

IAEA SAFETY STANDARDS SERIES

Format and Content of the Safety Analysis Report for Nuclear Power Plants

SAFETY GUIDE

No. GS-G-4.1



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The regulatory related publications by means of which the IAEA establishes safety standards and measures are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety, and also general safety (that is, of relevance in two or more of the four areas), and the categories within it are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides**.

Safety Fundamentals (blue lettering) present basic objectives, concepts and principles of safety and protection in the development and application of nuclear energy for peaceful purposes.

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FORMAT AND CONTENT OF THE SAFETY ANALYSIS REPORT FOR NUCLEAR POWER PLANTS

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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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FOREWORD

by Mohamed ElBaradei
Director General

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes, and to provide for the application of these standards to its own operations as well as to assisted operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of nuclear energy.

The following bodies oversee the development of safety standards: the Commission on Safety Standards (CSS); the Nuclear Safety Standards Committee (NUSSC); the Radiation Safety Standards Committee (RASSC); the Transport Safety Standards Committee (TRANSSC); and the Waste Safety Standards Committee (WASSC). Member States are widely represented on these committees.

In order to ensure the broadest international consensus, safety standards are also submitted to all Member States for comment before approval by the IAEA Board of Governors (for Safety Fundamentals and Safety Requirements) or, on behalf of the Director General, by the Publications Committee (for Safety Guides).

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State wishing to enter into an agreement with the IAEA for its assistance in connection with the siting, design, construction, commissioning, operation or decommissioning of a nuclear facility or any other activities will be required to follow those parts of the safety standards that pertain to the activities to be covered by the agreement. However, it should be recalled that the final decisions and legal responsibilities in any licensing procedures rest with the States.

Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance with national practice, may also be necessary. Moreover, there will generally be special aspects that need to be assessed on a case by case basis.

The physical protection of fissile and radioactive materials and of nuclear power plants as a whole is mentioned where appropriate but is not treated in detail; obligations of States in this respect should be addressed on the basis of the relevant instruments and publications developed under the auspices of the IAEA. Non-radiological aspects of industrial safety and environmental protection are also not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

The requirements and recommendations set forth in the IAEA safety standards might not be fully satisfied by some facilities built to earlier standards. Decisions on the way in which the safety standards are applied to such facilities will be taken by individual States.

The attention of States is drawn to the fact that the safety standards of the IAEA, while not legally binding, are developed with the aim of ensuring that the peaceful uses of nuclear energy and of radioactive materials are undertaken in a manner that enables States to meet their obligations under generally accepted principles of international law and rules such as those relating to environmental protection. According to one such general principle, the territory of a State must not be used in such a way as to cause damage in another State. States thus have an obligation of diligence and standard of care.

Civil nuclear activities conducted within the jurisdiction of States are, as any other activities, subject to obligations to which States may subscribe under international conventions, in addition to generally accepted principles of international law. States are expected to adopt within their national legal systems such legislation (including regulations) and other standards and measures as may be necessary to fulfil all of their international obligations effectively.

EDITORIAL NOTE

An appendix, when included, is considered to form an integral part of the standard and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.

The safety standards use the form 'shall' in making statements about requirements, responsibilities and obligations. Use of the form 'should' denotes recommendations of a desired option.

The English version of the text is the authoritative version.

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1. INTRODUCTION

BACKGROUND

1.1. In order for an operating organization to obtain regulatory approval to build and operate a nuclear power plant, an authorization is required to be requested from and granted by the regulatory body. Paragraphs 5.3 and 5.4 of the Safety Requirements publication GS-R-1, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety [1], state that: “5.3. Prior to the granting of an authorization, the applicant shall be required to submit a detailed demonstration of safety, which shall be reviewed and assessed by the regulatory body in accordance with clearly defined procedures.”; and that “5.4. The regulatory body shall issue guidance on the format and content of documents to be submitted by the operator in support of applications for authorization. The operator shall be required to submit or make available to the regulatory body, in accordance with agreed timescales, all information that is specified or requested.” This information should be presented in the form of a report, hereinafter referred to as a safety analysis report (SAR).

