, and by individuals in each department, as well as the lines of responsibility, authority and communication, should be unambiguous.

3.19. In the evaluation of bids, the operating organization should ensure that the proposed designs comply with the national safety requirements.

3.20. 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.

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

— Safety analysis reports (see paras ~~2.202–2.221~~ 2.215-2.235 on safety assessment for further information).
— Probabilistic safety analyses (which might be included in the safety analysis report; see paras 2.215-2.235 ~~2.202–2.221~~ on safety assessment for further information on probabilistic safety analysis).
— 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 limit the consequences of any such accidents, if they do occur. Operational limits and conditions are developed as a part of ensuring that the plant is operated in accordance with the design assumptions and design intent as well as with its licence conditions.

3.22. The operating organization should also be prepared to manage the licensing process, including providing additional information that will be required 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).

3.23. As required by SSR-2/2 [17], it is the responsibility of the operating organization to develop operating procedures and management programmes

management programmes for the safe operation of the plant should include, but are not limited to, the following:

- Staffing (see paras ~~2.158–2.177~~2.173-2.189 on human resources development);
- Qualification and training (see paras ~~2.158–2.177~~2.173-2.189 on human resources development);
- Commissioning (see paras ~~3.70–3.77~~3.76-3.86 on preparation for commissioning);
- Plant operations (in conjunction with the operational limits and conditions);
- Maintenance;
- In-service inspection;
- Surveillance;
- Fuel management;
- Chemistry;
- Safety analysis and review;
- ~~Physical protection programme(see paras 3.94–3.108 on interfaces with nuclear security);~~
- Radiation protection (see paras ~~2.190–2.201~~ 2.202-2.214 on radiation protection);
- Industrial safety;
- Waste management (see paras ~~2.222–2.238~~ 2.236-2.252 on safety of radioactive waste management, spent fuel management and decommissioning);
- Environmental monitoring (see paras ~~2.190–2.201~~ 2.202-2.214 on radiation protection and paras ~~3.24–3.48~~ 3.26-3.35 on site survey and site evaluation);
- Emergency preparedness (see paras ~~2.239–2.250~~ 2.253-2.269 on emergency preparedness and response);
- Fire safety;
- Quality assurance (see paras ~~2.142–2.157~~ 2.152-2.172 on leadership and management for safety and paras ~~2.107–2.141~~ 2.116-2.151 on external support organizations and contractors);
- Human factors;
- Feedback of operating experience;
- Plant modifications (see paras ~~3.49–3.69~~ 3.54-3.75 on design safety);
- Document control and records (see paras ~~2.142–2.157~~ 2.152-2.172 on leadership and management for safety);
- Management of ageing;
- Decommissioning (see paras ~~2.222–2.238~~ 2.236-2.252 on safety of radioactive waste management, spent fuel management and

3.24. 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 needs to ensure that any reasonably practicable safety improvements identified in the review are implemented in a timely manner, consistent with regulatory requirements.

~~3.25. The operating organization should prepare a physical protection programmer that prevents or deters unauthorized access, intrusion, theft, direct attack and internal or external sabotage of systems important to safety and nuclear materials. This programme should include clear plans and procedures to provide physical protection of the site by means of vehicle entrance and exit control, vehicle parking and traffic control and personnel access control.~~

ACTIONS 160–169: SITE SURVEY AND SITE EVALUATION

General

~~3.26.~~3.25. Principle 8 of the IAEA's Fundamental Safety Principles [1], 'Prevention of accidents', states that "all practical efforts must be made to prevent and mitigate nuclear or radiation accidents". Paragraph 3.32 of Ref. [1] mentions adequate site selection in the context of providing defence in depth.

~~3.27.~~3.26. The site selection process, also called siting for a new nuclear installation, is divided into two stages. In the first stage, 'site survey', potential sites are considered on the basis of existing available data and suitable candidate sites are chosen (Phase 1). The second stage, 'site selection', is aimed to select the site and is the completion of the site selection process. In stage 3, the acceptability of the selected site15 is confirmed, its complete characterization is performed and the site related parameters needed for the design of the nuclear power plant are derived (Phase 2). The site evaluation process follows the site survey and should be continued throughout the entire lifetime of the nuclear power plant (Phases 3 and 4) to take into account changes in the site characteristics, in evaluation methodologies and in safety standards (see Fig. 7). This process is usually divided into four stages: site selection, site assessment, the pre-operational stage and the operational stage.

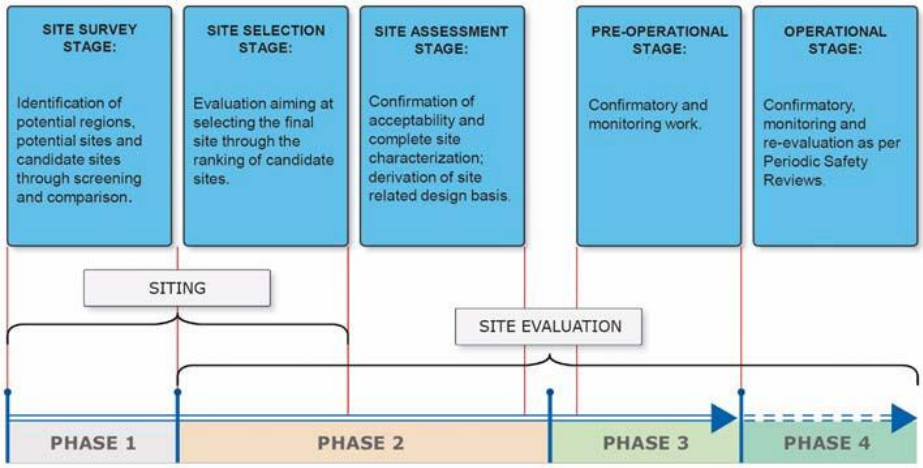

FIG. 7. The consecutive stages of site survey and site evaluation.

[15] For the purposes of this Safety Guide, it is assumed that only one single site is required for a nuclear power plant (to locate the number of reactor units under consideration). However, the methodology is fully applicable to a number of sites.

~~3.28.~~3.27. The emphasis necessary 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 potential sites), the safety aspects becomes more important. The data collected and the methods used for these few sites should all be treated and scrutinized with similar care, because for the site finally selected (i.e. the preferred candidate site), these data will be used in the subsequent stages of the licensing process.

~~3.29.~~3.28. In Phase 2, after the site selection stage, the confirmation of acceptability of the site and a complete site characterization are performed in the site assessment stage. This process precedes the preparation of the site evaluation report, which should be approved by the regulatory body.

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

3.30. Periodic review of site specific hazards ~~are required~~should be performed and, when necessary, ~~evaluating~~ the implications of ~~such a~~the review should be evaluated on the safe operation of the nuclear installation

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 31 of GSR Part 3 [8];
— Requirements 2.1–2.29, 3.1–3.55, 4.1–4.15, 6.1–6.9 of NS-R-3 [31].

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[16].

3.31. In accordance with Principle 8 of the IAEA's Fundamental Safety Principles [1], and in order to be able to make an informed policy decision at the end of Phase 1 on whether or not to introduce nuclear power, it should be evaluated whether suitable sites are available for locating 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 engaged 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.

[16] 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.

3.32. A set of criteria relating to the acceptability and comparison of sites should be identified from the beginning of Phase 1. Both safety related aspects and non-safety related aspects should be properly taken into account, because of the interface between them. This will provide for the development of the site selection and site evaluation process during the subsequent phases, without the need to revert to earlier steps because of a lack of suitable available sites.

3.33. While 'acceptability' (or exclusion) criteria in relation to safety are well defined in accordance with IAEA safety standards [2], the criteria for comparison of the candidate sites may 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.

3.34. These criteria should provide for a consistent set of boundary conditions from different fields (e.g. safety considerations versus development and social needs, safety considerations versus security considerations, safety considerations versus historical or archaeological conditions) that will exclude unacceptable sites in the early stages of the programme. This will leave for further consideration those sites that fulfil the acceptability conditions.

3.35. As regards safety related conditions, the relevant requirements established and the associated recommendations provided in the IAEA safety standards. As stated in NS-R-3 [31], three main aspects are considered:

— The effects on the nuclear power plant of external events occurring in the region of the site, i.e. external hazards of natural and human induced origins;
— The characteristics of the site and its environment that could influence the transfer to people and the environment of released radioactive material;
— The population density and population distribution, as well as other characteristics of the external zone[18], that may affect the effectiveness of necessary emergency response actions, ~~possibility of taking emergency measures, including the need to evaluate the~~ should be evaluated with regard to the risks to individuals and to the population.

