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IAEA Safety Standards

for protecting people and the environment

Safety of Nuclear Power Plants: Commissioning and Operation

Specific Safety Requirements
No. SSR-2/2



IAEA

International Atomic Energy Agency

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IAEA SAFETY 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

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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.

OTHER SAFETY 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**.

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SAFETY OF
NUCLEAR POWER PLANTS:
COMMISSIONING AND OPERATION

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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".

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IAEA SAFETY STANDARDS SERIES No. SSR-2/2

SAFETY OF NUCLEAR POWER PLANTS: COMMISSIONING AND OPERATION

SPECIFIC SAFETY REQUIREMENTS

This publication includes a CD-ROM containing the IAEA Safety Glossary: 2007 Edition (2007) and the Fundamental Safety Principles (2006), each in Arabic, Chinese, English, French, Russian and Spanish versions.

The CD-ROM is also available for purchase separately.

See: <http://www-pub.iaea.org/MTCDC/publications/publications.asp>

INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

by Yukiya Amano
Director General

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

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

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

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

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

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DISCLAIMER

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.

The accident at the Fukushima Daiichi nuclear power plant in Japan caused by the disastrous earthquake and tsunami of 11 March 2011 and the consequences of the emergency for people and the environment have to be fully investigated. They are already under study in Japan, at the IAEA and elsewhere. Lessons to be learned for nuclear safety and radiation protection and for emergency preparedness and response will be reflected in IAEA safety standards as they are revised and issued in the future.

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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

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of health and minimization of danger to life and property, and to provide for their application.

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

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

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

Safety Fundamentals

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

Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered 'overarching' requirements, are expressed

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

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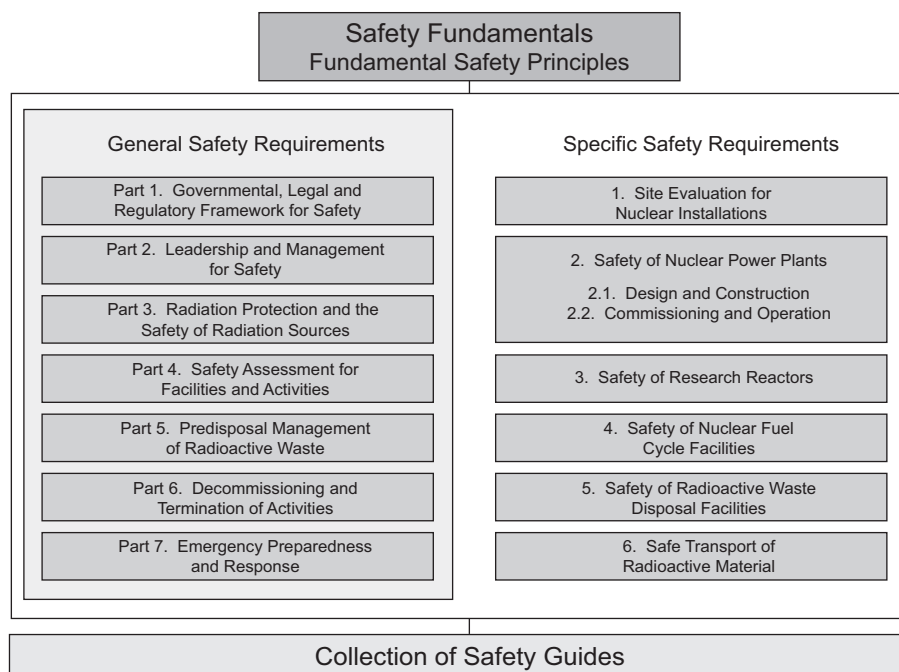


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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 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

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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).

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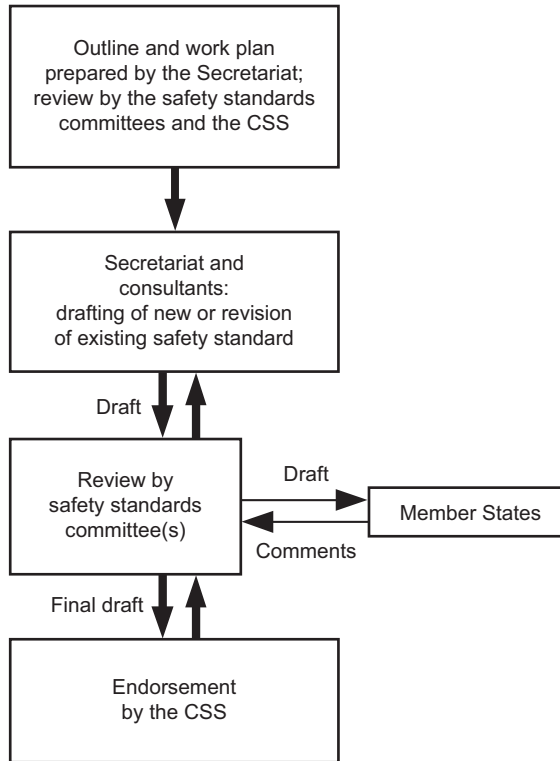


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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 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

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

INTERPRETATION OF THE TEXT

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

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

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

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

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1. INTRODUCTION

BACKGROUND

1.1. The safety of a nuclear power plant is ensured by means of proper site selection, design, construction and commissioning, and the evaluation of these, followed by proper management, operation and maintenance of the plant. In a later phase, a proper transition to decommissioning is required. The organization and management of plant operations ensures that a high level of safety is achieved through the effective management and control of operational activities.

1.2. This publication is a revision of the Safety Requirements publication Safety of Nuclear Power Plants: Operation, which was issued in 2000 as IAEA Safety Standards Series No. NS-R-2. The purpose of this revision was to restructure Safety Standards Series No. NS-R-2 in the light of new operating experience and new trends in the nuclear industry; to introduce new requirements that were not included in Safety Standards Series No. NS-R-2 on the operation of nuclear power plants; and to reflect current practices, new concepts and technical developments. This update also reflects feedback on the use of the standards, both from Member States and from the IAEA's safety related activities. The publication is presented in the new format for Safety Requirements publications.

1.3. The present publication reflects the safety principles of the Fundamental Safety Principles [1]. It has been harmonized with IAEA Safety Standards Series No. GS-R-3 on The Management System for Facilities and Activities [2].

1.4. Guidance on the fulfilment of the safety requirements is provided in supporting Safety Guides. The terminology used in this publication is defined and explained in the IAEA Safety Glossary [3].

OBJECTIVE

1.5. The objective of this publication is to establish the requirements which, in the light of experience and the present state of technology, must be satisfied to ensure the safe operation of nuclear power plants. These requirements are governed by the safety objective and safety principles that are established in the Fundamental Safety Principles [1].

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SCOPE

1.6. This publication deals with the safe commissioning and operation of a nuclear power plant. It covers commissioning and operation up to the removal of nuclear fuel from the plant, including maintenance and modifications made throughout the lifetime of the plant. It covers the preparation for decommissioning but not the decommissioning phase itself. The publication also establishes additional requirements relating only to commissioning. Normal operation and anticipated operational occurrences as well as accident conditions are taken into account.

STRUCTURE

1.7. This publication follows the relationship between principles and objectives for safety, and safety requirements and criteria. Section 2 elaborates on the safety objective and safety principles, which form the basis for deriving the safety requirements that must be met in the operation of a nuclear power plant. Sections 3–9 establish safety requirements under a series of individually numbered overarching requirements.

1.8. Section 3 establishes the requirements to be applied for the management and organizational structure of the operating organization. Section 4 establishes the requirements for the management of operational safety, while Section 5 establishes the requirements for operational safety programmes. Section 6 establishes the requirements for plant commissioning. Section 7 establishes the requirements for plant operations. Section 8 establishes the requirements for maintenance, testing, surveillance and inspection. Section 9 establishes the requirements for preparation for decommissioning. The requirements are mainly applicable to water cooled reactors, but they may also be used as a basis for establishing specific requirements for other reactor designs.

