

IAEA Safety Standards

for protecting people and the environment

Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants

Specific Safety Guide

No. SSG-48



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AGEING MANAGEMENT AND
DEVELOPMENT OF A PROGRAMME FOR
LONG TERM OPERATION OF
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".

IAEA SAFETY STANDARDS SERIES No. SSG-48

AGEING MANAGEMENT AND DEVELOPMENT OF A PROGRAMME FOR LONG TERM OPERATION OF NUCLEAR POWER PLANTS

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2018

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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.

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 as ‘shall’ statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

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

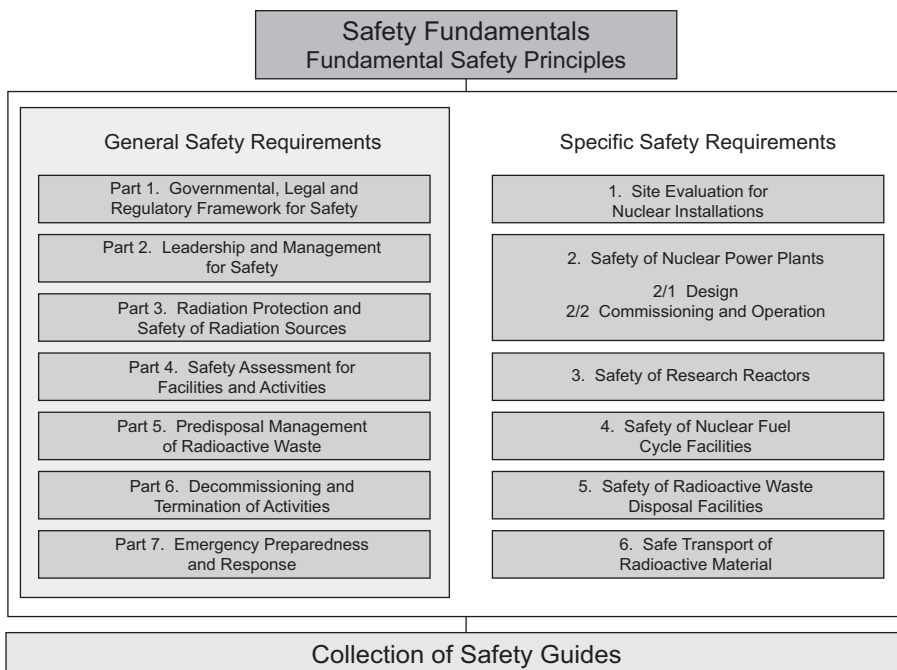


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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

All IAEA Member States may nominate experts for the safety standards committees and may provide comments on draft standards. The membership of

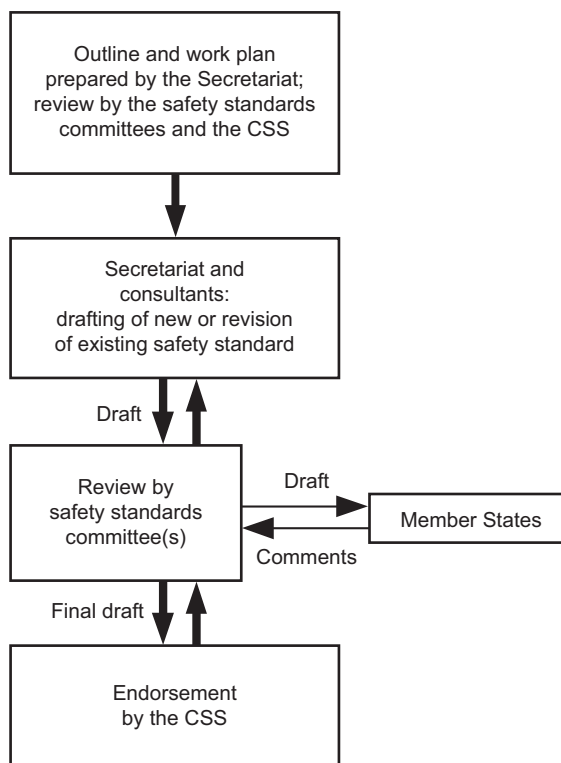


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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. This Safety Guide was prepared under the IAEA's programme for safety standards. The requirements for the design, commissioning and operation of nuclear power plants are established in IAEA Safety Standards Series Nos SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design [1], and SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation [2]. The requirements for safety assessment are established in IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), Safety Assessment for Facilities and Activities [3]. IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [4], addresses regulatory aspects throughout the operation of facilities and throughout the duration of associated activities and for any subsequent period of institutional control until there is no significant residual radiation hazard.