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

might provide protection against malicious acts.

3.37. The expected impacts of the plant on the public and the environment ~~are~~ should be considered, to estimate the consequences of discharges in normal operation and potential radioactive releases resulting from accidents. This requires a preliminary analysis of the dispersion of radioactive material due to atmospheric phenomena, through surface water and through groundwater. The prospective population distribution should also be analysed, to characterize dietary habits as well as the uses of land and water in the region. This should be done as part of the radiological environmental impact ~~analysis~~ assessment addressed in paras ~~2.190–2.201~~ 2.202-2.214 on radiation protection.

3.38. ~~As~~ With regards to the conditions that are not directly safety related, 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, and proximity to industrial and military centres).

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 31 of GSR Part 3 [8];
— Requirements 2.1–2.29, 3.1–3.55, 4.1–4.15, 6.1–6.9 of NS-R-3 [31].

Action 161. The regulatory body should establish specific safety requirements for site evaluation, including requirements for the process for 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, and 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

Action 164. The regulatory body should review and assess the site evaluation report, and should make a decision regarding the acceptability of the site selected and the site related design basies.

Action 165. The operating organization should use all the appropriate information relevant to safety and to regulatory control that is related to or derived from the site assessment to prepare the bid specifications for the nuclear power plant.

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

3.39. 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 body's intervention (for example, the review and approval process of the site evaluation report, issuance of a site permit).

3.40. Two main stages are implemented during Phase 2 which are driven by a different 'focus' and the depth of the substantiation process:

— Comparison and ranking studies of the candidate sites, focusing on a number of sites as identified, selected and preliminarily ranked in Phase 1;
— Detailed evaluation and assessment of the site selected, focusing on the site selected and making use of specific data, information and studies, and assessments conducted on the fullest possible scales of investigation, both temporal (for example, the prehistorical, historical and instrumental time periods) and spatial (for example, the regional, near-regional, site vicinity and site areas).

3.41. To be ready for inviting bids 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 for ranking them and selecting the preferred candidate site following the site selection stage. This site selection stage is followed by the site assessment stage. At this stage a full, specific and detailed evaluation of the site selected is carried out to confirm its acceptability, to derive the site related design basis and to prepare the radiological environmental impact analysis, as well as the non-radiological impact assessment (for example, of impacts of thermal discharges, chemical discharges) in accordance with the national regulatory framework. This is done by means of detailed evaluation studies and

3.42. 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 needs to consider collocated nuclear installations with special emphasis on those that may experience concurrent accidents ~~and the possible construction of multiple units in the same site~~.

3.43. In accordance with the requirements of NS-R-3 [31] and with regard to the potential radiological impacts on the region for operational states and for accident conditions leading to emergency response measures, an estimate should be made of expected releases of radioactive material. Since in Phase 2 the design of the plant and its safety features may not be known, 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.

3.44. During Phase 2, all site evaluation tasks should be conducted in accordance with the requirements and recommendations of the IAEA safety standards on site evaluation [31, 44–49, 58].

~~3.44.~~3.45. Information on frequency and severity derived from the characterization of the hazards resulting from external events are required for establishing the design basis hazard level for the nuclear installation, taking into account uncertainties in the design basis hazard level.

~~3.45.~~3.46. The site assessment process should lead to the preparation by the operating organization of the site evaluation report, which includes the confirmation of site acceptability and the complete site characterization. This should be used as the basis for the preparation of 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.

~~3.46.~~3.47. 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 (for example, external floods, groundwater level and hydrogeological conditions), provision of an ultimate heat sink, road access, communications and water supplies, which may also have an impact on the implementation of emergency plans.

~~3.47.~~3.48. This step should give rise to intensive interactions with the public at large, and in particular with the local population, local organizations and local authorities.

should be started well before commissioning of the plant, to obtain reference data on the radioactive isotopes to be found in the environment before operation of the plant is commenced. These data can later be consulted in identifying radioactive isotopes that might have been released from the nuclear power plant.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 31 of GSR Part 3 [8];
— Requirements 2.1–2.29, 3.1–3.55, 4.1–4.15, 5.1, 6.1–6.9 of NS-R-3 [31].

Action 167. The operating organization should prepare the chapter on site evaluation of the safety analysis report, and then update it, taking into account the specificities of the ~~reactor~~ 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, if required, as site protection measures determined as a result of the tasks of external hazard assessment.

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

~~3.49.~~3.50. The characteristics of natural and human induced hazards as well as the demographic, meteorological, seismological and hydrological conditions of relevance to the nuclear power plant should be monitored over the lifetime of the plant.

~~3.50.~~3.51. Site specific hazards are required to be periodically reviewed, typically every ten years, and re-evaluated when necessary. A review after a shorter interval shall be considered in the event of evidence of potentially significant changes in hazards (for example, in the light of the feedback of operating experience, a major accident or the occurrence of extreme events). The implications of such a review of site specific hazards for the safe operation of the nuclear installation have to be evaluated.

~~3.51.~~3.52. Activities for radiological environmental impact analysis or environmental monitoring are addressed in paras ~~2.190–2.201~~ 2.202-2.214 on

ACTIONS 170–184: DESIGN SAFETY

~~3.52.~~3.53. Principle 8 of the IAEA's Fundamental Safety Principles [1], 'Prevention of accidents', states that "All practical efforts must be made to prevent and mitigate nuclear or radiation accidents." Also, para 3.31 of Ref. [1] says: "The primary means of preventing and mitigating the consequences of accidents is 'defence in depth'".

~~3.53.~~3.54. The IAEA Safety Requirements publication SSR-2/1 [33], Safety of Nuclear Power Plants: Design, establishes the requirements to be fulfilled by the nuclear power plant.

~~3.54.~~3.55. The key design safety principles and issues that should be taken into account in the design include:

- The concept of multiple barriers and defence in depth for the prevention and mitigation of accidents;
- The concept of deterministic analysis for design safety: failure criteria, redundancy, diversity and physical separation;
- The concept of postulated initiating events and minimization of the plant's sensitivity to such events;
- The concept of postulated accident conditions and severe plant conditions;
- Internal hazards and external hazards;
- The systematic consideration of human factors, including the human–machine interface;
- Verification of the balanced design by means of probabilistic analyses;
- Safety classification of structures, systems and components and the correlation of safety classes with requirements on quality and reliability;
- The utilization of proven codes and standards for the design of structures, systems and components;
- Active versus passive safety functions;
- Safety aspects of systems important to safety such as the reactor core, reactor cooling system, containment, emergency power system and instrumentation and control systems.
- A systematic approach to training and qualification

Rev of SSR-2/1 [33] also states, inter alia, that: 'Sequences that lead to large or early radioactive releases are required to be 'practically eliminated'.

" The levels of defence in depth shall be independent as far as practicable to avoid a failure of one level reducing the effectiveness of other levels;

consideration to other implications for safety, to withstand the effects of hazards or to be protected, according to their importance to safety, against hazards and against common cause failure mechanisms generated by hazards;

— For multiple unit plant sites, the design shall take due account of the potential for specific hazards to give rise to impacts on all units on the site simultaneously;

— ;

— The design of items important to safety that would ultimately be necessary to prevent large or early radioactive releases shall provide an adequate margin against levels of natural hazards more severe than those selected for the design basis;

— Each unit of a multiple unit nuclear power plant shall have its own safety systems and shall have its own safety features for design extension conditions;

— Assurance that uncertainties have been given adequate consideration in the design of the plant and that adequate margins are available to avoid cliff edge effects and large or early radioactive releases;

— The heat transfer function shall be fulfilled for levels of natural hazards more severe than those selected for the design basis;

— The design shall include features to enable the safe use of non-permanent equipment for restoring the capability to remove heat from the containment, water inventory in the spent fuel pool and necessary power supply;

— Design shall be such that personnel will be able to perform expected tasks for managing an emergency under conditions generated by accidents and hazards;

— Alternate power source shall be capable of supplying the necessary power to preserve the integrity of the reactor coolant system and to prevent significant damage to the core and to spent fuel in the event of the loss of off-site power combined with failure of the emergency power supply. That alternate power source should also supply the necessary power in DE conditions;

— Equipment that is necessary to mitigate the consequences of melting of the reactor core shall be capable of being supplied by any available power source;

— Alternate power source shall be independent of and physically separated from the emergency power supply

— Continuity of DC power supply shall be ensured so that the monitoring of the key plant parameters is always available and any short term actions necessary for safety can be completed in the event of a loss of the AC

— Prevent the uncovering of fuel assemblies in all plant states that are of relevance for the spent fuel pool, so as to practically eliminate the possibility of early or large radioactive releases and to avoid high radiation fields on the site."