2. SAFETY OBJECTIVE AND PRINCIPLES

2.1. Any industrial activity yields benefits and incurs risks. Industrial activities such as activities in the operation of a nuclear installation may have associated risks of various types. Risks may be borne by the site personnel, by people living

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near the installation and/or by the whole society. The environment may also suffer harm if radioactive material were to be released, particularly under accident conditions. Consequently, it is necessary to limit the risks to which people and the environment are subject for all reasonably foreseeable circumstances [1].

2.2. Most requirements presented in this publication are derived from the fundamental safety objective of protecting people and the environment, and the related safety principles [1]:

Safety objective

The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation.

Principle 1: Responsibility for safety

The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.

Principle 3: Leadership and management for safety

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.

Principle 5: Optimization of protection

Protection must be optimized to provide the highest level of safety that can reasonably be achieved.

Principle 6: Limitation of risks to individuals

Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.

Principle 7: Protection of present and future generations

People and the environment, present and future, must be protected against radiation risks.

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Principle 8: Prevention of accidents

All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.

Principle 9: Emergency preparedness and response

Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.

The requirements derived from these principles must be applied to minimize and control the radiation risks to workers and site personnel, the public and the environment.

3. THE MANAGEMENT AND ORGANIZATIONAL STRUCTURE OF THE OPERATING ORGANIZATION

Requirement 1: Responsibilities of the operating organization

The operating organization shall have the prime responsibility for safety in the operation of a nuclear power plant.

3.1. The prime responsibility for safety shall be assigned to the operating organization of the nuclear power plant. This prime responsibility shall cover all the activities related to the operation directly and indirectly. It includes the responsibility for supervising the activities of all other related groups, such as designers, suppliers, manufacturers and constructors, employers and contractors, as well as the responsibility for operation of nuclear power plant(s) by the operating organization itself. The operating organization shall discharge this responsibility in accordance with its management system [2].

3.2. The management system, as an integrated set of interrelated or interacting components for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner, shall include the following activities:

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- (a) Policy making for all areas of safety, which includes:
- Setting management objectives;
 - Establishing the policy for safety;
 - Developing management and staff who value learning, have skills in creating, acquiring and transferring knowledge, and can adapt the organization on the basis of new knowledge and insights;
 - Promoting a strong safety culture.
- Strategies and management objectives shall be developed in accordance with the policy in order to put the policy into effect.
- (b) Allocation of responsibilities with corresponding lines of authority and communication, for:
- Allocating resources;
 - Providing human resources with the appropriate level of education and training and material resources;
 - Retaining the necessary competences;
 - Approving the contents of management programmes;
 - Developing procedures and instructions, and having a strict policy to adhere to these procedures and instructions;
 - Setting policies on fitness for duty;
 - Establishing a programme to make the necessary changes to any of these functions on the basis of the performance in achieving objectives.
- (c) Operating functions, which include executive decision making and actions for the operation of a plant for all operational states and accidents conditions.
- (d) Support activities, which include obtaining, from both on-site and off-site organizations, including contractors, the technical and administrative services and the use of facilities necessary to perform the operating functions. For sites with shared safety related resources (e.g. sites with multiple units or with more than one operating organization), the arrangements for the use of such shared resources shall be clearly defined.
- (e) Review activities, which include monitoring and assessing the performance of the operating functions and supporting functions on a regular basis. The purpose of monitoring is to verify compliance with the objectives for safe operation of the plant, to reveal deviations, deficiencies and equipment failures, and to provide information for the purpose of taking timely corrective actions and making improvements. Reviewing functions shall also include review of the overall safety performance of the organization to assess the effectiveness of management for safety and to identify opportunities for improvement. In addition, a safety review of the plant shall be performed periodically, including design aspects, to ensure that the

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plant is operated in conformity with the approved design and safety analysis report, and to identify possible safety improvements.

- (f) Design integrity, which includes maintaining a formally designated entity that has overall responsibility for the continuing integrity of the plant design throughout its lifetime, and managing the interfaces and lines of communication with the responsible designers and equipment suppliers contributing to this continuing integrity [4].

3.3. The operating organization shall establish liaison with the regulatory body and with relevant authorities to ensure a common understanding of, and to ensure compliance with, safety requirements and their interface with other requirements, such as those for security, protection of health or protection of the environment.

Requirement 2: Management system

The operating organization shall establish, implement, assess and continually improve an integrated management system.

3.4. The operating organization shall ensure through the establishment and use of a management system that the plant is operated in a safe manner and within the limits and conditions that are specified in the safety assessment and established in the authorization.

3.5. The management system shall integrate all the elements of management so that processes and activities that may affect safety are established and conducted coherently with other requirements, including requirements in respect of leadership, protection of health, human performance, protection of the environment, security and quality, and so that safety is not compromised by other requirements or demands.

3.6. The management system of the operating organization shall provide for arrangements to ensure safety in activities performed by external support organizations. Responsibility for activities performed by external support organizations, and for their overall control and supervision, rests with the operating organization. The operating organization shall establish a system for the supervision of work performed by support organizations. It shall be the responsibility of the operating organization to ensure that the personnel of external support organizations who perform activities on structures, systems or components important to safety or activities affecting safety are qualified to perform their assigned tasks. The overall contracted activity shall be clearly specified in writing and shall be approved by the operating organization prior to

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its commencement. The operating organization shall ensure long term access to knowledge of the plant design and manufacturing and construction throughout the lifetime of the plant.

3.7. The operational safety of a plant is subject to oversight by a regulatory body independent of the operating organization. The operating organization, in accordance with the regulatory requirements, shall submit or make available to the regulatory body all necessary documents and information. The operating organization shall develop and implement a procedure for reporting events to the regulatory body in accordance with the established criteria and the State's regulations. The operating organization shall provide the regulatory body with all necessary assistance to enable it to perform its duties, including enabling unhindered access to the plant and providing documentation.

Requirement 3: Structure and functions of the operating organization

The structure of the operating organization and the functions, roles and responsibilities of its personnel shall be established and documented.

3.8. Functional responsibilities, lines of authority, and lines of internal and external communication for the safe operation of a plant in all operational states and in accident conditions shall be clearly specified in writing. Authority for the safe operation of the plant may be delegated to the plant management. In this case, the necessary resources and support shall be provided.

3.9. Documentation of the plant's organizational structure and of the arrangements for discharging responsibilities shall be made available to the plant staff and, if required, to the regulatory body. The structure of the operating organization shall be specified so that all roles that are critical for safe operation are specified and described. Proposed organizational changes to the structure and associated arrangements, which might be of importance to safety, shall be analysed in advance by the operating organization. Where so required by the State's regulations, proposals for such organizational changes shall be submitted to the regulatory body for approval.

Requirement 4: Staffing of the operating organization

The operating organization shall be staffed with competent managers and sufficient qualified personnel for the safe operation of the plant.

3.10. The operating organization shall be responsible for ensuring that the necessary knowledge, skills, attitudes and safety expertise are sustained at the plant, and that long term objectives for human resources policy are developed and are met.

3.11. The organization, qualifications and number of operating personnel shall be adequate for the safe and reliable operation of the plant in all operational states and in accident conditions. Succession planning shall be an established practice for the operating personnel. The recruitment and selection policy of the operating organization shall be directed at retaining competent personnel to cover all aspects of safe operation. A long term staffing plan aligned to the long term objectives of the operating organization shall be developed in anticipation of the future needs of the operating organization for personnel and skills.

3.12. The shift team shall be staffed to ensure that sufficient authorized operators are present to operate the plant in accordance with the operational limits and conditions. The shift staffing patterns, shift cycles and controls on working hours shall provide sufficient time for the training of shift personnel. Distractions to control room operators shall be minimized. To avoid overburdening control room operators and to allow them to focus on their responsibilities for safety, activities shall be scheduled to reduce simultaneous activities as far as possible.

3.13. A staff health policy shall be instituted and maintained by the operating organization to ensure the fitness for duty of personnel. Attention shall be paid to minimizing conditions causing stress, and to setting restrictions on overtime and requirements for rest breaks. The health policy shall cover the prohibition of alcohol consumption and drug abuse.