1.2. Ageing management for nuclear power plants is implemented to ensure that the effects of ageing will not prevent structures, systems and components (SSCs) from being able to accomplish their required safety functions throughout the lifetime of the nuclear power plant (including its decommissioning) and it takes account of changes that occur with time and use [1]. This requires addressing both the effects of physical ageing of SSCs, resulting in degradation of their performance characteristics, and the non-physical ageing (obsolescence) of SSCs (i.e. their becoming out of date in comparison with current knowledge, codes, standards and regulations, and technology).

1.3. Ageing management is most effective when it is properly carried out at all stages of the lifetime of a nuclear power plant.

1.4. Effective ageing management of SSCs is a key element of the safe and reliable operation of nuclear power plants. To assist its Member States in managing ageing effectively, the IAEA has developed the International Generic Ageing Lessons Learned (IGALL) programme (see Refs [5, 6]). In addition, the safety of nuclear power plants during long term operation has become more important owing to the steady increase in the number of operating organizations giving high priority to continuing the operation of nuclear power plants beyond the time frame originally anticipated for their operation.

1.5. This Safety Guide supplements and provides recommendations on meeting the requirements relating to ageing management and long term operation that are established in SSR-2/1 (Rev. 1) [1] and SSR-2/2 (Rev. 1) [2]. It identifies key elements of effective ageing management for nuclear power plants.

1.6. This publication revises and supersedes the Safety Guide on Ageing Management for Nuclear Power Plants issued in 2009, and also supersedes two Safety Reports issued by the IAEA in 1999 and 2007.¹ This revision takes into account developments in the ageing management of nuclear power plants worldwide and expands the scope to include provisions for maintaining the safety of nuclear power plants during long term operation.

1.7. IAEA Safety Standards Series No. SSG-25, Periodic Safety Review for Nuclear Power Plants [7], also provides recommendations on some aspects of physical ageing of SSCs but focuses more on non-physical ageing of SSCs. SSG-25 [7] also stresses the need to seek safety improvements and implement those improvements that are practicable if the plant is to continue to operate beyond the time frame originally anticipated for its operation.

OBJECTIVE

1.8. The objective of this Safety Guide is to provide recommendations for meeting Requirement 30 (Qualification of items important to safety) and Requirement 31 (Ageing management) of SSR-2/1 (Rev. 1) [1] and Requirement 14 (Ageing management) and Requirement 16 (Programme for long term operation) of SSR-2/2 (Rev. 1) [2].

1.9. This Safety Guide provides guidance for operating organizations on implementing and improving ageing management and on developing a programme for safe long term operation for nuclear power plants that, among other aspects, takes due account of ageing management.

¹ INTERNATIONAL ATOMIC ENERGY AGENCY, Ageing Management for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.12, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Implementation and Review of a Nuclear Power Plant Ageing Management Programme, Safety Reports Series No. 15, IAEA, Vienna (1999).

INTERNATIONAL ATOMIC ENERGY AGENCY, Safe Long Term Operation of Nuclear Power Plants, Safety Reports Series No. 57, IAEA, Vienna (2007).

1.10. This Safety Guide may also be used by the regulatory body in preparing regulatory requirements, codes and standards and in verifying effective ageing management in nuclear power plants.

SCOPE

1.11. The recommendations provided in this Safety Guide are applicable for nuclear power plants throughout their entire lifetime (including their decommissioning), taking into account the different reactor designs existing worldwide.

1.12. This Safety Guide focuses mainly on managing the physical ageing of SSCs within the scope of ageing management ('in-scope SSCs'). It also provides recommendations on safety aspects of managing technological obsolescence and recommendations on the programme for safe long term operation of nuclear power plants with emphasis on ageing management related activities.

1.13. Other aspects relating to safe long term operation, such as obsolescence of knowledge (i.e. matters relating to knowledge management and human resources) and compliance with current regulatory requirements, codes and standards, as well as plant design, the environmental impact of long term operation, economic assessment and long term investment strategies, are outside the scope of this Safety Guide. They are addressed in other IAEA safety standards (see Refs [1, 7, 8]).

1.14. The recommendations in this Safety Guide also apply to facilities for spent fuel storage and radioactive waste management that are part of the nuclear power plant. The recommendations in this Safety Guide can also be used as a basis for ageing management at separate facilities for storage of spent nuclear fuel and for radioactive waste management. In this context, the recommendations provided in IAEA Safety Standards Series No. SSG-15, Storage of Spent Nuclear Fuel [9], should be followed.

STRUCTURE

1.15. Section 2 presents basic concepts of managing ageing and obsolescence as well as their implications for a programme for safe long term operation, which provide a common basis for the recommendations provided in Sections 3–7. Section 3 provides recommendations on ageing management of SSCs at each

separate stage in the lifetime of a nuclear power plant. Section 4 provides recommendations on plant documentation and programmes relevant to ageing management and safe long term operation. Section 5 provides recommendations on managing ageing that are applicable throughout the entire lifetime of the nuclear power plant. Section 6 provides recommendations on the management of technological obsolescence at the operation stage. Section 7 provides recommendations on ageing related activities important to the safe long term operation of the nuclear power plant.