~~Protection of the power supply against infrequent and severe external hazards and availability of cooling water and an ultimate heat sink.~~

~~Assessment of failures potentially affecting multiple redundant safety system trains or even multiple units on the same site (due to common cause failures), station black out (SBO) and long lasting loss of the ultimate heat sink.~~

~~Extreme accident scenarios considering potential events that could lead to a loss of the structural integrity of buildings and uncontrollable radioactive releases.~~

~~Focus on the first layer defence in depth measures and implementation of countermeasures which are cost effective and can be implemented in short period involving the third and fourth layers of defence in depth.~~

3.56. A comprehensive consideration of external hazards in the design of NPPs needs to include among others:

- Consideration of hazards during the design of the plant layout
- Consideration that a total loss of all power sources might occur, regardless of its low or very low probability, as a result from an external event (eg; natural phenomena) and result in a severe accident.
- Periodic assessment of the severity of the external hazard design basis, taking into account up to date scientific knowledge;
- Evaluation of safety margins beyond the design basis (in particular, in the case of extreme external hazards), including scenarios leading to core damage and major releases of radioactivity to the environment;

~~3.55.~~ - ~~Stricter c~~Consideration of uncertainties associated with site characterization and in the siting and design of new nuclear power plants is needed.

- ~~A questioning attitude to emphasize safety and proactively implement~~Implementation of countermeasures based on the understanding that records of natural phenomena can be limited and highly uncertain.

~~3.56.~~3.57. Other factors that should be considered in the design include:

— Optimization of radiation protection (for occupational and public exposure);
— Minimization of the generation of radioactive waste;
— The feasibility of decommissioning.

~~3.57.~~3.58. 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. The IAEA Safety Requirements publication SSR-2/1 [33] states in para. ~~3.6~~ 4.15: ~~that~~ "~~Where~~ National and international codes and standards that are used as design rules, ~~they~~ 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 ~~final~~ quality of the design is commensurate with the ~~necessary~~associated safety function." Experience shows that the vendor usually proposes a set of codes and standards. The operating organization and the regulatory body should assess the applicability of these codes and standards and their consistency with national safety requirements.

the safety of the operation of a nuclear power plant. A nuclear power plant does not exist in isolation; its safe and reliable operation should be supported by a number of external factors. These include the reliabilities of external electrical 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 grid.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements of SSR-2/1 as a whole [33];

Action 170. The government should ~~learn~~ 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 as well as the reliability of the national power grid, and should consider the potential impacts of these on the design requirements for the safety of the plant.

~~3.59.~~3.60. Individuals to be involved in the nuclear power programme should ~~start~~ acquir~~eing~~ knowledge of the ~~major~~ principal technical requirements ~~aspects of~~given in IAEA Safety Requirements publication No. SSR-2/1, Safety of Nuclear Power Plants: Design [33], as well as the features of the various nuclear reactor technologies. It is not required to go into too much technical detail in this phase, but the main features and principles of design safety should be understood.

~~3.60.~~3.61. The supply of electrical power is a vital service for a nuclear power plant, and external grid connections are the normal way to feed safety related consumers of the plant. ~~and the reliability of the power supply depends mostly on the reliability of the external grid.~~ Consideration should be given to the risk associated with events in which a nuclear power plant goes to a fast shutdown and the electrical grid collapses as a consequence, resulting in at least temporary loss of external power. Also, the reliability of on-site power depends on external elements such as the provision of high quality industrial products (for example, fuel, fluids including oils, gases). Among other factors contributing to safety are the supply chain for spare parts and consumables and

necessary.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 5, 15, 16 and 29 of GSR Part 3 [8];
— Requirements of SSR-2/1 as a whole [33];
— Requirements 6.43–6.51 of NS-R-5 [43].

Action 172. All the 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.

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 all the safety and regulatory aspects that should be considered in the design, with account taken of the status of the national technical infrastructure.

~~3.61.~~3.62. In the preparation of bid specifications, the operating organization should take into account the information identified in the evaluation of the site, to make sure that they are adequately reflected in the design basis for the structures, systems and components.

~~3.62.~~3.63. The call for bids should require the potential vendors to specify the codes and standards that they are planning to use and should require them to meet the safety requirements included in the bid specifications.

~~3.63.~~3.64. 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 the site on which the plant will be built.

~~3.64.~~3.65. During Phase 2, the government and the operating organization should develop plans for improving the national technical infrastructure, as feasible, and should start implementing those plans. In so doing, it is ensuring 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.

~~3.65.~~3.66. Where the supply of external services cannot be ensured with adequate reliability, compensatory measures should be planned and taken into account in the bid specifications, since they may 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.

~~3.66.~~3.67. The interfaces between nuclear 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

an appropriate balance is achieved.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirements 5, 15, 16 and 29 of GSR Part 3 [8];
— Requirements of SSR-2/1 as a whole [33];
— Requirements 10 and 11 of SSR-2/2 [17];
— Requirements 6.43–6.51 of NS-R-5 [43].

Action 177. The operating organization should establish a 'design ~~entity'~~ 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, 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 reports, 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.

~~3.67.~~3.68. When evaluating bids, the operating organization should verify that the proposed designs satisfy the national safety requirements.

~~3.68.~~3.69. Although a comprehensive design review before the acceptance of a bid is not a general practice, the operating organization should conduct an adequate design verification of the submitted bid so as to provide confidence that the main design features are in compliance with the respective safety requirements, including qualified personnel.

~~3.69.~~3.70. Once the bid 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 as specified in the national regulations or as agreed upon with the regulatory body.

~~3.70.~~3.71. 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 grid management organization and should test the reliability of the external grid.

~~3.71.~~3.72. 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 ~~analysis~~ assessment should be submitted at the latest at the same time. The safety related construction activities ~~–~~on the site cannot commence until a construction licence has been granted.

~~3.72.~~3.73. The regulatory body should review the safety analysis report, and supporting documentation as necessary, to verify that the design requirements as established in the national regulations are met for the safe operation of the nuclear power plant and for preventing safety related incidents and accidents or for mitigating their consequences. The review of the safety analysis report might take some time, and its schedule should be discussed and agreed upon between the regulatory body and operating organization to the extent possible. The process of review and assessment is dealt with in other sections of this Safety Guide.

~~3.73.~~3.74. At this stage a process should be specified by means of which

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 all permanent and temporary modifications, if any. This procedure should be followed to ensure that the plant's design basis 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

~~3.74.~~3.75. Commissioning activities are beyond the scope of this Safety Guide, since Phase 3 ends just before the beginning of commissioning tests. However, some activities in preparation for commissioning are conducted in Phase 3.

~~3.75.~~3.76. At 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.

~~3.76.~~3.77. IAEA Safety Guide No. ~~NS-G-2.9~~SSG-28, on Commissioning for Nuclear Power Plants [50], provides recommendations on all steps of the commissioning stage.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

Requirement 25 of SSR-2/2 [17]

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

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.

~~3.77.~~3.78. The regulatory body should establish requirements concerning commissioning, which may include the establishment of hold points beyond which the operating organization may not proceed without the approval of the regulatory body, such as:

— Overall cold and hot system performance~~hydraulic~~ tests;
— Fuel loading;
— First criticality and zero power tests;
— Power tests on different levels;
— Trial operation;
— Commercial operation.

3.79. The operating organization should develop a commissioning programme so as to provide evidence that the plant as constructed meets the design intent and complies with the safety requirements. Operating procedures should be validated to the extent practicable as part of the commissioning programme, with the participation of the ~~future~~ operating personnel of the nuclear power plant. The operating personnel should be trained through the operator's systematic approach to training programme.

~~3.78.~~3.80. Commissioning includes both non-nuclear and nuclear tests. ~~Active~~ Nuclear tests ~~should~~ are ~~be~~ performed with nuclear fuel in the core, and ~~the test should~~ consist of fuel loading tests, first criticality tests, zero power level tests, power escalation tests at different power levels and trial operation.

~~3.79.~~3.81. The operating organization, because of its responsibilities in the subsequent operating phase of the plant, should verify that the commissioning programme checks as exhaustively as possible the characteristics of the plant. In particular, the commissioning programme should ~~do the following~~:

analysis report, and record baseline data on the performance of structures, systems and components to be used later as reference data;
— Ensure that the plant meets the requirements of the regulatory body;
— Demonstrate the validity of the operating instructions and procedures, and provide an opportunity for the operating personnel to learn operating skills and to acquire experience in the plant's response to control commands;
— Supply the information and data necessary to verify the adequate implementation of the integrated management ~~programmes~~system.