4. MANAGEMENT OF OPERATIONAL SAFETY

Requirement 5: Safety policy

The operating organization shall establish and implement operational policies that give safety the highest priority.

4.1. The operational policy established and implemented by the operating organization shall give safety the utmost priority, overriding the demands of production and project schedules. The safety policy shall promote a strong safety culture, including a questioning attitude and a commitment to excellent performance in all activities important to safety. Managers shall promote an attitude of safety consciousness among plant staff [2].

4.2. The safety policy shall stipulate clearly the leadership role of the highest level of management in safety matters. Senior management shall communicate the provisions of the safety policy throughout the organization. Safety performance standards shall be developed for all operational activities and shall be applied by all site personnel. All personnel in the organization shall be made aware of the safety policy and of their responsibilities for ensuring safety. The safety performance standards and the expectations of the management for safety performance shall be clearly communicated to all personnel, and it shall be ensured that they are understood by all those involved in their implementation.

4.3. Key aspects of the safety policy shall be communicated to external support organizations, including contractors, so that the operating organization's requirements and expectations for the safety related activities of external support organizations, including contractors, will be understood and met.

4.4. The safety policy of the operating organization shall include commitments to perform periodic safety reviews of the plant throughout its operating lifetime in compliance with the regulatory requirements. Operating experience and significant new safety related information from relevant sources, including information on agreed corrective actions and on necessary improvements that have been implemented, shall be taken into account (see also Requirement 12).

4.5. The safety policy of the operating organization shall include a commitment to achieving enhancements in operational safety. The strategy of the operating organization for enhancing safety and for finding more effective ways of applying and, where feasible, improving existing standards shall be continuously

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monitored and supported by means of a clearly specified programme with clear objectives and targets.

Requirement 6: Operational limits and conditions

The operating organization shall ensure that the plant is operated in accordance with the set of operational limits and conditions.

4.6. The operational limits and conditions shall form an important part of the basis for the authorization of the operating organization to operate the plant. The plant shall be operated within the operational limits and conditions to prevent situations arising that could lead to anticipated operational occurrences or accident conditions, and to mitigate the consequences of such events if they do occur. The operational limits and conditions shall be developed for ensuring that the plant is being operated in accordance with the design assumptions and intent, as well as in accordance with its licence conditions.

4.7. The operational limits and conditions shall reflect the provisions made in the final design as described in the safety analysis report. The operational limits and conditions shall be submitted to the regulatory body for assessment and approval before the commencement of operation, if so required by the regulatory body. All operational limits and conditions shall be substantiated by a written statement of the reason for their adoption.

4.8. The operational limits and conditions shall be reviewed and revised as necessary in consideration of experience, developments in technology and approaches to safety, and changes in the plant.

4.9. The operational limits and conditions shall include requirements for normal operation, including shutdown and outage stages, and shall cover actions to be taken and limitations to be observed by the operating personnel.

4.10. The operational limits and conditions shall include the following:

- (a) Safety limits;
- (b) Limiting settings for safety systems;
- (c) Limits and conditions for normal operation;
- (d) Surveillance and testing requirements;
- (e) Action statements for deviations from normal operation.

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4.11. Operating personnel who are directly responsible for the conduct of operations shall be trained in and shall be thoroughly familiar with the operational limits and conditions in order to comply with the provisions contained therein.

4.12. The operating organization shall ensure that an appropriate surveillance programme is established and implemented to ensure compliance with the operational limits and conditions, and that its results are evaluated, recorded and retained.

4.13. The plant shall be returned to a safe operational state when an event occurs in which parameters deviate from the limits and conditions for normal operation. Appropriate remedial actions shall be taken. The operating organization shall undertake a review and evaluation of the event. The regulatory body shall be notified in accordance with the established event reporting system.

4.14. A process shall be established to ensure that deviations from operational limits and conditions are documented and reported in an appropriate manner and that appropriate actions are taken in response. Responsibilities and lines of communication for responding to such deviations shall be clearly specified in writing.

4.15. The operating organization shall not intentionally exceed the operational limits and conditions. Where circumstances necessitate plant operation outside the operational limits and conditions, clear formal instructions for such operations shall be developed, on the basis of safety analysis, if applicable. These instructions shall include instructions for returning the plant to normal operation within the operational limits and conditions. The instructions shall also include specification of the arrangements for approval by the operating organization and the regulatory body, as appropriate, of the changed operational limits and conditions, prior to operation under these changed operational limits and conditions.

Requirement 7: Qualification and training of personnel

The operating organization shall ensure that all activities that may affect safety are performed by suitably qualified and competent persons.

4.16. The operating organization shall clearly define the requirements for qualification and competence to ensure that personnel performing safety related

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functions are capable of safely performing their duties. Certain operating positions may require formal authorization or a licence.

4.17. Suitably qualified personnel shall be selected and shall be given the necessary training and instruction to enable them to perform their duties correctly for different operational states of the plant and in accident conditions, in accordance with the appropriate procedures.

4.18. The management of the operating organization shall be responsible for the qualification and the competence of plant staff. Managers shall participate in determining the needs for training and in ensuring that operating experience is taken into account in the training. Managers and supervisors shall ensure that production needs do not unduly interfere with the conduct of the training programme.

4.19. A suitable training programme shall be established and maintained for the training of personnel before their assignment to safety related duties. The training programme shall include provision for periodic confirmation of the competence of personnel and for refresher training on a regular basis. The refresher training shall also include retraining provision for personnel who have had extended absences from their authorized duties. The training shall emphasize the importance of safety in all aspects of plant operation and shall promote safety culture.

4.20. Performance based programmes for initial and continuing training shall be developed and put in place for each major group of personnel (including, if necessary, external support organizations, including contractors). The content of each programme shall be based on a systematic approach. Training programmes shall promote attitudes that help to ensure that safety issues receive the attention that they warrant.

4.21. The training programmes shall be assessed and improved by means of periodic review. In addition, a system shall be put in place for the timely modification and updating of the training facilities, computer models, simulators and materials to ensure that they adequately reflect current plant conditions and operating policy, and that any differences are justified.

4.22. Operating experience at the plant, as well as relevant experience at other plants, shall be appropriately incorporated into the training programme. It shall be ensured that training is conducted on the root cause(s) of the events and on the

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determination and implementation of corrective actions to make their recurrence less likely.

4.23. All training positions shall be held by adequately qualified and experienced persons, who provide the requisite technical knowledge and skills and have credibility with the trainees. Instructors shall be technically competent in their assigned areas of responsibility, shall have the necessary instructional skills and shall also be familiar with routines and work practices at the workplace. Qualification requirements shall be established for the training instructors.

4.24. Adequate training facilities, including a representative simulator, appropriate training materials, and technical and maintenance training facilities, shall be made available for the training of operating personnel. Simulator training shall incorporate training for plant operational states and for accident conditions.

Requirement 8: Performance of safety related activities

The operating organization shall ensure that safety related activities are adequately analysed and controlled to ensure that the risks associated with harmful effects of ionizing radiation are kept as low as reasonably achievable.

4.25. All routine and non-routine operational activities shall be assessed for the potential risks associated with harmful effects of ionizing radiation. The level of assessment and control shall depend on the safety significance of the task.

4.26. All activities important to safety shall be carried out in accordance with written procedures to ensure that the plant is operated within the established operational limits and conditions. Acceptable margins shall be ensured between normal operating values and the established safety system settings to avoid undesirably frequent actuation of safety systems.

4.27. No experiments shall be conducted without adequate justification. If there is a need to conduct a non-routine operation or test that is not covered by existing operating procedures, a specific safety review shall be performed and a special procedure shall be developed and subject to approval in accordance with national or other relevant regulations.

4.28. Written communication shall be preferred and spoken communication shall be minimized. If spoken communication is used, attention shall be given to ensuring that spoken instructions are clearly understood.

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4.29. Aspects of the working environment that influence human performance factors (such as work load or fatigue) and the effectiveness and fitness of personnel for duty shall be identified and controlled. Tools for enhancing human performance shall be used as appropriate to support the responses of operating personnel.