2. BASIC CONCEPTS

2.1. This section presents the basic concepts of ageing management, including their application to long term operation, which provide a common basis for the recommendations given in Sections 3–7 of this Safety Guide.

2.2. Physical ageing is a general process in which the physical characteristics of SSCs gradually deteriorate with time or use owing to physical degradation or chemical or biological processes (i.e. degradation mechanisms).

2.3. Non-physical ageing of SSCs is the process of their becoming out of date (i.e. obsolete) owing to the availability and evolution of knowledge and technology, and the associated changes in requirements, codes and standards.

2.4. In this Safety Guide, physical ageing is referred to as ‘ageing’, while non-physical ageing is referred to as ‘obsolescence’.

2.5. Evaluation of the consequences of the cumulative effects of both ageing and obsolescence on the safety of a nuclear power plant is a continuous process and is required to be assessed in a periodic safety review or an equivalent safety assessment under alternative arrangements (see paras 4.6–4.8) [2, 7].

AGEING MANAGEMENT

2.6. Effective ageing management throughout the lifetime of SSCs requires the use of a systematic approach to managing the effects of ageing that provides a framework for coordinating all activities relating to the understanding, prevention, detection, monitoring and mitigation of ageing effects on the plant’s

structures and components. This approach is illustrated in Fig. 1, which is an adaptation of Deming’s ‘plan–do–check–act’ cycle to the ageing management of SSCs.

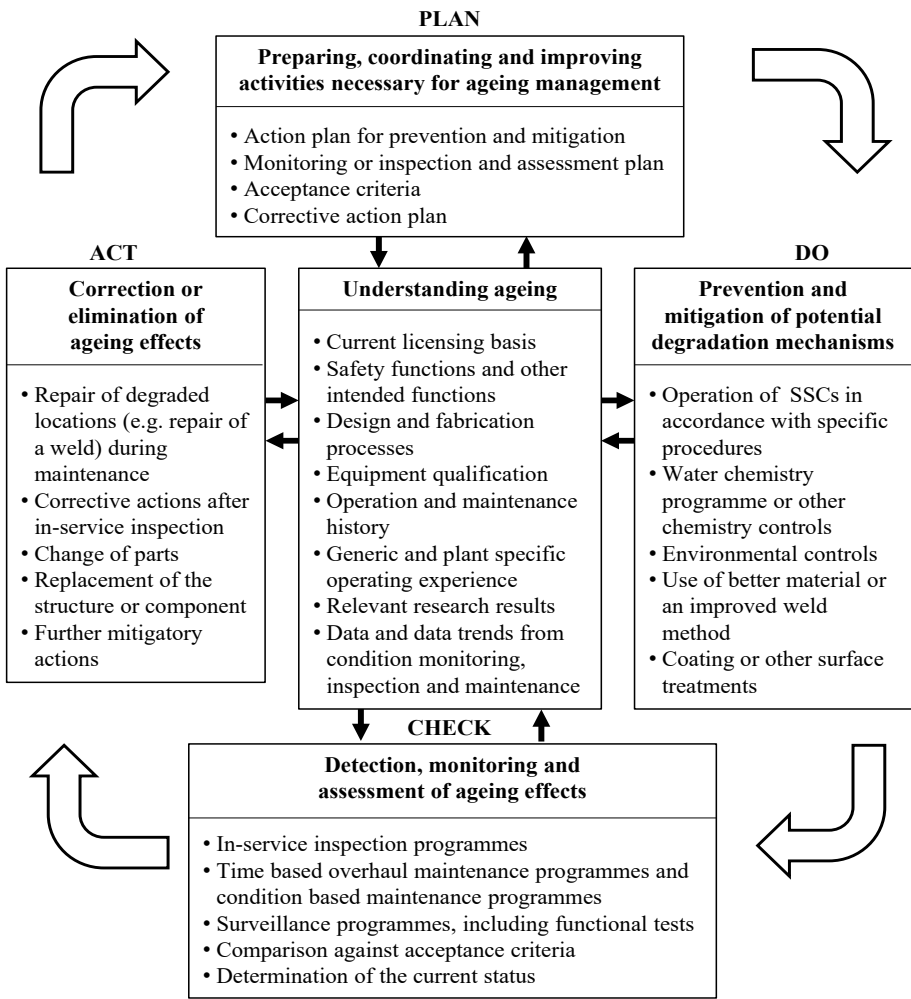


FIG. 1. Systematic approach to ageing management.