~~3.80.~~3.82. Even if commissioning activities are performed by the supplier or other groups, the operating organization should make the necessary arrangements to participate, review and approve these activities at all stages, since the responsibility for safety rests with the operating organization.

3.83. The operating organization should establish mechanisms ~~for~~ to ~~the~~ transfer ~~from the vendor~~ the ownership of the plant systems from the vendor.

3.84. 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 the IAEA Safety Requirements publication SSR-2/2 [17].

~~3.81.~~3.85. Specific approval by the regulatory body should be required before the start of normal operation. Such approval 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

~~3.82.~~3.86. The implementation of a nuclear power programme necessitates transporting radioactive material with specific characteristics, which may require amending or complementing the existing national framework for safety in transport. This radioactive material will include fresh and used nuclear

the transport of other radioactive waste may increase significantly.

~~3.83.~~3.87. The safety of radioactive material transport is principally assured through a graded approach including elements of design, testing and review of the transport package. The graded approach to the transport requirements is established based on the type and quantity of radioactive material to be shipped. Fresh nuclear fuel has a very 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 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 may be required.

~~3.84.~~3.88. Spent fuel, in contrast, is highly radioactive, and the main technical means for protection against hazards during its transport should be the design, testing and review of a transport package that contains the fuel in a certified package that has been type tested in all credible accident conditions and has been shown to maintain its integrity and leak-tightness. Another important safety measure is the control of external radiation levels of the transport package. The possibility of nuclear criticality and damage caused by heat should also be taken into consideration. As for all nuclear related activities, the transport of certain radioactive material requires a prior approval of the package design and, depending on the material to be shipped, approval of the shipment by a competent authority.

~~3.85.~~3.89. 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.

~~3.86.~~3.90. A comprehensive corpus of regulations is established in the IAEA Safety Requirements publication ~~TS-R-1~~SSR-6 on Regulations for the Safe Transport of Radioactive Material (the Transport Regulations) [32]. A well structured legal system should incorporate these rules.

~~3.87.~~3.91. An adequate legal framework should be established to implement international regulations for the transport of dangerous goods. Different modes of transport (by road, rail, sea, air) have their own international or regional regulations as issued by the respective transport organizations. The Transport Regulations [32] are implemented through incorporation into these instruments.

Phase 1

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 7 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirements of ~~TS-R-1~~SSR-6 [32] 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, over and above the existing transport of other radioactive material.

~~3.88.~~3.92. Activities involving radioactive sources (for example, at research reactors, or in industrial or medical applications of radiation) that require the establishment of regulations in respect of the transport of radioactive material will already be being carried out in most States. 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, for which international conventions apply (in respect of transport by air and by sea, and for some States also by land). There may also be a regulatory body in charge of the oversight of safety in the transport of nuclear material. However, the regulatory system may not be in active use in some areas in States without a nuclear power programme.

~~3.89.~~3.93. The IAEA Safety Guide on Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2012~~05~~ Edition) [51] sets out the different schedules by UN number. There are essentially two sets of UN numbers; one set (for fissile material) relates closely 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 the appropriate controls are in place. The transport of spent nuclear fuel is an especially demanding task that is likely to require new types of arrangements to be made.

~~3.90.~~3.94. 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 afforded by this small number of additional packages should be significantly higher than that afforded by the

~~3.91.~~3.95. A crucial aspect to prepare for the transport of radioactive material is to ensure that new regulators are cognizant of the existing regulatory regimes.

~~3.92.~~3.96. The key functions of a regulatory body in relation to the transport of radioactive material are set out in the IAEA Safety Guide on Compliance Assurance for the Safe Transport of Radioactive Material [52]. An important part of information gathering is to examine each of these functions and to assess the resources and skills available. It may be that some functions are initially carried out in other States, but the regulatory body for transport in a State with a nuclear power programme should develop domestic competence in all areas. The following paragraphs provide a summary of the issues in each area.

- *Design assessment.* In many cases, this function will be limited in scope and resources or may not exist at all until a nuclear power programme is established.
- *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 for the majority of shipments of radioactive material. The testing may involve skills that are not available in the regulatory body if there is no nuclear power programme.
- *Witnessing of manufacture.* It is possible that many regulatory bodies for the transport of radioactive material do not need to 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 also witness the manufacture of packaging from time to time as a part of compliance assurance.
- *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 peculiar 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.
- *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.
- *Enforcement actions and investigation of incidents.* Most States will have adequate capabilities in this area.
- *Interdepartmental liaison and/or cooperation.* The key issue with regard to interdepartmental liaison and/or cooperation is that any new regulatory body that is proposed should fit into the existing regulatory framework

— *Issuing of approvals.* The issuing of approvals may be a new process for the regulatory body. The approval system may be modelled on other industries within the country (for example, aircraft certification) or other systems in Member States identified through networking and interactions with other Member States.
— *Regulatory review and maintenance of an effective legal framework.* While some new legislation may be required, the area of regulatory review and maintenance of an effective legal framework may increase resource requirements, but the necessary skills should be available in one of the existing regulatory bodies.
— *Training and distribution of information.* 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.
— *Emergency planning and exercises.* Since the quantity of radioactive material being transported will increase considerably, there should be effective planning for an emergency response. Up to this point the radioactive material being transported is most likely to pose a secondary risk in any serious transport accident. However, with the development of a nuclear power programme, there may 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 an emergency.
— *Audits of management systems.* Most States will have adequate capability in the area of audits of management systems.

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 7 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirements of ~~TS-R-1~~SSR-6 [32] as a whole.

Action 190. All relevant organizations should make 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

~~3.93.~~3.97. 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.

~~3.94.~~3.98. 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 ~~interim~~ storage or disposal site is under consideration, as opposed to the ~~disposal~~storage of radioactive waste in a location on the nuclear power plant site.

~~3.95.~~3.99. As a consequence of the internationally harmonized requirements for the transport of radioactive material, it should be possible to obtain assistance from another State. There are several international groupings or associations of regulatory bodies for the transport of radioactive material which can offer mutual support. The regulatory body should consider joining such a grouping or association at this stage.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 7 of GSR Part 1 [5];
— Requirement 2 of GSR Part 3 [8];
— Requirements of ~~TS-R-1~~SSR-6 [32] 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 in Phase 2.

~~3.96.~~3.100. 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 in place and implemented before planning the transport. While other types of transport are not expected to take place during Phase 3, it is often a requirement that operating organizations of nuclear power plants should have contingency plans in

be considered by the regulatory body during Phase 3, even though such transport may not start until some years later.

ACTIONS 193–~~200~~197: INTERFACES WITH NUCLEAR SECURITY

General

~~3.97.~~3.101. The IAEA Fundamental Safety Principles [1] state in para 1.10 that "safety measures and security measures have in common the aim of protecting human life and health and the environment" and that "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"

~~3.98.~~3.102. This section concerns interfaces between safety aspects and nuclear security aspects, to be taken into account in the development process of a nuclear power programme. The relevant guidance with regard to the establishment of a nuclear security regime is provided in the IAEA Nuclear Security Series. A specific Implementing Guide~~s~~ [56] ~~are~~in relation to the establishment of nuclear security infrastructure for a nuclear power programme is available in the ~~available in the~~ IAEA Nuclear Security Series ~~[53, 54]~~.

3.103. The fields covered by safety and by nuclear security, respectively, ~~3.99. –~~are ~~partially~~ distinct, but safety and nuclear security have a common purpose, to protect people and the environment from harmful effects of ionizing radiation as well as from the harmful consequences of 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 ~~malicious act~~nuclear security event. Nuclear s~~S~~ecurity ~~covers~~ is concerned with the prevention of, detection ~~or~~of, and response to, criminal or intentional unauthorized acts involving or directed at nuclear and other radioactive material, associated facilities and associated activities [55]. ~~prevention W~~with regard to ~~theft of nuclear material, as well as prevention of any risk of sabotage of nuclear facilities or radioactive material. With regard to the risk of theft of nuclear materials, control measures and accountability of nuclear material developed either at the national level or within the framework of international controls (safeguards) are also a specific part of security.~~

~~3.100.~~3.104. During each phase of the development process of a nuclear power programmer, ~~N~~nuclear security [56] and safety infrastructures ~~should be built developed during each phase of the development process of a nuclear power programme. They~~ should be developed, as far as possible, in a well coordinated manner.