4.30. The operating organization shall encourage plant personnel to have a questioning attitude and to make appropriate and conservative decisions, so as to minimize risk and to maintain the plant in a safe condition.

4.31. The responsibilities and authorities for restarting a reactor after an event leading to an unplanned shutdown, scram or major transient, or to an extended period of maintenance, shall be clearly established in writing. An investigation shall be carried out to determine the cause of the event and corrective actions shall be taken to make its recurrence less likely. Prior to the restart or the resumption of full power of the affected plant, the operating organization shall carry out necessary remedial actions, including inspection, testing and repair of damaged structures, systems and components, and shall revalidate the safety functions that might be challenged by the event. Restart conditions and criteria shall be established and followed after the timely implementation of the necessary corrective actions.

4.32. If a probabilistic assessment of risk is to be used for decision making purposes, the operating organization shall ensure that the risk analysis is of appropriate quality and scope for decision making purposes. The risk analysis shall be performed by appropriately skilled analysts and shall be used in a manner that complements the deterministic approach to decision making, in compliance with applicable regulations and plant licence conditions.

Requirement 9: Monitoring and review of safety performance

The operating organization shall establish a system for continuous monitoring and periodic review of the safety of the plant and of the performance of the operating organization.

4.33. An adequate audit and review system shall be established by the operating organization to ensure that the safety policy of the operating organization is being implemented effectively and that lessons are being learned from its own experience and from the experience of others to improve safety performance.

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4.34. Self-assessment by the operating organization shall be an integral part of the monitoring and review system. The operating organization shall perform systematic self-assessments to identify achievements and to address any degradation in safety performance. Where practicable, suitable objective performance indicators shall be developed and used to enable senior managers to detect and to react to shortcomings and deterioration in the management of safety.

4.35. Monitoring of safety performance shall include the monitoring of personnel performance, attitudes to safety, response to infringements of safety, and violations of operational limits and conditions, operating procedures, regulations and licence conditions. The monitoring of plant conditions, activities and attitudes of personnel shall be supported by systematic walkdowns of the plant by the plant managers.

4.36. The persons and organization performing quality assurance functions shall have sufficient authority and organizational independence to identify problems relating to quality and to initiate, to recommend and to verify the implementation of solutions. These persons and organizations shall report to a high level of management such that the necessary authority and organizational independence are provided, including sufficient independence from costs and schedules when considering safety related matters.

4.37. The appropriate corrective actions shall be determined and implemented as a result of the monitoring and review of safety performance. Progress in taking the corrective actions shall be monitored to ensure that actions are completed within the appropriate timescales. The completed corrective actions shall be reviewed to assess whether they have adequately addressed the issues identified in audits and reviews.

Requirement 10: Control of plant configuration

The operating organization shall establish and implement a system for plant configuration management to ensure consistency between design requirements, physical configuration and plant documentation.

4.38. Controls on plant configuration shall ensure that changes to the plant and its safety related systems are properly identified, screened, designed, evaluated, implemented and recorded. Proper controls shall be implemented to handle changes in plant configuration that result from maintenance work, testing, repair, operational limits and conditions, and plant refurbishment, and from

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modifications due to ageing of components, obsolescence of technology, operating experience, technical developments and results of safety research.

Requirement 11: Management of modifications

The operating organization shall establish and implement a programme to manage modifications.

4.39. A modification programme shall be established and implemented to ensure that all modifications are properly identified, specified, screened, designed, evaluated, authorized, implemented and recorded. Modification programmes shall cover structures, systems and components, operational limits and conditions, procedures, documents and the structure of the operating organization. Modifications shall be characterized on the basis of their safety significance. Modifications shall be subject to the approval of the regulatory body, in accordance with their safety significance, and in line with national arrangements.

4.40. Modification control, in compliance with the requirements set out in Ref. [4], shall ensure the proper design, safety assessment and review, control, implementation and testing of all permanent and temporary modifications. Consequences of the modification for human tasks and performance shall be systematically analysed. For all plant modifications, human and organizational factors shall be adequately considered.

4.41. Temporary modifications shall be limited in time and number to minimize the cumulative safety significance. Temporary modifications shall be clearly identified at their location and at any relevant control position. The operating organization shall establish a formal system for informing relevant personnel in good time of temporary modifications and of their consequences for the operation and safety of the plant.

4.42. The plant management shall establish a system for modification control to ensure that plans, documents and computer programs are revised in accordance with modifications.

4.43. Before commissioning a modified plant or putting the plant back into operation after modifications, personnel shall be trained, as appropriate, and all relevant documents necessary for plant operation shall be updated.

Requirement 12: Periodic safety review

Systematic safety assessments of the plant, in accordance with the regulatory requirements, shall be performed by the operating organization throughout the plant's operating lifetime, with due account taken of operating experience and significant new safety related information from all relevant sources.

4.44. Safety reviews shall be carried out at regular intervals. Safety reviews shall address, in an appropriate manner, the consequences of the cumulative effects of plant ageing and plant modification, equipment requalification, operating experience, current standards, technical developments, and organizational and management issues, as well as siting aspects. Safety reviews shall be aimed at ensuring a high level of safety throughout the operating lifetime of the plant.

4.45. The operating organization shall report to the regulatory body as required, in a timely manner, the confirmed findings of the safety review that have implications for safety.

4.46. The scope of the safety review shall include all safety related aspects of an operating plant. To complement deterministic safety assessment, probabilistic safety assessment (PSA) can be used for input to the safety review to provide insight into the contributions to safety of different safety related aspects of the plant.

4.47. On the basis of the results of the systematic safety assessment, the operating organization shall implement any necessary corrective actions and reasonably practicable modifications for compliance with applicable standards aiming at enhancing the safety of the plant.

Requirement 13: Equipment qualification

The operating organization shall ensure that a systematic assessment is carried out to provide reliable confirmation that safety related items are capable of the required performance for all operational states and for accident conditions.

4.48. Appropriate concepts and the scope and process of equipment qualification shall be established, and effective and practicable methods shall be used to upgrade and preserve equipment qualification. A programme to establish, to confirm and to maintain required equipment qualification shall be launched from

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the initial phases of design, supply and installation of the equipment. The effectiveness of equipment qualification programmes shall be periodically reviewed.

4.49. The scope and details of the equipment qualification process, in terms of the required inspection area(s), method(s) of non-destructive testing, possible defects inspected for and required effectiveness of inspection, shall be documented and submitted to the regulatory body for review and approval. Relevant national and international experience shall be taken into account in accordance with national regulations.

Requirement 14: Ageing management

The operating organization shall ensure that an effective ageing management programme is implemented to ensure that required safety functions of systems, structures and components are fulfilled over the entire operating lifetime of the plant.

4.50. The ageing management programme shall determine the consequences of ageing and the activities necessary to maintain the operability and reliability of structures, systems and components. The ageing management programme shall be coordinated with, and be consistent with, other relevant programmes, including the programme for periodic safety review. A systematic approach shall be taken to provide for the development, implementation and continuous improvement of ageing management programmes.

4.51. Long term effects arising from operational and environmental conditions (i.e. temperature conditions, radiation conditions, corrosion effects or other degradations in the plant that may affect the long term reliability of plant equipment or structures) shall be evaluated and assessed as part of the ageing management programme. Account shall be taken in the programme of the safety relevance of structures, systems and components.

Requirement 15: Records and reports

The operating organization shall establish and maintain a system for the control of records and reports.

4.52. The operating organization shall identify the types of records and reports, as specified by the regulatory body, that are relevant for the safe operation of the plant. Records of operation, including maintenance and surveillance, shall be

kept available from initial testing during the startup of each plant system important to safety, including relevant off-site tests. The records of operation shall be retained in proper archives for periods as required by the regulatory body. All records shall be kept readable, complete, identifiable and easily retrievable [2]. Retention times for records and reports shall be commensurate with their level of importance for the purposes of operation and plant licensing and for future decommissioning.

Requirement 16: Programme for long term operation

Where applicable, the operating organization shall establish and implement a comprehensive programme for ensuring the long term safe operation of the plant beyond a time-frame established in the licence conditions, design limits, safety standards and/or regulations.