1.2. The requirements for SARs depend strongly on the type of regulatory regime adopted by a State, which may affect the scope and depth of the information presented in the SAR. For States with small nuclear power programmes or States that import nuclear power plants, there may be significant reliance on the vendor State’s practices or on international work that helps to demonstrate the safety of the design. In any event, there should be a dialogue between the regulator and the operator at an early stage, possibly at the siting stage, to agree on what is necessary to demonstrate the required level of safety of any proposed installation and the programme of submissions. Some States give very comprehensive guidance on the contents of a SAR; a widely quoted and used document is the Standard Format produced by the United States Nuclear Regulatory Commission (NRC) [2]. The NRC document and other relevant references are considered in this Safety Guide, which draws heavily on IAEA safety standards [1, 3–6] and other publications to present one possible format and content option for a comprehensive SAR for any type of nuclear power plant. Alternative formats to that presented in this Safety Guide may be used; in such cases the recommendations presented here should be regarded as potential elements for use in such alternative formats.

OBJECTIVE

1.3. The objective of this Safety Guide is to provide recommendations and guidance on the possible format and content of a SAR in support of a request to the regulatory body for authorization to construct and/or operate a nuclear power plant. As such, this Safety Guide recommends how to meet the requirements established in the Safety Requirements publication GS-R-1 (Ref. [1], para. 5.4) and complements the related Safety Guide [3].

1.4. Guidance on the assessment and verification to be conducted by the design and operating organizations in preparing the SAR is provided in Safety Guide NS-G-1.2, Safety Assessment and Verification for Nuclear Power Plants [4]. Guidance on the review and assessment to be performed by the regulatory body in the authorization process is provided in another Safety Guide, GS-G-1.2, Review and Assessment of Nuclear Facilities by the Regulatory Body [7].

SCOPE

1.5. This Safety Guide is intended primarily for use with land based stationary thermal nuclear power plants but it may, in parts, have a wider applicability to other nuclear facilities. The particular contents of the SAR will depend on the specific type and design of the nuclear power plant proposed, and this will determine how sections as in this Safety Guide are included in the SAR. Although intended mainly for use with new plants, the guidance presented here would also be useful for existing nuclear power plants when operating organizations periodically review their existing SARs to identify any areas in which improvements may be appropriate and/or to review the licensing basis. This Safety Guide covers at the same level of importance both technical aspects and human factors that should be addressed adequately in a SAR in order to substantiate plant safety.

STRUCTURE

1.6. Section 2 covers general considerations. Section 3 sets out the standard content of a SAR for a nuclear power plant. Section 4 provides recommendations for the review and updating of a SAR.

2. GENERAL CONSIDERATIONS

2.1. The SAR represents an important communication between the operating organization and the regulatory body, and it forms an important part of the basis for licensing a nuclear power plant and an important part of the basis for the safe operation of a plant. The SAR should therefore contain accurate and sufficiently precise information on the plant and its operating conditions and should typically include information on, for example, safety requirements, the design basis, site and plant characteristics, operational limits and conditions, and safety analyses in such a way that the regulatory body will be able to evaluate independently the safety of the plant. In particular, it should be demonstrated that the interdependence between the safety aspects of technical factors and human factors have been considered throughout the report. The SAR should present sufficient information on the plant that, for the purposes of nuclear and radiation safety assessment, the amount of additional documentation necessary to allow the authorization process to proceed is minimized. The SAR may refer to more detailed supplementary information, which should be made available to the regulatory body, if requested.