~~3.101.~~3.105. 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 ~~synergies~~ interfaces between safety and nuclear security have to be ~~developed and encouraged~~recognized and; ~~–~~ safety and nuclear security infrastructures should be developed in a manner that ~~have to~~ complements and enhances ~~one another~~each ~~other~~both disciplines.

Phase 1

The following actions are recommended to be completed in this phase as a step

— Requirement 12 of GSR Part 1 [5];
— Requirement 2.1 of GS-R-3 [16].

Action 193. The government should foster both safety culture and nuclear security culture, taking into account their commonalities and differences.

~~3.102.~~3.106. A safety culture and a nuclear security culture that govern the attitudes and behaviour of individuals should be developed within the management system.

~~3.103.~~3.107. Safety culture and nuclear security culture are based on similar notions. However, there are also some notions that are unique to nuclear security culture, such as ~~deterrence~~ trustworthiness and confidentiality [57]. ~~Furthermore, with regard to the sharing of responsibility and the confidentiality of information, the development of a security culture will involve major participation of the government. The involvement of several competent authorities in security matters imposes a certain number of structures and communication and information exchange systems so that the organizations involved understand and complement each other.~~

Phase 2

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 12 of GSR Part 1 [5];
— Requirement 2.1 of GS-R-3 [16];
— Requirement 5 of GSR Part 5 [9];
— Requirement ~~5.16~~ 2 and 23 of GS~~-R-2~~R Part 7 [26].
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Action 194. All the relevant organizations should coordinate safety and nuclear security aspects from the early stages of development, establishing maximum synergy and, where necessary, integration.

Action 195. ~~The government should define the responsibilities of the operating organization and other competent authorities in relation to security.~~

Action 196. ~~The government should develop mechanisms to communicate to the public appropriate information regarding safety and nuclear security.~~

~~the State's nuclear security regime, including the assignment of regulatory tasks to one or more competent authorities. The government should ensure effective overall cooperation and relevant information sharing between the competent authorities and other parts of the government responsible for security matters. This should include sharing of the relevant information in accordance with national arrangements.~~

~~3.105.~~3.108. 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.

A single regulatory body may be responsible for both safety and nuclear security, or the regulatory body may consist of separate competent authorities owing to the different areas covered for safety and nuclear security. ~~For nuclear security, there could be specific structures and means of control of a different type.~~ A consultation and coordination mechanism is required between the two authorities to ~~ensure effective protection with regard to possible malicious acts and to~~ manage regulatory requirements that may be conflicting.

~~3.106.~~3.109. With respect to the degree to which nuclear safety and nuclear security are to be integrated, special attention should be paid to differences in the government's involvement since a larger number of authorities are concerned with nuclear security than with safety. Consequently, there are more interfaces to deal with and a greater need for cooperation and coordination.

Phase 3

The following actions are recommended to be completed in this phase as a step towards the full implementation of all relevant IAEA Safety Requirements:

— Requirement 12 of GSR Part 1 [5];
— Requirement 2.1 of GS-R-3 [16];
— Requirement 5 of GSR Part 5 [9];
— Requirement 2 and 23 of GSR Part 7 [26].

Action 197. 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 198. ~~The operating organization should prepare a physical protection programme and should submit it to the regulatory body as~~

Action 199. All the relevant organizations should ensure that emergency preparedness and response plans in the fields of safety and contingency and response plans in the field of nuclear security are complementary, coherent and well-coordinated among all of the entities involved.

Action 200. The operating organization and the regulatory body should continue to promote safety culture and nuclear security culture in their respective organizations.

~~3.107. The operating organization should provide a physical protection programme that prevents or deters unauthorized access, intrusion, theft, direct attack and internal or external sabotage of systems important to safety and nuclear materials. This programme should include clear plans and procedures to provide physical protection of the site by means of vehicle entrance and exit control, vehicle parking and traffic control and personnel access control~~

~~3.108.~~3.110. Major decisions regarding safety enhancements and security enhancements require the consultation of each discipline on a continuous basis. For example, enhancements such as barriers, locks and fences that are designed to improve physical ~~security~~ protection may 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 security aspects.

~~3.109.~~3.111. If safety and nuclear security regulatory bodies are separate, there should be consultation and coordination mechanisms between them.

~~3.110. Both the operating organization and the competent authorities should develop plans as appropriate to limit the consequences of an accident~~a nuclear ~~security event.~~

~~3.111. These plans should be developed consistently with emergency plans for cases when the nuclear security event triggers an emergency.~~

Appendix

OVERVIEW OF ACTIONS TO BE TAKEN IN EACH PHASE FOR THE ESTABLISHMENT OF SAFETY INFRASTRUCTURE

PHASE 1

Action No.	Responsible entities (main): Government, legislators	Responsible entities (main): Regulatory body	Responsible entities (main): Operating organization	Actions to be taken to implement the IAEA Safety Requirements in Phase 1, and bases for these actions
Implementing the IAEA General Safety Requirements for Safety Infrastructure				
1 — National policy and strategy for safety				
Basis	Requirement 1 of GSR Part 1 [5]~~;~~ Requirements 10 and 29 of GSR Part 3 [8] ~~(revision of BSS);~~ Requirement 2 of GSR Part 5 [9]~~.~~ Requirement 2 of GSR Part 7 [26]			
1				The government should consider the necessary elements of a national policy and strategy for safety to meet the fundamental safety objective and the principles established in the Fundamental Safety Principles (IAEA Safety Fundamentals).
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 radiological 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 or not to introduce a nuclear power programme.
2 — Global nuclear safety regime				
Basis	Requirements 1~~, and~~ 14, and 36 of GSR Part 1 [5]~~.~~			
11				The government should prepare for participation in the global nuclear safety regime.
12				The government should begin dialogue with neighbouring States regarding its ~~projects for~~ consideration for ~~-~~establishing a nuclear power programme.
13		XXX	XXX	The government and relevant organizations, if they already exist, should establish contact with organizations in other States and

3 — Legal framework				
Basis	Requirements 1–4 of GSR Part 1 [5]~~;~~ Requirement 2 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirement 1 of GSR Part 5 [9]~~;~~ Requirements 3.3 and 3.4 of GSR Part 6 ~~WS-R-5~~[18]~~.~~ Requirements 2 and 20 of GSR Part 7 [26]			
20				The government should identify all necessary elements of a legal framework for the safety infrastructure, and should plan how to structure it and develop it.
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 [5]~~;~~ Requirements 2 and 3 of GSR Part 3 [8]~~[8] (revision of BSS);~~ Requirement 1 of GSR Part 5 [9]~~.~~			
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 [5]~~;~~ Requirements 3.6 and 5.26 of GS-R-3 [16]~~;~~ Requirement 1 of GSR Part 5 [9]~~.~~			
39				The government should establish a policy and guidance to inform the public and interested parties of the benefits and risks of nuclear power, to facilitate their involvement in the decision making on a prospective nuclear power programme.
40				The government should establish a process to ensure that the comments arising from consultation with relevant interested parties are considered, and it should communicate about the results of these considerations to the interested parties.
6 — Funding and financing				
Basis	Requirements 1, 3, 10 and 11 of GSR Part 1 [5]~~;~~ Requirement 4.1 of GS-R-3 [16]~~;~~ Requirement 1 of GSR Part 5 [9]~~;~~ Requirements 6.1–6.5 of GSR Part 6 [18]~~WS-R-5;~~ Requirements 1, 3 and 4 of SSR-2/2 [17]~~.~~ Requirement 2 of GSR Part 7 [26]			

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 consider the long term economic conditions of nuclear power plant operation to ensure that the operating organization is able 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 [5]; Requirements 3.14 and 5.23 of GS-R-3 [16]; Requirement 2 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirement 3 of SSR-2/2 [17].			
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 to 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 [5]; GS-R-3 as a whole [16]; Requirement 5 of GSR Part 3 [8][~~8] (revision of BSS);~~ Requirements 6.1–6.9 of NS-R-3 [31].			
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 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 persons with leadership capabilities and an attitude emphasizing safety culture.