4.53. The justification for long term operation shall be prepared on the basis of the results of a safety assessment, with due consideration of the ageing of structures, systems and components. The justification for long term operation shall utilize the results of periodic safety review and shall be submitted to the regulatory body, as required, for approval on the basis of an analysis of the ageing management programme, to ensure the safety of the plant throughout its extended operating lifetime.

4.54. The comprehensive programme for long term operation shall address:

- (a) Preconditions (including the current licensing basis, safety upgrading and verification, and operational programmes);
- (b) Setting the scope for all structures, systems and components important to safety;
- (c) Categorization of structures, systems and components with regard to degradation and ageing processes;
- (d) Revalidation of safety analyses made on the basis of time limited assumptions;
- (e) Review of ageing management programmes in accordance with national regulations;
- (f) The implementation programme for long term operation.

5. OPERATIONAL SAFETY PROGRAMMES

Requirement 17: Consideration of objectives of nuclear security in safety programmes

The operating organization shall ensure that the implementation of safety requirements and security requirements satisfies both safety objectives and security objectives.

5.1. The operating organization shall be responsible for managing the implementation of safety requirements and security requirements by ensuring close cooperation between safety managers and security managers, with the objective of minimizing risks.¹ Security and safety shall be viewed as complementary, as many of the measures designed to ensure one will also serve to ensure the other. Safety and security measures shall be designed and implemented in such a manner that they do not compromise each other. The operating organization shall establish mechanisms to resolve potential conflicts and to manage safety–security interfaces.

Requirement 18: Emergency preparedness

The operating organization shall prepare an emergency plan for preparedness for, and response to, a nuclear or radiological emergency.

5.2. Emergency preparedness arrangements shall cover the capability of maintaining protection and safety in the event of accident conditions; mitigating the consequences of accidents if they do occur; protection of site personnel and the public, and protection of the environment; coordinating response organizations, as appropriate; and communicating with the public in a timely manner [1, 5]. Emergency preparedness arrangements shall include arrangements for the prompt declaration of an emergency, timely notification and alerting of response personnel, assessment of the progress of the emergency, its consequences and any measures that need to be taken on the site, and the necessary provision of information to the authorities. Appropriate arrangements shall be established from the time that nuclear fuel is first brought to the site, and

¹ Guidance on nuclear security measures is provided in the IAEA Nuclear Security Series.

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the emergency plan and all emergency preparedness arrangements shall be completed before the commencement of fuel loading.

5.3. The operating organization shall develop an emergency plan and shall establish the necessary organizational structure, with assigned responsibilities for managing an emergency, and shall contribute to the development of off-site emergency procedures.

5.4. The emergency plan shall cover all activities under the responsibility of the operating organization and it shall be adhered to in the event of an emergency. The emergency plan shall include arrangements for an emergency involving a combination of non-nuclear hazards and nuclear hazards, such as a fire in conjunction with significant levels of radiation or contamination, or toxic or asphyxiating gases in conjunction with radiation or contamination. Account shall be taken in the emergency plan of the specific site conditions. Preparation of the emergency plan shall be coordinated with those bodies having responsibilities in an emergency, including public authorities and private enterprises, as relevant, and the plan shall be submitted to the regulatory body as required. The plan shall be subject to review and updating in the light of experience gained.

5.5. A training programme for emergencies shall be established and implemented to ensure that plant staff and, as required, staff from other participating organizations possess the essential knowledge, skills and attitudes required for the accomplishment of non-routine tasks under stressful emergency conditions.

5.6. The emergency plan shall be tested in exercises before the commencement of fuel loading. Emergency preparedness exercises shall be planned and conducted at suitable intervals, to evaluate the preparedness of plant staff and staff from external response organizations to perform their tasks, and to evaluate their cooperation in coping with an emergency and in improving the efficiency of the response.

5.7. Facilities, instruments, tools, equipment, documentation and communication systems to be used in an emergency shall be kept available and shall be maintained in good operational condition in such a manner that they are unlikely to be affected by, or made unavailable by, accident conditions.

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Requirement 19: Accident management programme

The operating organization shall establish an accident management programme for the management of beyond design basis accidents.

5.8. An accident management programme shall be established that covers the preparatory measures and guidelines that are necessary for dealing with beyond design basis accidents. The accident management programme shall be documented and periodically reviewed and revised as necessary. It shall include instructions for utilization of the available equipment — safety related equipment as far as possible, but also conventional equipment — and the technical and administrative measures to mitigate the consequences of an accident. The accident management programme shall also include organizational arrangements for accident management, communication networks and training necessary for the implementation of the programme.

5.9. Arrangements for accident management shall provide the operating staff with appropriate systems and technical support in relation to beyond design basis accidents. These arrangements and guidance shall be available before the commencement of fuel loading and they shall address the actions necessary following beyond design basis accidents, including severe accidents. In addition, arrangements shall be made, as part of the emergency plan, to expand the emergency response arrangements, where necessary, to include the responsibility for long term actions.

Requirement 20: Radiation protection

The operating organization shall establish and implement a radiation protection programme.

5.10. The operating organization shall ensure that the radiation protection programme is in compliance with the requirements of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources [6]. The operating organization shall verify, by means of surveillance, inspections and audits, that the radiation protection programme is being correctly implemented and that its objectives are being met. The radiation protection programme shall be reviewed on a regular basis and updated if necessary.

5.11. The radiation protection programme shall ensure that for all operational states, doses due to exposure to ionizing radiation in the plant or doses due to any

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planned releases of radioactive material from the plant are kept below authorized limits and are as low as reasonably achievable.

5.12. The radiation protection programme in the operating organization shall have sufficient independence and resources to be able to enforce and to advise on radiation protection regulations, standards and procedures, and on safe working practices.

5.13. All plant personnel shall understand and acknowledge their individual responsibility for putting into practice the measures for controlling exposures that are specified in the radiation protection programme. Consequently, particular emphasis shall be given to the training of all site personnel so that they are aware of radiological hazards and of the necessary protective measures.

5.14. All site personnel, including contractors, who are working in a controlled area or who are regularly present in a supervised area shall have their occupational exposures assessed in accordance with the requirements of Ref. [6]. Dose records shall be kept and shall be made available to personnel on demand and to the regulatory body.

5.15. The radiation protection programme shall include the health surveillance of site personnel who may be occupationally exposed to radiation for ascertaining their physical fitness and for giving advice in cases of accidental overexposure. This health surveillance shall consist of a preliminary medical examination followed by periodic checkups.

5.16. The radiation protection programme shall ensure control over radiation dose rates for exposures due to activities in areas where there is radiation arising from or passing through structures, systems and components, such as in inspection, maintenance and fuel handling. It also addresses plant chemistry activities as well as exposures due to radioactivity of substances in the fuel coolant (liquid or gas) and associated fluids. The programme shall make arrangements to maintain these doses as low as reasonably achievable.

Requirement 21: Management of radioactive waste

The operating organization shall establish and implement a programme for the management of radioactive waste.

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5.17. Adequate operating practices shall be implemented to ensure that the generation of radioactive waste is kept to the minimum practicable in terms of both activity and volume.

5.18. The operating organization shall establish and implement a programme for the management of radioactive waste. The programme for the management of radioactive waste shall include the pretreatment, characterization, classification, treatment, conditioning, transport, storage and disposal of radioactive waste, as well as regular updating of the inventory of radioactive waste. Treatment and storage of radioactive waste shall be strictly controlled in a manner consistent with the requirements for the predisposal management of radioactive waste [7]. Records shall be maintained for waste generation and waste classification, as well as for the storage, treatment and disposal of waste.

5.19. The operating organization shall establish and implement procedures consistent with international standards, national regulations and licence conditions for the monitoring and control of discharges of radioactive effluents. These procedures shall be made available to the regulatory body if required. The volume and activity of radioactive discharges to the environment shall be reported periodically to the regulatory body.

5.20. The operating organization shall ensure that a programme is established and implemented for monitoring the environment in the vicinity of the plant site, to assess radiological consequences of any radioactive releases to the environment. Results from this monitoring shall be made available to the public, and in particular to the public living in the vicinity of the plant site.