2.2. It is common practice in many States that SARs are issued in successive and complementary parts, which may include:

- (a) An initial (preliminary) SAR or pre-construction SAR (PCSAR) that supports the application for authorization for siting and/or construction.
- (b) An updated (intermediate) SAR or pre-operation SAR (POSAR) that, in the licensing process, precedes an application for authorization to operate. In some States licensing arrangements envisage the issue of formal permission for the commissioning of a nuclear power plant. In such cases, this intermediate version of the SAR, amended as a result of the primary regulatory review of the PCSAR, should be submitted to the regulatory body in order to demonstrate the readiness of the operating organization to start trial testing operations of the plant before putting it into commercial operation.
- (c) A finalized (final) SAR or station SAR (SSAR) that incorporates the revisions to the intermediate report prior to the plant entering first routine operation.

2.3. The regulatory body should be kept well informed about the process of site selection and the subsequent development of the selected site and plant. Parts of the SAR should be submitted to the regulatory body at an early stage

and in accordance with an agreed timetable; this approach will permit a smoother review process and help prevent unnecessary delays.

2.4. The initial report (PCSAR) may be of limited scope. Informal contacts should be encouraged before the pre-construction review stage between those planning to build a reactor and the regulatory body to develop a common understanding of the nature of the project and the likely regulatory requirements. The PCSAR should include a statement of the safety principles adopted and the safety objectives set for the intended design. It should include a statement of the manner of conforming with the fundamental safety principles and a statement of how the safety objectives are being met. It should typically contain sufficiently detailed information, specifications and supporting calculations to enable those responsible for safety to assess whether the plant can be constructed and operated in a manner that is acceptably safe throughout its lifetime. The safety features incorporated into the design, together with the possible challenges to the plant that have been considered, should be described, with due regard to any site specific aspects. The amount of information to be provided in the preliminary report will depend on the extent to which the proposed reactor design is based on a generic type or a standard design for which the licensing process has been followed previously, including the production of a SAR.

2.5. The intermediate report (POSAR) should revise and provide more specific information on the topics outlined in the PCSAR and on any departure from or revisions to the safety provisions or the design intent as set out in the preliminary report. The POSAR should essentially justify the finalized detailed design of the plant and presents a demonstration of its safety. In addition, the POSAR should deal in greater detail than the PCSAR with matters relating to the commissioning and operation of the plant during this phase of its lifetime. The POSAR should provide more up to date information on the licensing basis for the plant.

2.6. The final report (SSAR) incorporates any necessary revisions to the intermediate report (POSAR) following the commissioning and licensing process for the first entry into routine operation of the as-built nuclear power plant. The final report should clearly demonstrate that the plant meets its design intent. Systematic updating of the SAR would then become a requirement for the operating organization during the remaining lifetime of the plant. This would usually be done periodically so as to reflect any feedback of operating experience, plant modifications and improvements, new regulatory requirements or changes to the licensing basis.

2.7. The SAR is prepared by the operating organization for submission to the regulatory body to enable it to assess the suitability of the plant for licensing. The SAR should also serve as a basis for the operating organization to assess the safety implications of changes to the plant or to operating practices. The following sections of this Safety Guide set out a list and provide a description of possible topics for inclusion in a comprehensive SAR for a nuclear power plant. A standard format for the SAR is also discussed in the appropriate sections. In the application of this Safety Guide, adaptation may be necessary to reflect the differences between the phases of plant licensing and the licensing practices in different States. Where required by States, the SAR or any parts thereof may be made available to the public.

2.8. One of the main purposes of submitting the SAR is to provide the necessary information to the regulatory body. Plant staff and management should also have an understanding of the main findings of the SAR. This may be aided by providing supplementary documentation that summarizes the relevant sections of the SAR.

3. FORMAT AND CONTENT OF A SAR

CHAPTER I: INTRODUCTION

General considerations

3.1. The SAR should start with an introduction, which should include:

- (a) A statement of the main purpose of the SAR;
- (b) A description of the existing authorization status;
- (c) An identification of the designer, vendor, constructor and operating organization of the nuclear power plant;
- (d) A statement of any similar (or identical) plants that the regulatory body has already reviewed and approved and a statement of the specific differences and improvements that have been made since such an approval was granted;
- (e) The main information on the preparation of the SAR;
- (f) A description of the structure of the SAR, the objectives and scope of each of its sections and the intended connections between them.

