

IAEA Safety Standards

for protecting people and the environment

Safety of Nuclear Power Plants: Commissioning and Operation

Specific Safety Requirements

No. SSR-2/2



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IAEA SAFETY STANDARDS

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

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

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

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

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

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

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**.

This publication has been superseded by SSR-2/2 (Rev. 1)

SAFETY OF
NUCLEAR POWER PLANTS:
COMMISSIONING AND OPERATION

This publication has been superseded by SSR-2/2 (Rev. 1)

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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/MTCD/publications/publications.asp>

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2011

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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.

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.

THE IAEA SAFETY STANDARDS

BACKGROUND

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

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

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

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

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

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

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection

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

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

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

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

Safety Fundamentals

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

Safety Requirements

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

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

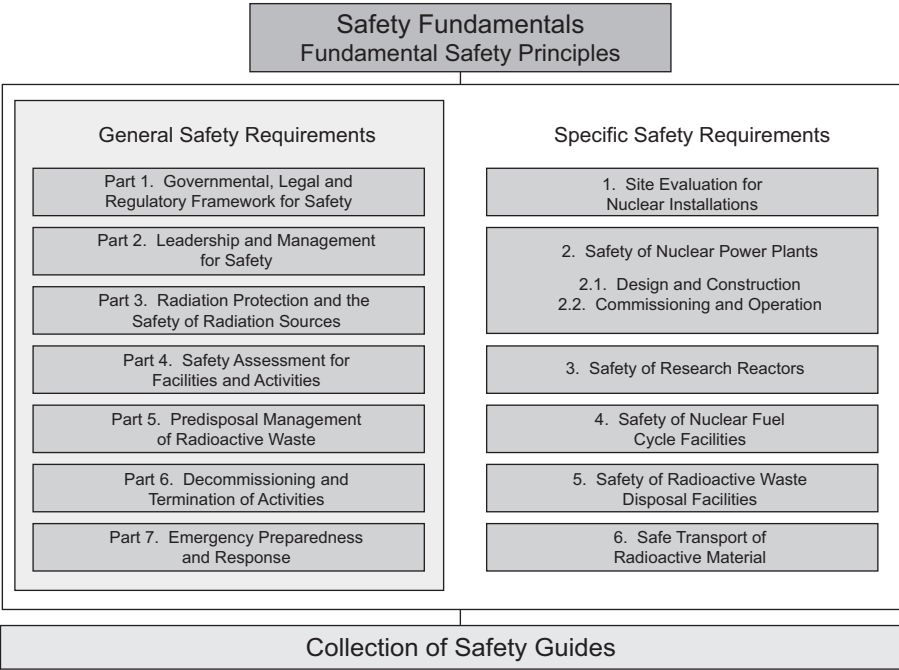


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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

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).

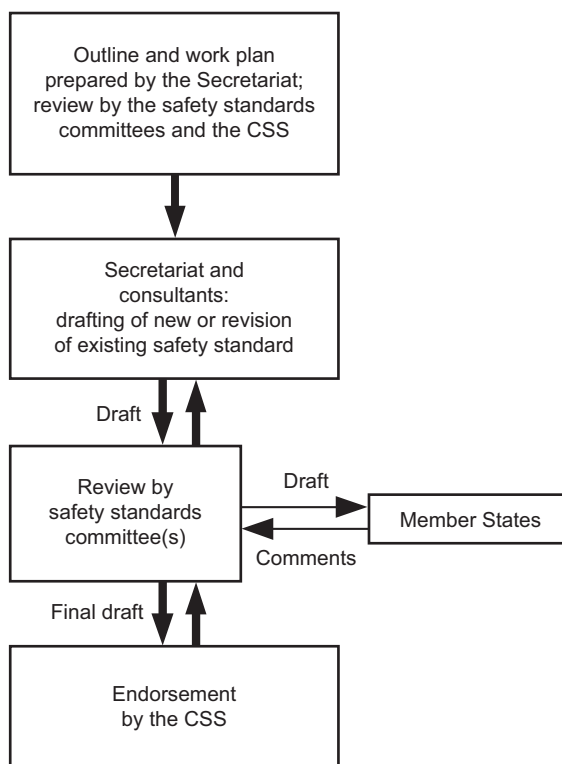


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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

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].

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

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.

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:

- (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

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