Requirement 22: Fire safety

The operating organization shall make arrangements for ensuring fire safety.

5.21. The arrangements for ensuring fire safety made by the operating organization shall cover the following: adequate management for fire safety; preventing fires from starting; detecting and extinguishing quickly any fires that do start; preventing the spread of those fires that have not been extinguished; and providing protection from fire for structures, systems and components that are necessary to shut down the plant safely. Such arrangements shall include, but are not limited to:

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- (a) Application of the principle of defence in depth;
- (b) Control of combustible materials and ignition sources, in particular during outages;
- (c) Inspection, maintenance and testing of fire protection measures;
- (d) Establishment of a manual firefighting capability;
- (e) Assignment of responsibilities, and training and exercising of plant personnel;
- (f) Assessment of the impact of plant modifications on fire safety measures.

5.22. A comprehensive fire hazard analysis shall be developed for the plant and shall be periodically reviewed and, if necessary, updated.

5.23. In the arrangements for firefighting, special attention shall be paid to cases for which there is a risk of release of radioactive material in a fire. Appropriate measures shall be established for the radiation protection of firefighting personnel and the management of releases to the environment.

5.24. The operating organization shall be responsible for ensuring that appropriate procedures are in place for effectively coordinating and cooperating with all firefighting services involved. Periodic joint fire drills and exercises shall be conducted to assess the effectiveness of the fire response capability.

5.25. Fire protection systems and firefighting systems shall be designed to ensure that damage to, or inadvertent operation of, these systems does not significantly impair the capabilities of the structures, systems and components necessary for safe shutdown.

Requirement 23: Non-radiation-related safety

The operating organization shall establish and implement a programme to ensure that safety related risks associated with non-radiation-related hazards to personnel involved in activities at the plant are kept as low as reasonably achievable.

5.26. The non-radiation-related safety programme² shall include arrangements for the planning, implementation, monitoring and review of the relevant preventive and protective measures, and it shall be integrated with the nuclear

² Non-radiation-related safety concerns hazards other than radiation related hazards; this is sometimes referred to as industrial safety or conventional safety.

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and radiation safety programme. All personnel, suppliers, contractors and visitors (where appropriate) shall be trained and shall possess the necessary knowledge of the non-radiation-related safety programme and its interface with the nuclear and radiation safety programme, and shall comply with its safety rules and practices. The operating organization shall provide support, guidance and assistance for plant personnel in the area of non-radiation-related hazards.

Requirement 24: Feedback of operating experience

The operating organization shall establish an operating experience programme to learn from events at the plant and events in the nuclear industry and other industries worldwide.

5.27. The operating organization shall establish and implement a programme to report, collect, screen, analyse, trend, document and communicate operating experience at the plant in a systematic way. It shall obtain and evaluate information on relevant operating experience at other nuclear installations to draw lessons for its own operations. It shall also encourage the exchange of experience within national and international systems for the feedback of operating experience. Relevant lessons from other industries shall also be taken into consideration, as necessary.

5.28. Events with safety implications shall be investigated in accordance with their actual or potential significance. Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors. The results of such analyses shall be included, as appropriate, in relevant training programmes and shall be used in reviewing procedures and instructions. Plant event reports and non-radiation-related accident reports shall identify tasks for which inadequate training may be contributing to equipment damage, excessive unavailability of equipment, the need for unscheduled maintenance work, the need for repetition of work, unsafe practices or lack of adherence to approved procedures.

5.29. Information on operating experience shall be examined by competent persons for any precursors to, or trends in, adverse conditions for safety, so that any necessary corrective actions can be taken before serious conditions arise.

5.30. As a result of the investigation of events, clear recommendations shall be developed for the responsible managers, who shall take appropriate corrective actions in due time to avoid any recurrence of the events. Corrective actions shall

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be prioritized, scheduled and effectively implemented and shall be reviewed for their effectiveness. Operating personnel shall be briefed on events of relevance and shall take the necessary corrective actions to make their recurrence less likely.

5.31. The operating organization shall be responsible for instilling an attitude among plant personnel that encourages the reporting of all events, including low level events and near misses, potential problems relating to equipment failures, shortcomings in human performance, procedural deficiencies or inconsistencies in documentation that are relevant to safety.

5.32. The operating organization shall maintain liaison, as appropriate, with support organizations (manufacturers, research organizations and designers) involved in the design, in order to feed back information on operating experience and to obtain advice, if necessary, in the event of equipment failure or in other events.

5.33. The operating experience programme shall be periodically evaluated to determine its effectiveness and to identify any necessary improvements.

6. PLANT COMMISSIONING

Requirement 25: Commissioning programme

The operating organization shall ensure that a commissioning programme for the plant is established and implemented.

6.1. The commissioning programme for the plant shall cover the full range of plant conditions required in the design and the safety case. The results shall be used to demonstrate that the behaviour of the plant as built is in compliance with the design assumptions and the licence conditions. Special attention shall be paid to ensuring that no commissioning tests are performed that might place the plant in an unanalysed condition. Commissioning stages, test objectives and acceptance criteria shall be specified in such a way that the programme is auditable.

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6.2. The commissioning programme shall provide the operating organization and the regulatory body with the means of identifying the hold points in the commissioning process at which approval may be required prior to continuing to the next stage.

6.3. The commissioning programme shall be divided into stages. A review of the test results for each stage shall be completed before commissioning is continued to the next stage. On the basis of the review, a judgement shall be made on whether the commissioning programme can proceed to the next stage. Judgements shall also be made on the basis of the review on whether the succeeding stages will be modified as a consequence of the test results, or because some tests in the stage had not been undertaken, or some tests had been undertaken but had not been completed. The results for some stages may be subject to approval by the regulatory body before commissioning can proceed to the next stage.

6.4. The commissioning programme shall include all the tests necessary to demonstrate that the plant as built and as installed meets the requirements of the safety analysis report and satisfies the design intent and, consequently, that the plant can be safely operated in accordance with the operational limits and conditions.

6.5. Operating and maintenance procedures shall be validated to the extent practicable as part of the commissioning programme, with the participation of future operating personnel.

6.6. Suitably qualified operations personnel shall be directly involved in the commissioning process. Operating personnel and plant technical staff shall be involved in the commissioning process to the extent necessary to ensure proper preparation for the operational phase.

6.7. The commissioning programme shall be sufficiently comprehensive as to provide reference data to characterize structures, systems and components. Such reference data shall be retained as they are important for ensuring the safety of the plant and for subsequent safety reviews.

6.8. All the functions of the operating organization shall be performed at the appropriate stages during commissioning. These functions shall include responsibilities for management, training of personnel, the radiation protection programme, waste management, managements of records, fire safety, physical protection and the emergency plan.

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6.9. Operating procedures and test procedures shall be verified to ensure their technical accuracy and shall be validated to ensure their usability with the installed equipment and control systems. Verification and validation of procedures shall be performed to confirm their applicability and quality, and to the extent possible shall be performed prior to fuel handling operations on the site. This process shall continue during the commissioning phase. Verification and validation shall also be carried out for procedures for overall operation.

6.10. From the commencement of commissioning, reviewed and approved arrangements for work control, modification control and plant configuration control shall be in place to meet the conditions of the commissioning tests.

6.11. Initial fuel loading shall not be authorized until all relevant pre-operational tests have been performed and the results have been accepted by the operating organization and the regulatory body. Reactor criticality and initial power increase shall not be authorized until all necessary tests have been performed and the results have been accepted by the operating organization and the regulatory body, as appropriate. The tests of the commissioning programme shall be successfully completed as a necessary condition for authorization, as appropriate, for normal operation of the plant to be commenced.

6.12. The operating organization shall ensure that interfaces and the communication lines between different groups (i.e. groups for design, for construction, contractors, for commissioning and for operations) shall be clearly specified and controlled.