Information on the layout and other aspects

3.6. Basic technical and schematic drawings of the main plant systems and equipment should be included in this section, together with details of the physical and geographical location of the facility, connections with the electricity grid and means of access to the site by rail, road and water. The operating organization should provide general layout drawings for the entire plant. The illustrations should be complemented with a brief description of the main plant systems and equipment, together with their purposes and interactions. References should be made, where necessary, to other chapters of the SAR that present detailed descriptions of specific systems and equipment.

3.7. The main interfaces and boundaries between on-site equipment and systems provided by different design organizations should be described, together with interfaces with equipment and systems external to the plant (including, for example, the electricity grid), with sufficient detail of the way in which plant operation is co-ordinated.

3.8. This section may, if required, also include or refer to confidential information on the provisions made for the physical protection of the plant. In some States this may also include coverage of the steps taken to provide protection in the event of malicious action on or off the site.

Operating modes of the nuclear power unit

3.9. All possible operating modes of the unit should be described, including startup, normal power operation, shutdown, refuelling and any other allowable modes of operation. The permissible periods of operation at different power levels in the event of a deviation from normal operating conditions should be described. The methods for restoring the unit to normal operating conditions should also be specified.

Material incorporated by reference

3.10. This section should provide a listing of the topical reports that are incorporated by reference as part of the SAR. Results of tests and analyses (e.g. results of manufacturers' material tests and qualification data) may be submitted as separate reports. In such cases, the reports should be listed in this section and referenced or summarized in the appropriate section of the SAR.

CHAPTER III: MANAGEMENT OF SAFETY

General considerations

3.11. This chapter should describe and evaluate the operating organization's management structure and the procedures and processes that have been put in place to achieve satisfactory control of all aspects of safety throughout the lifetime of the plant. This should include the roles of on-site safety assessment organizations and any off-site safety advisory committees that will advise the operating organization's management. The aim is to demonstrate that the operating organization will be able to fulfil its responsibility to operate the plant safely throughout its operating lifetime.

Specific aspects of management processes

3.12. The site and the corporate management structure and technical support organization of the operator should be described in this section. The way in which effective management control of the design and operating organizations will be achieved so as to promote safety, as well as the measures employed to ensure the implementation and observance of the management safety procedures, should be presented and justified. Further discussion on matters to be covered in this section of the SAR is provided in Ref. [8].

Consideration of safety culture

3.13. This subsection should present the operating organization's strategy to encourage the development, maintenance and enhancement of a strong safety culture throughout the lifetime of the plant. The information provided should demonstrate that the necessary arrangements are adequate and are in place at the plant. These arrangements should be aimed at promoting good awareness of all aspects of safety and at regularly reviewing with staff the level of safety awareness achieved on the site. The operating organization should, where possible, determine indicators of safety culture and should develop a programme to monitor such indicators. The staff should be consulted on the determination of these indicators and should be kept informed of the outcome of the reviews. Action should be taken in response to any indications of declining safety levels.

Quality assurance

3.14. The principal aspects of the quality assurance (QA) system developed for the plant should be described in this subsection. It should be demonstrated that appropriate provisions for QA, including a QA programme, and audit, review and self-assessment functions, have been implemented for all safety related plant activities. These activities should include design, procurement of goods and services (including the use of contractors' organizations), plant construction and operation, maintenance, repair and replacement, in-service inspection, testing, refuelling, modification, commissioning and decommissioning. The QA arrangements should cover safety matters relating to the plant throughout its lifetime. Further discussion on matters to be covered in this subsection of the SAR is provided in Ref. [9].

Monitoring and review of safety performance

3.15. The information presented in this section should demonstrate that an adequate audit and review system has been established to provide assurance that the safety policy of the operating organization is being implemented effectively and that lessons are being learned from its own experience and from that of others, to enhance safety performance. It should be shown that means for independent safety review are in place and that an objective internal self-evaluation programme supported by periodic external reviews conducted by experienced industry peers is established. It should also be shown that relevant measurable indicators of safety performance are used to enable senior management to detect and respond in a timely way to any shortcomings and deterioration in safety.