9 — Human resources development				
Basis	Requirements 1, 11 and 18 of GSR Part 1 [5]~~;~~ Requirements 4.1, 4.3 and 4.5 of GS-R-3 [16]~~;~~ Requirement 2 of GSR Part 3 [8] ~~[8] (revision of BSS)~~; Requirement 4 of SSR-2/2 [17]~~.~~ Requirement 21 and 25 of GSR Part 7 [26]			
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 [5].			
99				The government should consider in which areas knowledge in depth 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 ~~gaps in~~ the capabilities of domestic research centres to meet needs in core areas, and should plan to establish new research centres for core areas as necessary.
11 — Radiation protection				
Basis	Requirement 7 of GSR Part 1 [5]~~;~~ Requirements 2 and 43 of GSR Part 3[8] ~~[8] (revision of BSS);~~ Requirements 4.1–4.15 of NS-R-3 [31]~~.~~			
105				The government should consider the additional radiation risks and needs associated with the operation of nuclear power plants.
106				The government should ensure that an initial radiological environmental impact analysis 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 for integrating radiation protection regulations and new safety regulations for nuclear power plants.
12 — Safety assessment				
Basis	Requirements 5, 6 and 8 of GSR Part 4 [41].			
117				The government should familiarize itself with the IAEA safety standards and with other States' practices, as appropriate, to gain an understanding of the resources needed for capabilities for safety assessment.
13 — Safety of radioactive waste management, spent fuel management and decommissioning				
Basis	Requirements 7 and 10 of GSR Part 1 [5]; Requirement 2 of GSR Part 3 [8] [8] (revision of BSS); Requirements 1 and 2 of GSR Part 5 [9]; Requirements 2.1, 3.1–3.4, 6.1–6.5 of WS-R-5 1, 4, 5 and 9 of GSR Part 6 [18].			
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 strategy.
14 — Emergency preparedness and response				
Basis	Requirements 7 and 8 of GSR Part 1 [5]; Requirement 43 of GSR Part 3 [8] [8] (revision of BSS); Requirement 2.1–2.6 of GS-R-2. Requirements 1 and 2 of GSR Part 7 [26]			
133				The government should develop awareness of the need for the early establishment of emergency plans.
134				The government should identify institutions and new arrangements for supporting emergency preparedness and response.
Implementing the IAEA Specific Safety Requirements for Safety Infrastructure				
15 — Operating organization				
Basis	Principles Requirements 5, 6 and 11 of GSR Part 1 [5]; Requirement 4 of GSR Part 3 [8] (revision of BSS); Requirements 1 and 4 of SSR-2/2 [17].			
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, site selection and evaluation				
Basis	Requirement 3~~1~~2 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirements 2.1–2.29, 3.1–3.55, 4.1–4.15, 6.1–6.9 of NS-R-3 [31]~~.~~			
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	SSR-2/1 [33]			
170				The government should ~~learn~~ 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 as well as the reliability of the national power grid, and should consider the potential impacts of these on the design requirements for the safety of the plant.
18 — Preparation for commissioning				
				No action in Phase 1.
19 — Transport safety				
Basis	Requirement 7 of GSR Part 1 [5]~~;~~ Requirement 2 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ ~~TS-R-1~~SSR-6 [32] 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, over and above the existing transport of other radioactive material.
20 — Interfaces with nuclear security				
Basis	Requirement 12 of GSR Part 1 [5]~~;~~ Requirement 2.1 of GS-R-3 [16]~~.~~			
193				The government should foster both safety culture and security culture, taking into account their commonalities and differences.

PHASE 2

Action No.	Responsible entities (main): Government, legislators	Responsible entities (main): Regulatory body	Responsible entities (main): Operating organization	Actions to be taken to implement the IAEA safety standards in Phase 2, and bases for these actions
Implementing the IAEA General Safety Requirements for the Safety Infrastructure				
1 — National policy and strategy for safety				
Basis				Requirement 1 of GSR Part 1 [5]~~;~~ Requirements 10 and 29 of GSR Part 3 [8] ~~;[8] (revision of BSS);~~ Requirement 2 of GSR Part 5 [9]~~.~~ Requirement 2 of GSR Part 7 [26]
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 the IAEA's Fundamental Safety Principles [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 [5]~~;~~ Requirement 6.3–6.6 of GS-R-3 [16]~~.~~ Requirement 24 of SSR 2/2 [17]
14				All the relevant organizations should participate in the global nuclear safety framework.
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 with advanced nuclear power programmes.

3 — Legal framework					
Basis	Requirements 1–4 of GSR Part 1 [5]~~;~~ Requirement 2 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirement 1 of GSR Part 5 [9]~~;~~ Requirement 4 of GSR Part 6 [18]~~s 3.3 and 3.4 of WS-R-5.~~ Requirements 2 and 20 of GSR Part 7 [26]				
22				The government should enact and implement the essential elements of the legal framework for the safety infrastructure.	
4 — Regulatory framework					
Basis	Requirements 1, 3, 4, 7, 11, 16–18, 21– 26, 30 and 32 of GSR Part 1 [5]~~;~~ Requirements 2 and 3 of GSR Part 3[8] ~~[8] (revision of BSS);~~ Requirements 1 and 3 of GSR Part 5 [9]~~;~~ Requirements ~~3.~~5 ~~and 3.6~~ of ~~WS-R-5~~GSR Part 6 [18]~~;~~ ~~–~~Requirement 3.7 of GS-R-3 [17]~~.~~ Requirement 2 of GSR Part 7 [26]				
27				The government should establish an effectively independent regulatory body and should empower it with adequate legal authority, technical and managerial competence, and 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 tentatively plan 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 and issue regulations and guides specifying the documentation and procedures necessary in the various steps of the licensing process and inspections to be	
31				The regulatory body should ~~specify~~ develop and issues those ~~the~~ safety regulations~~requirements~~ that ~~should be known~~are needed for the bidding process.	
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 [5]~~;~~ Requirements 3.6, 5.26 and 5.27 of GS-R-3 [16]~~;~~ Requirement 3 of GSR Part 3[8] ~~[8] (revision of BSS);~~ Requirements 1 and 3 of GSR Part 5 [9]~~;~~				

41				The government should inform ~~all~~the public and interested parties regarding the safety implications of the decision on the implementation of a nuclear power programme.
42				All the relevant organizations should continue to inform the public and interested parties on 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 [5]; ~~-~~ Requirement 4.1 of GS-R-3 [16]; ~~-~~ Requirement 1 of GSR Part 5 [9]; ~~-~~ Requirement~~s~~ 9 of GSR Part 6 [18]; ~~6.1 -~~ ~~6.5 of WS-R-5;~~ Requirements 1, 3 and 4 of SSR-2/2 [17]. ~~-~~ Requirement 2 of GSR Part 7 [26]			
52				The government should make provision for long term funding of 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 mamagement and decommissioning.
7 — External support organizations and contractors				
Basis	Requirements 4, 11, 13, 17 and 20 of GSR Part 1 [5]; ~~-~~ Requirements 3.14, 5.14, 5.23 and 5.24 of GS-R-3 [16]; ~~-~~ Requirements 2 and 3 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ ~~Requirement 37 of SSR/2/1 [33];~~ Requirements 3 and 31 of SSR-2/2 [17]. ~~-~~			
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 [5]~~;~~ GS-R-3 [16] as a whole~~;~~ Requirement 5 of GSR Part 3[8] ~~[8] (revision of BSS);~~ Requirement 7 of GSR Part 5 [9]~~;~~ Requirements 6.1–6.9 of NS-R-3[31]~~;~~ Requirement 2 of SSR-2/2 [17]~~;~~ Requirement 306 of ~~TS-R-1~~SSR-6 [32]~~.~~			
75	XXX XXX XXX x			The regulatory body and the operating organization should start developing and implementing effective integrated management systems in their respective organizations and should promote a strong safety culture.
76	XXX XXX XXX			The regulatory body and the operating organization should develop competences in managing the growth of and change in the organization.
77	XXX XXX XXX XXX			The regulatory body and the operating organization should make appropriate arrangements for measurement, assessment (both 'self-assessment' and independent assessment) and continuous improvement of their integrated management systems.
9 — Human resources development				
Basis	Requirements 1, 11 and 18 of GSR Part 1 [5]~~;~~ Requirements 4.1, 4.3–4.5 of GS-R-3 [16]~~;~~ Requirements 2–4 and 26 of GSR Part 3 [8]~~[8] (revision of BSS);~~ Requirements 4 and 7 of SSR-2/2 [17]~~;~~ Requirements 311–315 of ~~TS-R-1~~SSR-6 [32]~~.~~			
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 prospective nuclear 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		XXX XXX	XXX XXX	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 necessary number of persons for ensuring safety.