6.13. Authorities and responsibilities shall be clearly specified and shall be delegated to the individuals and groups performing the commissioning activities. The operating organization shall be responsible for ensuring that construction activities are of appropriate quality and that completion data on commissioning activities and comprehensive baseline data, documentation or information are provided. The operating organization shall also be responsible for ensuring that the equipment supplied is manufactured under a quality assurance programme that includes inspection for proper fabrication, cleanliness, calibration and verification of operability.

6.14. During construction and commissioning, the plant shall be monitored, preserved and maintained so as to protect plant equipment, to support the testing stage and to maintain consistency with the safety analysis report.

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6.15. During construction and commissioning, a comparison shall be carried out between the as built plant and its design parameters. A comprehensive process shall be established to address non-conformities in design, manufacturing, construction and operation. Resolutions to correct differences from the initial design and non-conformities shall be documented.

7. PLANT OPERATIONS

Requirement 26: Operating procedures

Operating procedures shall be developed that apply comprehensively (for the reactor and its associated facilities) for normal operation, anticipated operational occurrences and accident conditions, in accordance with the policy of the operating organization and the requirements of the regulatory body.

7.1. The level of detail for a particular procedure shall be appropriate for the purpose of that procedure. The guidance provided in the procedures shall be clear and concise and, to the extent possible, it shall be verified and validated. The procedures and reference material shall be clearly identified and shall be readily accessible in the control room and in other operating locations if necessary. They shall be made available to the regulatory body, as required. Strict adherence to written operating procedures shall be an essential element of safety policy at the plant.

7.2. Procedures shall be developed for normal operation to ensure that the plant is operated within the operational limits and conditions.

7.3. Procedures shall be developed for use in the event of anticipated operational occurrences and design basis accidents. Emergency operating procedures and guidance for managing beyond design basis accidents shall also be developed. Both event based approaches and symptom based approaches shall be used, as appropriate. The related analysis and justifications shall be documented.

7.4. Operating procedures and supporting documentation shall be issued under controlled conditions, and shall be subject to approval and periodically reviewed

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and revised as necessary to ensure their adequacy and effectiveness. Procedures shall be updated in a timely manner in the light of operating experience and the actual plant configuration.

7.5. A system shall be established to administer and control an effective operator aids programme. The control system for operator aids shall prevent the use of non-authorized operator aids and any other non-authorized materials such as instructions or labels of any kind on the equipment, local panels, boards and measurement devices within the work areas. The control system for operator aids shall be used to ensure that operator aids contain correct information and that they are updated, periodically reviewed and approved.

7.6. A clear operating policy shall be maintained to minimize the use of, and reliance on, temporary operator aids. Where appropriate, temporary operator aids shall be made into permanent plant features or shall be incorporated into plant procedures.

Requirement 27: Operation control rooms and control equipment

The operating organization shall ensure that the operation control rooms and control equipment are maintained in a suitable condition.

7.7. The habitability and good condition of control rooms shall be maintained. Where the design of the plant foresees additional or local control rooms that are dedicated to the control of processes that could affect plant conditions, clear communication lines shall be developed for ensuring an adequate transfer of information to the operators in the main control room.

7.8. The emergency control room and the shutdown panel and all other safety related operational panels outside the control room shall be kept operable and free from obstructions, as well as from non-essential material that would prevent their immediate operation. The operating organization shall periodically confirm that the emergency control room or the shutdown panel and all other safety related operational panels are in the proper state of operational readiness, including proper documentation, communications, alarm systems and habitability.

7.9. The alarms in the main control room shall be managed as an important feature in operating a plant safely. The plant information system shall be such that off-normal conditions are easily recognizable by the operators. Control room alarms shall be clearly prioritized. The number of alarms, including alarm messages from process computers, shall be minimized for any analysed

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operational state, outage or accident condition of the plant. The operating organization shall establish procedures for operators to manage the response to alarms.

Requirement 28: Material conditions and housekeeping

The operating organization shall develop and implement programmes to maintain a high standard of material conditions, housekeeping and cleanliness in all working areas.

7.10. Administrative controls shall be established to ensure that operational premises and equipment are maintained, well lit and accessible, and that temporary storage is controlled and limited. Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified, reported and corrected in a timely manner.

7.11. An exclusion programme for foreign objects shall be implemented and monitored, and suitable arrangements shall be made for locking, tagging or otherwise securing isolation points for systems or components to ensure safety.

7.12. The operating organization shall be responsible for ensuring that the identification and labelling of safety equipment and safety related equipment, rooms, piping and instruments are accurate, legible and well maintained, and that they do not introduce any degradation.

Requirement 29: Chemistry programme

The operating organization shall establish and implement a chemistry programme to provide the necessary support for chemistry and radiochemistry.

7.13. The chemistry programme shall be developed prior to normal operation and shall be in place during the commissioning programme. The chemistry programme shall provide the necessary information and assistance for chemistry and radiochemistry for ensuring safe operation, long term integrity of structures, systems and components, and minimization of radiation levels.

7.14. Chemistry surveillance shall be conducted at the plant to verify the effectiveness of chemistry control in plant systems and to verify that structures, systems and components important to safety are operated within the specified chemical limit values.

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7.15. The chemistry programme shall include chemistry monitoring and data acquisition systems. These systems, together with laboratory analyses, shall provide accurate measuring and recording of chemistry data and shall provide alarms for relevant chemistry parameters. Records shall be kept available and shall be easily retrievable.

7.16. Laboratory monitoring shall involve the sampling and analysis of plant systems for specific chemical parameters, concentrations of dissolved and suspended impurities, and radionuclide concentrations.

7.17. The use of chemicals in the plant, including chemicals brought in by contractors, shall be kept under close control. The appropriate control measures shall be put in place to ensure that the use of chemical substances and reagents does not adversely affect equipment or lead to its degradation.

Requirement 30: Core management and fuel handling

The operating organization shall be responsible and shall make arrangements for all activities associated with core management and with on-site fuel handling.

7.18. Provision shall be made to ensure that only fuel that has been appropriately manufactured is loaded into the core. In addition, the fuel design criteria and fuel enrichment shall be in accordance with design specifications and shall be subject to approval by the regulatory body as required. The same requirements shall be applied before the introduction of fuel of a new design or of a modified design into the core.

7.19. The operating organization shall be responsible for the development of the specifications and procedures for the procurement, verification, receipt, accounting and control, loading, utilization, relocation, unloading and testing of fuel and core components. A fuelling programme shall be established in accordance with the design assumptions and details shall be submitted to the regulatory body if required. Following refuelling, it shall be confirmed by means of calculations and measurements that the performance of the core meets the safety criteria. It shall also be confirmed that all core alterations comply with approved configurations.

7.20. The operating organization shall be responsible for establishing a safe reactivity management programme under a strong management system for quality. Decisions on, and the planning, evaluation, conduct and control of, all

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operations or modifications involving the fuel that are liable to affect reactivity control shall be undertaken by using approved procedures and respecting predefined operational limits for the core.

7.21. A comprehensive core monitoring programme shall be established to ensure that core parameters are monitored, analysed for trends and evaluated to detect abnormal behaviour; to ensure that actual core performance is consistent with core design requirements; and to ensure that the values of key operating parameters are recorded and retained in a logical, consistent and retrievable manner.

7.22. Reactivity manipulations shall be made in a deliberate and carefully controlled manner to ensure that the reactor is maintained within prescribed operational limits and conditions and that the desired response is achieved.

7.23. The operating procedures for reactor startup, power operation, shutdown and refuelling shall include the precautions and limitations necessary to maintain fuel integrity and to comply with the operational limits and conditions throughout the lifetime of the fuel.

7.24. Radiochemistry data that are indicative of fuel cladding integrity shall be systematically monitored and analysed for trends so as to be able to monitor whether fuel cladding integrity is maintained under all operating conditions.

7.25. Appropriate methods shall be established to identify any anomalous changes in the activity of coolant and to perform data analysis for fuel defects to determine their nature and severity, their location, their probable root causes and the necessary corrective actions.

7.26. For fuel and core components, handling procedures shall be developed to ensure the controlled movement of unirradiated and irradiated fuel, proper storage on the site and preparation for transport from the site. The plans for storage of unirradiated and irradiated fuel shall be submitted to the regulatory body for approval, if so required.