3.16. This section should include a description of the way in which the operating organization intends to identify any development of the organization that could lead to the degradation of safety performance and should justify the appropriateness of the measures planned to prevent such a degradation. Further discussion on matters to be covered in this section of the SAR is provided in Ref. [8].

CHAPTER IV: SITE EVALUATION

General considerations

3.17. This chapter should provide information on the geological, seismological, volcanic, hydrological and meteorological characteristics of the site and the surrounding region in conjunction with the present and projected population distribution and land use that is relevant to the safe design and operation of the plant. Sufficient data should be included to permit an independent evaluation.

3.18. Site characteristics that may affect the safety of the plant should be investigated and the results of the assessment should be presented. The SAR should provide information concerning the site evaluation task¹ as support for the design phase, design assessment phase [4] and periodic safety review [10], and may include:

- (a) Site specific hazard evaluation for external events (of human or natural origin);
- (b) Design targets in terms of recurrence probability of external events (see also paras 3.26 and 3.27);
- (c) Definition of the design basis for external events;
- (d) Collection of site reference data for the plant design (geotechnical, seismological, volcanic, hydrological and meteorological);
- (e) Evaluation of the impact of the site related issues to be considered in the parts of the SAR on emergency preparedness and accident management;
- (f) Arrangements for the monitoring of site related parameters throughout the lifetime of the plant.

3.19. A discussion of considerations concerning the site exclusion and/or acceptance criteria applied for the purposes of preliminary screening of the site for suitability after the site survey phase [11] should be provided in this section of the SAR.

3.20. Site related information represents a very important input to the design process and may be one of the sources of uncertainty in the final safety evaluation. The measures employed to account for such uncertainty levels should be considered in the SAR.

¹ In some States such information is collected in an environmental report.

3.21. Further discussion on matters to be covered in this section of the SAR is provided in Ref. [11].

Site reference data

3.22. This section should specify the site location, including both the area under the control of the licensee and the surrounding area in which there is a need for consultation on the control of activities with the potential to affect plant operation, including flight exclusion zones. Information on such activities would include relevant data on the population distribution and density and on the disposition of public and private facilities (airports, harbours, rail transport centres, factories and other industrial sites, schools, hospitals, police services, fire fighting services and municipal services) around the plant site. This section should also cover the uses of the land and water resources in the surrounding area, for example for agriculture, and should include an assessment of any possible interaction with the plant.

3.23. Site reference data relating to geotechnical soil properties and groundwater hydrology should also be provided. The investigation campaigns for the collection of data for the design of foundations, the evaluation of the effects of soil–structure interaction, the construction of earth structures and buried structures, and soil improvements at the site should be described.

3.24. The SAR should present the relevant data for the site and the associated ranges of uncertainty to be used in the structural design and the dispersion studies for radioactive material. Reference should be made to the technical reports describing in detail the conduct of the investigation campaigns, and their extension, and the origin of the data collected on a regional basis and/or on a bibliographic basis. The design of earth structures and site protection measures [11], if relevant, should also be documented. A description of projected developments relating to the above mentioned information should also be provided and should be updated as required.

Evaluation of site specific hazards

3.25. This section should present the results of a detailed evaluation of natural and human induced hazards at the site. Where administrative measures are employed to mitigate these hazards (especially for human induced events), information should be presented on their implementation, together with the roles and responsibilities for their enforcement.

3.26. The screening criteria used for each hazard (including the envelope, probability thresholds and credibility of events) and the expected impact of each hazard in terms of the originating source, the potential propagation mechanisms and the predicted effects at the site [11–16] should be discussed in the SAR.

3.27. The definition of the target probability levels for design against external events and their consistency with the acceptable limits should be discussed in this section of the SAR.