10 — Research for safety and regulatory purposes				
Basis	Requirements 1 and 11 of GSR Part 1 [5]; Requirement 3 of GSR Part 5 [9].			
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 identified in Phase 1necessary.
103				Research centres should begin conducting research relating to safety in areas in which knowledge in depth is essential to support safe long term operation of nuclear power plants.
11 — Radiation protection				
Basis	Requirement 7 of GSR Part 1 [5]; Requirements 1–4, 6-16, 19-32 and 6–33, 43, 44, Schedule III and Schedule IV of GSR Part 3[8] [8] (revision of BSS); Requirements 4.1–4.15 of NS-R-3 [31]; Requirements 78 and 79 of SSR/2/1 [33]; Requirements 301–303 of SSR-6 [32]TS-R-1.			
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 constrain regarding workers and the public both for normal and potential exposure situations in a nuclear power plant.
110				The operating organization should update the radiological environmental impact analysis for the site selected, as appropriate.
111				The regulatory body should review and assess the radiological environmental impact analysis 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 for the nuclear power plant.
12 — Safety assessment				
Basis	Requirements 24–26 of GSR Part 1 [5]; Requirement 13 of GSR Part 3[8] [8] (revision of BSS); Requirements 1–6, 8, 14–16 of GSR Part 4 [41].			

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

13 — Safety of radioactive waste management, spent fuel management and decommissioning				
Basis	Requirements 7 and 10 of GSR Part 1 [5]~~;~~ Requirements 2 and 31 of GSR Part 3[8] ~~[8] (revision of BSS);~~ Requirements 1–12 and 17 of GSR Part 5 [9]~~;~~ Requirements ~~2.1–2.3, 2.5, 3.1–3.4, 3.5–3.8, 4.1–4.8, 6.1–6.5 of WS-R-5;~~1, 4, 5, 6, 8 and 9 of GSR Part 6 [18] Requirement 22 of SSR-2/2 [17]~~;~~ Requirements 35, 36 and 38 of SSR-2/1 [33]~~.~~ Requirement 15 of GSR Part 7 [26]			
124		XXX XXX XXX XXX XXX	XXX XXX XXX XXX XXX	The government and other interested parties as appropriate should establish the national 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 for establishing a national organization responsible for radioactive waste management, or for extending the organization for radioactive waste management, if this 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.
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 [5]~~;~~ Requirements 43–4~~6~~ ~~and Schedule IV~~ of GSR Part 3 [8]~~[8] (revision of BSS);~~ Requirements ~~2.1–2.6, 3.1–3.20, 5.2–5.30 of GS-R-2~~1, 2, 4, 5 and 20-23 of GSR Part 7 [26]~~;~~ Requirements 18 and 19 of SSR-2/2 [17]~~;~~ Requirements 304 and 305 of ~~TS-R-1~~SSR-6 [32]~~.~~			
135				The government should ~~specify~~ determine the national institutions 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 thebasic regulations on emergency planning, as necessary for the development of infrastructure.

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139				The operating organization should start developing a general emergency preparedness programme for nuclear power plants.
Implementing the IAEA Specific Safety Requirements for Safety Infrastructure				
15 — Operating organization				
Basis	Requirements 5, 6 and 11 of GSR Part 1 [5]; ~~Requirement 4 of GSR Part 3~~[8] ~~[8] (revision of BSS);~~ Requirements 1–5 of SSR-2/2 [17].			
149				The operating organization should be formed, if it has not already been formed, and it should be expressly assigned its primeresponsibility 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 a management system in which safety has the overriding priority.
152				The operating organization should establish a suitable working relationship with the regulatory body and with relevant national and international organizations.
153				The operating organization should establish a bidding process and should specify the safety requirements to be included in the call for bids, 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, consistent with governmental policy.
16 — Site survey and site evaluation				
Basis	Requirement 3~~7~~ of GSR Part 3 [8]~~[8] (revision of BSS);~~ Requirements 2.1–2.29, 3.1–3.55, 4.1–4.15, 6.1–6.9 of NS-R-3 [31].			
161				The regulatory body should establish specific safety requirements for site evaluation, including requirements for the process for 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, and 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 regarding the acceptability of the site selected and the site related design bases.
165				The operating organization should use all the appropriate information relevant to safety and to regulatory control that is related to or derived from the site assessment to prepare the bid specifications for the nuclear power plant.
166				The operating organization should start to evaluate and modify the site and 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[8] ~~[8] (revision of BSS);~~ SSR-2/1 [33] as a whole~~;~~ Requirements 6.43–6.51 of NS-R-5 [43]~~.~~			
172				All the 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.
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 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 [5]~~;~~ Requirement 2 of GSR Part 3[8] ~~[8] (revision of BSS); TS-R-1~~SSR-6 [32] as a whole~~.~~				
190				All relevant organizations should make 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 [5]~~;~~ Requirement 2.1 of GS-R-3 [16]~~;~~ Requirement 5 of GSR Part 5 [9]~~;~~ Requirements -2 and 23 of GSR Part 7 [26]~~5.16 of GS-R-2.~~				
194				All the relevant organizations should coordinate safety and security aspects from the early stages of development, establishing maximum synergy and, where necessary, integration.	
195				~~The government should define the responsibilities of the operating organization and other competent authorities in relation to security.~~	
196				~~The government should develop mechanisms to communicate to the public appropriate information regarding safety and nuclear security.~~	

PHASE 3

Action No.	Responsible entities (main): Government, legislators	Responsible entities (main): Regulatory body	Responsible entities (main): Operating organization	Actions to be taken to implement the IAEA safety standards in Phase 3, and bases for these actions
Implementing the IAEA General Safety Requirements for Safety Infrastructure				
1 — National policy and strategy for safety				
Basis	Requirement 1 of GSR Part 1 [5]~~;~~ Requirement 10 and 29 of GSR Part 3[8] ~~[8]~~ Requirement 2 of GSR Part 5 [9]~~.~~ Requirement 2 of GSR Part 7 [26]			
9				The government should verify the ~~continue to~~ implementation of the national policy and strategy for safety.
10				The government should ensure that the regulatory body and the operating organization are fulfilling their responsibilities.
2 — Global nuclear safety regime				
Basis	Requirements 1 and 14 of GSR Part 1 [5]~~;~~ Requirements 6.3–6.6 of GS-R-3 [16]~~;~~ Requirement 24 of SSR-2/2 [17]~~.~~			
17				All the 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 [5]~~;~~ Requirement 2 of GSR Part 3 [8]~~[8] (revision of BSS);~~ Requirement 1 of GSR Part 5 [9]~~;~~ Requirement~~s 3.3 and 3.~~4 of ~~WS-R-5.~~GSR Part 6 [18] Requirements 2 and 20 of GSR Part 7 [26]			
23				The government should ensure that the legal framework for the safety infrastructure is fully in place and that the legislation is

4 — Regulatory framework				
Basis	Requirements 1, 3, 4, 7, 11, 16–18, 21–33 of GSR Part 1 [5]~~;~~ Requirements 2 and 3 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirements 1 and 3 of GSR Part 5 [9]~~;~~ Requirements ~~3.~~5 ~~and 3.6~~ of ~~WS-R-5~~GSR Part 6 [18]~~;~~ Requirement 3.7 of GS-R-3 [16]~~.~~ Requirement 2 of GSR Part 7 [26]			
33				The regulatory body should maintain suitable working relations with the operating organization.
34				The regulatory body should plan and conduct all the required licensing and oversight activities to be conducted during the licensing process, including 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 safety related components.
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 [5]~~;~~ Requirements 3.6, 5.26 and 5.27 of GS-R-3 [16]~~;~~ Requirement 3 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirements 1 and 3 of GSR Part 5 [9]~~;~~ Requirements 4.53, 4.54, 4.82–4.84 of ~~GS-R-2~~GSR Part 7 [26]~~;~~ Requirement 2 of SSR-2/2 [17]~~.~~			
43				All relevant organizations should seek to establish and maintain the confidence and trust of the public and other interested parties~~,~~ ~~including the public,~~ on safety issues.
44				All relevant organizations, as appropriate to their role, should continue to explain ~~to~~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 to the public and other ~~with~~ interested parties about the licensing process, safety

46				The operating organization and the regulatory body should communicate with 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 ~~all~~other interested parties involved in the construction programme, including suppliers, regarding the problems and difficulties encountered.
6 — Funding and financing				
Basis	Requirements 1, 3, 10 and 11 of GSR Part 1 [5]~~;~~ Requirement 4.1 of GS-R-3 [16]~~;~~ Requirement 1 of GSR Part 5 [9]~~;~~ Requirement~~s 6.1–6.5 of WS-R-5~~9 of GSR Part 6 [18]~~;~~ Requirements 1, 3 and 4 of SSR-2/2 [17]~~.~~ Requirement 2 of GSR Part 7 [26]			
56				The government should provide ~~appropriate~~ sustainable funding for the efficient and effective conduct of the regulatory body's activities and emergency arrangements of 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 and radioactive waste management, 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 [5]~~;~~ Requirements 3.14, 5.14, 5.15–5.20, 5.23–5.25 of GS-R-3 [16]~~;~~ Requirements 2~~, and~~ 3 and 20 of GSR Part 3 [8]~~ [8] (revision of BSS);~~ ~~Requirement 37 of SSR-2/1;~~ Requirements 3 and 31 of SSR-2/2 [17]~~.~~			
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 the relevant organizations should ensure clarity in specifying the roles and responsibilities of external support organizations.