7.27. The packaging, carriage and transport of unirradiated and irradiated fuel shall be carried out in accordance with appropriate national regulations for domestic transport and, in the event of international transport, with the IAEA Regulations for the Safe Transport of Radioactive Material [8].

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7.28. Before any fuel handling takes place, the operating organization shall ensure that an authorized, trained and qualified person is present, who shall be responsible for control and handling of the fuel on the site in accordance with written procedures. Access to fuel storage areas shall be limited to authorized personnel.

7.29. Detailed auditable accounts shall be maintained as required for the storage, irradiation and movement of all fissile material, including unirradiated and irradiated fuel, for at least as long as the regulatory body requires in regulations.

8. MAINTENANCE, TESTING, SURVEILLANCE AND INSPECTION

Requirement 31: Maintenance, testing, surveillance and inspection programmes

The operating organization shall ensure that effective programmes for maintenance, testing, surveillance and inspection are established and implemented.

8.1. Maintenance, testing, surveillance and inspection programmes shall be established that include predictive, preventive and corrective maintenance activities. These maintenance activities shall be conducted to maintain availability during the service life of structures, systems and components by controlling degradation and preventing failures. In the event that failures do occur, maintenance activities shall be conducted to restore the capability of failed structures, systems and components to function within acceptance criteria.

8.2. The operating organization shall establish surveillance programmes for ensuring compliance with established operational limits and conditions and for detecting and correcting any abnormal condition before it can give rise to significant consequences for safety.

8.3. The operating organization shall develop procedures for all maintenance, testing, surveillance and inspection tasks. These procedures shall be prepared, reviewed, modified when required, validated, approved and distributed in accordance with procedures established under the management system.

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8.4. Data on maintenance, testing, surveillance and inspection shall be recorded, stored and analysed for confirming that the operating performance is in accordance with the design intent and with requirements for the reliability and availability of equipment.

8.5. The frequency of maintenance, testing, surveillance and inspection of individual structures, systems and components shall be determined on the basis of:

- (a) The importance to safety of the structures, systems and components, with insights from probabilistic safety assessment taken into account;
- (b) Their reliability in, and availability for, operation;
- (c) Their assessed potential for degradation in operation and their ageing characteristics;
- (d) Operating experience;
- (e) Recommendations of vendors.

8.6. A comprehensive and structured approach to identifying failure scenarios shall be taken to ensure the proper management of maintenance activities, using methods of probabilistic safety analysis as appropriate.

8.7. New approaches that could result in significant changes to current strategies for maintenance, testing, surveillance and inspection shall be taken only after careful consideration of the implications for safety and after appropriate authorization, as required.

8.8. A comprehensive work planning and control system shall be implemented to ensure that work for purposes of maintenance, testing, surveillance and inspection is properly authorized, is carried out safely and is documented in accordance with established procedures.

8.9. An adequate work control system shall be established for the protection and safety of personnel and for the protection of equipment during maintenance, testing, surveillance and inspection. Pertinent information shall be transferred at shift turnovers and at pre-job and post-job briefings on maintenance, testing, surveillance and inspection.

8.10. The work control system shall ensure that plant equipment is released from service for maintenance, testing, surveillance or inspection only with the authorization of designated operations department staff and in compliance with the operational limits and conditions. The work control system shall also ensure

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that permission to return equipment to service following maintenance, testing, surveillance and inspection is given by the operating personnel. Such permission shall be given only after the completion of a documented check that the new plant configuration is within the established operational limits and conditions and, where appropriate, after functional tests have been performed.

8.11. Coordination shall be maintained between different maintenance groups (e.g. maintenance groups for mechanical, electrical, instrumentation and control, and civil equipment). Coordination shall also be maintained between maintenance groups and operations groups and support groups (e.g. groups for fire protection, radiation protection, physical protection and non-radiation-related safety). The operating organization shall make arrangements with the external grid operator to ensure that appropriate procedures are applied in maintaining the connections of the plant to the external grid.

8.12. A management system for managing and correcting deficiencies shall be established and shall be used to ensure that operating personnel are not overly burdened. This system shall also ensure that safety at the plant is not compromised by the cumulative effects of these deficiencies.

8.13. The operating organization shall ensure that maintenance work during power operation is carried out with adequate defence in depth. Probabilistic safety assessment shall be used, as appropriate, to demonstrate that the risks are not significantly increased.

8.14. Corrective maintenance of structures, systems and components shall be performed as promptly as practicable and in compliance with operational limits and conditions. Priorities shall be established, with account taken first of the relative importance to safety of the defective structures, systems and components.

8.15. The operating organization shall establish suitable arrangements to procure, receive, control, store and issue materials (including supplies), spare parts and components.

8.16. The operating organization shall be responsible for using these arrangements for the procurement of materials (including supplies), spare parts and components and for ensuring that their characteristics are consistent with applicable safety standards and with the plant design.

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8.17. The operating organization shall ensure that storage conditions are adequate and that materials (including supplies), spare parts and components are available and are in proper condition for use.

Requirement 32: Outage management

The operating organization shall establish and implement arrangements to ensure the effective performance, planning and control of work activities during outages.

8.18. Outage planning shall be a continuing, improving process involving past, present, next scheduled and future outages. Reference points shall be determined and shall be used to track pre-outage work.

8.19. In the processes for planning and performing outage activities, priority shall be given to safety related considerations. Special attention shall be given to maintaining the plant configuration in accordance with the operational limits and conditions.

8.20. The operating organization shall be responsible for issuing programmes and procedures for outage management and for the provision of adequate resources for ensuring safety during shutdown operations.

8.21. The tasks, authorities and responsibilities of the groups and persons involved in preparing, conducting or assessing outage schedules and activities shall be set out in writing and shall be followed by all the plant staff and contractor staff who are involved.

8.22. The interfaces between the group responsible for outages and other groups, including groups on the site and off the site, shall be clearly defined. Operating personnel shall be kept informed of current activities for maintenance, modification and testing.

8.23. Optimization of radiation protection, optimization of non-radiation-related safety, waste reduction and control of chemical hazards shall be essential elements of outage programmes and planning, and this shall be clearly communicated to relevant plant staff and contractors.

8.24. A comprehensive review shall be performed after each outage to draw lessons to be learned.

9. PREPARATION FOR DECOMMISSIONING

Requirement 33: Preparation for decommissioning

The operating organization shall prepare a decommissioning plan and shall maintain it throughout the lifetime of the plant, unless otherwise approved by the regulatory body, to demonstrate that decommissioning can be accomplished safely and in such a way as to meet the specified end state.

9.1. The decommissioning plan shall be updated in accordance with changes in regulatory requirements, modifications to the plant, advances in technology, changes in the need for decommissioning activities and changes in national policies [9].

9.2. A human resource programme shall be developed for ensuring that sufficient motivated and qualified personnel are available for the safe operation of the plant up to final shutdown, for conducting activities in a safe manner during the preparatory period for decommissioning and for safely carrying out the decommissioning of the plant.

9.3. In the preparatory period for decommissioning, a high level of operational safety shall be maintained until the nuclear fuel has been removed from the plant.

9.4. For a multiple unit plant, appropriate measures shall be put in place to ensure that common systems and common equipment remain fully available to support the safe operation of all the generating units.

9.5. The operating organization shall be aware, over the operating lifetime of the plant, of the needs in relation to future decommissioning. Experience and knowledge with regard to contaminated or irradiated structures, systems and components gained in modification and maintenance activities at the plant shall be recorded and retained to facilitate the planning of decommissioning. Complete and reviewed information shall be compiled to be transferred to the organization responsible for managing the decommissioning phase.

9.6. The implications for safety of the activities in the transitional phase prior to the commencement of decommissioning shall be assessed and shall be managed so as to avoid undue hazards and to ensure safety.

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BODIES FOR THE ENDORSEMENT OF IAEA SAFETY STANDARDS

An asterisk denotes a corresponding member. Corresponding members receive drafts for comment and other documentation but they do not generally participate in meetings. Two asterisks denote an alternate.

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Yukiya Amano
Director General

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