3.28. It should be demonstrated that appropriate arrangements are in place to update evaluations of site specific hazards periodically in accordance with the results of updated methods of evaluation, monitoring data and surveillance activities.

Proximity of industrial, transport and military facilities

3.29. This section should present the results of a detailed evaluation of the effects of potential incidents at present or proposed industrial, transport or other installations in the vicinity of the site. Any identified threats to the plant should be considered for inclusion in the design basis events to help determine any additional design features considered necessary to mitigate the effects of the potential incidents identified. A description of projected developments relating to this information should also be provided and should be updated as required.

Activities at the plant site that may influence the plant's safety

3.30. Any processes or activities on the plant site that if incorrectly carried out might influence the safe operation of the plant should be presented and described; examples of such processes or activities are vehicular traffic in the plant area, the storage and potential spillage of fuels, gases and other chemicals, intakes (e.g. of air for control room ventilation) or contamination by harmful particles, smoke or gases.

3.31. Measures for site protection (including dams, dykes and drainage) and any modifications to the site (such as soil substitution or modifications to the site elevation) are usually considered part of the site characterization stage and their assessment in relation to the design basis should be considered in this section of the SAR. This assessment may be made on the basis of guidance documents and Refs [11, 17, 18].

Hydrology

3.32. This section should present sufficient information to allow an evaluation of the potential implications of the hydrological conditions at the site for the plant design, performance requirements and safe operation. These conditions should include conditions relating to phenomena such as abnormally heavy rainfall and runoff floods from watercourses, reservoirs, adjacent drainage areas and site drainage. This section should also include a consideration of flood waves resulting from dam failures, ice related flooding and seismically generated water based effects on and off the site. For coastal and estuary sites, tsunamis, seiches and the combined effects of tides and strong wind should be evaluated. The information given in this section will be relevant to the assessment of the transport of radioactive material to and from the site and the dispersion of radionuclides to the environment. Further discussion on matters to be covered in this section of the SAR is provided in Ref. [18].

Meteorology

3.33. This section should provide a description of the meteorological aspects relevant to the site and its surrounding area, with account taken of regional and local climatic effects. To this end, data deriving from on-site meteorological monitoring programmes should be documented. The extreme values of meteorological parameters, including temperature, humidity levels, rainfall levels, wind speeds for straight and rotational winds, and snow loads, should be evaluated in relation to the design. The potential for lightning and windborne debris to affect plant safety should be considered, where appropriate. The information given in this section will be relevant to the assessment of the transport of radioactive material to and from the site and the dispersion of radionuclides to the environment. Further discussion on matters to be covered in this section of the SAR is provided in Ref. [19].

Seismology

3.34. This section should provide information concerning the seismic and tectonic characteristics of the site and of the region surrounding the site. The evaluation of seismic hazards should be based on a suitable geotectonic model substantiated by appropriate evidence and data. The results of this analysis, to be used further in other sections of the SAR in which structural design, seismic qualification of components and safety analysis are considered, should be described in detail. Further discussion on matters to be covered in this section of the SAR is provided in Refs [16, 17].

Radiological conditions due to external sources

3.35. The radiological conditions in the environment at the plant site, with account taken of the radiological effects of neighbouring plant units and other external sources, if any, should be described in sufficient detail to serve as an initial reference point and to permit the regulatory body to develop a view of the radiological conditions at the site.

3.36. A short description may be presented of the radiation monitoring systems available and the corresponding technical means for the detection of any radiation or radioactive contamination. If appropriate, this section may reference other relevant sections of the SAR concerned with the radiological aspects of licensing the plant.

Site related issues in emergency planning and accident management

3.37. Accident management relies strongly on the availability of adequate access and egress roads, sheltering and supply networks in the vicinity of the site. Many hazard scenarios for the site are expected to include effects in the vicinity of the site also, and thus the possibility of the evacuation of personnel and of access to the site. The availability of local transport networks and communications networks during and after an accident is a key issue for the implementation of a suitable emergency plan. The feasibility of emergency arrangements in terms of access to the plant and of transport in the event of a severe accident should be discussed in this section of the SAR. It should be shown that the requirements for adequate infrastructures external to the site are met. The needs for any necessary administrative measures should be identified, together with the relevant responsibilities of bodies other than the operating organization.