70				All the 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 [5]~~;~~ GS-R-3 [16] as a whole~~;~~ Requirement 5 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirement 7 of GSR Part 5 [9]~~;~~ Requirements 5.37–5.39 of GS-R Part 7 [26] ~~2;~~ Requirements 6.1–6.9 of NS-R-3 [31]~~;~~ Requirement 2 of SSR-2/1 [33]~~;~~ Requirements 2, 8, 9 and 15 of SSR-2/2 [17]~~;~~ Requirement 4 of GSR Part 6 [32] ~~306 of TS-R-1.~~			
78				The senior management of all the 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 the 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.
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 continuous
81				All the relevant organizations should ensure that appropriate arrangements for management of safety related knowledge (including record management and report management) and knowledge transfer are in place.
82				All the 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 prepare a safety management programme as well as the corresponding chapter of the safety analysis report.
84				The regulatory body should review and assess the operating

9 — Human resources development					
Basis	Requirements 1, 11 and 18 of GSR Part 1 [5]~~;~~ Requirements 4.1, 4.3–4.5 of GS-R-3 [16]~~;~~ Requirements 2–4 and 26 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirements 4 and 7 of SSR-2/2 [17]~~;~~ Requirements 311–315 of ~~TS-R-1~~SSR-6 [32]~~.~~ Requirements 21and 25 of GSR Part 7 [26]				
95				The operating organization, the regulatory body and external support organizations and all other relevant response organizations should ensure the availability of sufficient competent human resources for the efficient and effective conduct	
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 [5]~~;~~ Requirements 3 of GSR Part 5 [9]~~.~~				
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 [5]~~;~~ Requirements 1–4, 6–16, 19-32 ~~33~~, ~~43, 44, Schedule III and Schedule IV~~ of GSR Part 3 ~~[8] (revision of BSS);~~ Requirements 4.1–4.15 of NS-R-3 [31]~~;~~ Requirements 78 and 79 of SSR-2/1 [33]~~;~~ Requirement 21 of SSR-2/2 [17]~~;~~ Requirements 301–303 of ~~TS-R-1~~SSR-6 [32]~~.~~				
114				The operating organization should establish a radiation protection programme, should continue implementing an environmental radiological monitoring programme, and should prepare the	

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 releases from the nuclear power plant to the environment.
12 — Safety assessment				
Basis	Requirements 24–26 of GSR Part 1 [5]~~;~~ Requirement 13 of GSR Part 3[8] ~~[8] (revision of BSS);~~ Requirements 1–24 of GSR Part 4 [41]~~;~~ Requirements 5 and 39 of SSR-2/1 [33]~~;~~ Requirement 12 of SSR-2/2 [17]~~.~~			
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 [5]~~;~~ Requirements 2 and 31 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirements 1–20 of GSR Part 5 [9]~~;~~ Requirements ~~2.1–2.5, 3.1–3.8, 4.1–4.8, 5.1–5.14, 6.1–6.5 of WS-R-5~~1, 4, 5, 6, 8, 9 and 10 of GSR Part 6 [18]~~;~~ Requirements 22 and 33 of SSR-2/2 [17]~~;~~ Requirements 35, 36 and 38 of SSR-2/1 [33]~~.~~ Requirement 15 of GSR Part 7 [26]			
128				The operating organization should prepare a programme for radioactive waste management and spent fuel management, as well as a decommissioning management programme, in accordance with the national 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 interim 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 the 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 [5]~~;~~ Requirement 43–46 and Schedule IV of GSR Part 3 [8] ~~[8] (revision of BSS); Requirements 2.1–2.6, 3.1–3.20, 4.1–4.100, 5.2–5.39 of GS-R-2;~~ Requirements 1-26 and Appendices I and II of GSR Part 7 [26] Requirement 18 of SSR-2/2 [17]~~;~~ Requirements 304 and 305 of ~~TS-R-1~~SSR-6 [32]~~.~~			
140				The regulatory body should establish detailed regulations on emergency planning.
141				The operating organization should develop and implement an emergency preparedness programme, and emergency plans and procedures for nuclear power plants, and should prepare the corresponding chapter of the safety analysis report.
142				The government and the regulatory body should develop and implement emergency preparedness programmes at the local, national and international level.
143				The government and the regulatory body should establish arrangements for coordination between the emergency response plan of the nuclear power plant and the plans of the relevant national institutions that would be involved in emergency response.
144				The regulatory body should review and assess the emergency programme, plans and procedures for nuclear power plants, to the extent necessary to~~and should~~ verify compliance with the regulatory requirements.
145				The government, the regulatory body and the operating organization should demonstrate emergency response capabilities by conducting appropriate exercises that include local authorities and local communities.
Implementing the IAEA Specific Safety Requirements for Safety Infrastructure				
15 —Operating organization				

Basis	Requirements 5, 6 and 11 of GSR Part 1 [5]; Requirement 3.7 of GS-R-3 [16]; Requirement 4 of GSR Part 3 [8] [8] (revision of BSS); Requirement 1 of SSR-2/1 [33]; Requirements 1–32 of SSR-2/2 [17]; Requirements 9.4, 9.49–9.53 of NS-R-5 [33]. Requirement 2 of GSR Part 7 [26]

155				The operating organization should implement a safety policy that includes goals and objectives that give safety matters the highest priority, as part of its management system.
156				The operating organization should give primary consideration to safety aspects during the evaluation of bids.
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 the completion of construction of the nuclear power plant in accordance with the design bases licensing conditions and with primary consideration given to safety aspects.
16 — Site survey and site evaluation				
Basis	Requirement 31 of GSR Part 3 [8] ~~[8] (revision of BSS);~~ Requirements 2.1–2.29, 3.1–3.55, 4.1–4.15, 5.1, 6.1–6.9 of NS-R-3 [31]~~.~~			
167				The operating organization should prepare the chapter on site evaluation of the safety analysis report, and then update it, taking into account the specificities of the ~~reactor~~ nuclear power plant selected and the data and information gathered during the pre-
168				The operating organization should implement necessary safety improvements to the site, if required, as site protection measures determined as a result of the tasks of 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 [8] ~~[8] (revision of BSS);~~ SSR-2/1 [33] as a whole~~;~~ Requirements 10 and 11 of SSR-2/2 [17]~~;~~ Requirements 6.43–6.51 of NS-R-5 [43]~~.~~			
177				The operating organization should establish a ‘design entity’ 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, including an assessment of the associated sets of codes and standards.

179				The operating organization should establish a proper interaction with the selected vendor for 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 reports, and should verify 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 [17]			
185				The regulatory body should issue requirements on commissioning.
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 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 [5]~~;~~ Requirement 2 of GSR Part 3 [8]~~[8] (revision of BSS); TS-R-1~~SSR-6 [32] 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 in Phase 2.
20 — Interfaces with nuclear security				
Basis	Requirement 12 of GSR Part 1 [5]~~;~~ Requirement 2.1 of GS-R-3 [16]~~;~~ Requirement 5 of GSR Part 5 [9]~~;~~ ~~Requirement 5.16 of GS-R-2.~~ Requirement 2 and 23of GSR Part 7 [26]			
197				The regulatory body (possibly consisting of several authorities) should ensure that security regulations do not compromise safety and that safety regulations do not compromise security.
198				~~The operating organization should prepare a physical protection programme and should submit it to the regulatory body as appropriate.~~
199				All the relevant organizations should ensure that emergency preparedness and response plans in the fields of safety and nuclear security are complementary, coherent and well coordinated among the entities involved.
200				The operating organization and the regulatory body should continue to promote safety culture and nuclear security culture in their respective organizations.

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