Monitoring of site related parameters

3.38. The provisions to monitor site related parameters affected by seismic, atmospheric, water and groundwater related, demographic, industrial and transport related developments should be described in this section. This may be used to provide necessary information for emergency operator actions in response to external events, to support the periodic safety review at the site, to develop dispersion modelling for radioactive material and as confirmation of the completeness of the set of site specific hazards taken into account.

3.39. Long term monitoring programmes should include the collection of data recorded using site specific instrumentation and data from specialized national institutions for use in comparisons to detect significant variations from the design basis; for example, variations due to the possible effects of global warming.

3.40. The strategy for monitoring and the use of the results in preventing, mitigating and forecasting the effects of site related hazards should be described in some detail in the SAR.

CHAPTER V: GENERAL DESIGN ASPECTS

General considerations

3.41. This chapter should outline the general design concept and the approach adopted to meet the fundamental safety objectives [20, 21]. The compliance of the actual design with the specific technical safety requirements should be demonstrated in more detail in other sections of the SAR, which may be referenced here.

Safety objectives and design principles

3.42. The safety objectives and principles used in the design should be presented in this section. These should be based on the objectives presented in paras 2.2, 2.4 and 2.5 of Ref. [5], which refers to the general nuclear safety objective, the radiation protection objective and the technical safety objective, as defined by the IAEA. This subject is discussed further in paras 3.43–3.52.

Defence in depth

3.43. This part of the SAR should describe in general terms the design approach adopted to incorporate the defence in depth concept into the design of the plant. It should be demonstrated that the defence in depth concept has been considered for all safety related activities. The design approach adopted should ensure that multiple and (to the extent possible) independent levels of and barriers for defence are present in the design to provide protection against operational occurrences and accidents regardless of their origin. The selection of the main barriers should be described and justified. Particular emphasis should be placed on systems important to safety. Where appropriate, any proposed operator actions to mitigate the consequences of events and to assist

in the performance of important safety functions should be included. Guidance on the defence in depth concept is given in Ref. [5].

Safety functions

3.44. The Safety Requirements publication *Safety of Nuclear Power Plants: Design* [5] specifies the fundamental safety functions required to be performed to ensure safety as: the control of reactivity; the removal of heat from the core; and the confinement of radioactive material and the control of operational discharges, as well as the limitation of accidental releases. This part of the SAR should identify and justify the fundamental safety functions to be fulfilled by the specific plant design. It should specify the corresponding structures, systems and components necessary to fulfil these safety functions at various times following a postulated initiating event (PIE).

3.45. In addition to the fundamental safety functions, any specific safety functions should be identified. For example, heat removal should be considered a safety function necessary not only for the safety of the reactor core but also for the safety of any other part of the plant containing radioactive material that needs to be cooled, such as spent fuel pools and storage areas. Guidance on the identification of specific safety functions for plants with light water reactors is given in the annex of Ref. [5].

Deterministic design principles and criteria

3.46. This subsection should provide a general description of the way in which the selected deterministic design principles are embodied in the design. The safety assessment for the plant may be considerably simplified if conservative deterministic principles and criteria are adopted in the design to ensure the adequacy of safety margins in meeting a legal or regulatory requirement. Where aspects of the design are to be based on conservative deterministic principles, such as those embodied in international standards or internationally accepted industrial codes and standards, or in regulatory guidance documents, the use of such approaches should be elaborated in this subsection of the SAR.

3.47. In some cases the design of a nuclear power plant may not fully comply with a specific deterministic principle in a regulatory guidance document. In such cases, either it should be demonstrated that adequate safety margins have been provided by another means or else the proposed design changes or deviations should be justified. In either case the regulatory body should be consulted at an early stage.