2.7. Understanding the ageing of SSCs, as illustrated in Fig. 1, is the key to effective ageing management. This understanding is derived from knowledge of:

- (a) The current licensing basis² and anticipated updates to the licensing basis, where relevant (including regulatory requirements, codes and standards);
- (b) The safety functions and other intended functions of the SSCs;
- (c) The design and fabrication processes used (including the material, the material properties, adverse residual effects from fabrication methods, such as cold work or residual stresses in welds, specific service conditions, results from inspections and examinations, and testing in manufacturing);
- (d) Equipment qualification (where applicable);
- (e) The environmental conditions of the SSCs during any delayed construction period, as these may affect the ageing performance of the SSCs;
- (f) The environmental conditions of the SSCs during operation and shutdown conditions, including, at a minimum, temperatures, humidity levels, aqueous parameters (e.g. water quality and levels of deleterious constituents) and neutron or gamma radiation fields;
- (g) The operation, irradiation and maintenance histories of SSCs, including their commissioning, repair, modification and surveillance histories;
- (h) Operating experience at the plant or at other nuclear power plants;
- (i) Relevant research results;
- (j) Data and data trends from condition monitoring, inspection and maintenance.

2.8. To maintain plant safety, the effects of ageing on SSCs (i.e. net changes in characteristics) should be detected in a timely manner, so as to be able to take appropriate actions to ensure that the required safety functions of SSCs are fulfilled over the entire lifetime of the nuclear power plant.

2.9. The ‘plan’ activity in Fig. 1 involves coordinating, integrating and modifying existing programmes and activities relating to the ageing management of SSCs, and developing new programmes if necessary.

² The ‘current licensing basis’ is the set of regulatory requirements applicable to a specific plant, the operating organization’s commitments to ensuring compliance with and operation within applicable regulatory requirements, and the plant specific design basis (including all modifications and additions to such commitments over the life of the licence). The current licensing basis also includes the plant specific design basis information as documented in a safety analysis report (which typically includes time limited ageing analyses), reports of periodic safety reviews and other plant documents.

2.10. Ageing management consists of design, operations and maintenance actions to prevent or to control, within acceptable limits, the ageing of SSCs. Ageing management is an interdisciplinary activity that involves engineering, maintenance, surveillance, equipment qualification, in-service inspection, safety analysis and other relevant plant programmes. IAEA Safety Standards Series No. NS-G-2.6, Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants [10], provides guidance on maintenance, surveillance and inspection practices.

2.11. Ageing management covers all activities that aim to prevent or control ageing effects, within acceptable limits, throughout the entire lifetime of the nuclear power plant (i.e. design; fabrication or construction; commissioning; operation, including long term operation; and decommissioning, including long term shutdown), as described in Section 3.

2.12. The ageing of SSCs increases the probability of common cause failures (i.e. the degradation of two or more physical barriers or redundant structures and components), which could result in the impairment of one or more levels of protection provided by application of the defence in depth concept. Therefore, in setting the scope of ageing management for structures and components, no credit should be taken for redundancy among SSCs.

2.13. Ageing management programmes should be developed using a structured methodology, to ensure a consistent approach in implementing ageing management, as described in Section 5.

2.14. Existing plant programmes, including those for maintenance, equipment qualification, in-service inspection, surveillance and water chemistry, that can be credited where appropriate to manage ageing, ageing effects and degradation mechanisms are described in Section 4.

2.15. Where existing plant programmes are not sufficient, they should be improved or new ageing management programmes should be developed and implemented, as described in Section 5.

2.16. In practice, ageing effects and degradation mechanisms are studied and managed at the level of the structure or component. However, the ageing management programmes for individual structures or components may be integrated into an ageing management programme at the system and/or plant level.

2.17. The ‘do’ activity in Fig. 1 involves preventing and mitigating expected ageing effects and degradation mechanisms of SSCs by developing a specific operating procedure, a water chemistry programme or another chemistry or environmental control programme, and/or by means of other preventive and mitigatory actions.

2.18. Effective ageing management is in practice accomplished by coordinating existing plant programmes and processes (or elements thereof that are relevant to ageing), as well as external activities such as research and development, and by implementing, coordinating or taking credit for other specific actions, as described in Section 5.

2.19. The ‘check’ activity in Fig. 1 involves the timely detection and characterization of significant ageing effects and degradation mechanisms through the inspection and monitoring of structures and components and the assessment of observed ageing effects to determine the type and timing of any corrective actions required [8].

2.20. The ‘act’ activity in Fig. 1 involves the timely correction of ageing effects on structures and components and the introduction of further preventive or mitigatory actions through appropriate maintenance and design modifications, including the repair and replacement of structures and components.

2.21. The closed loop of Fig. 1 indicates the continuation and improvement of ageing management on the basis of feedback on relevant operating experience, results from research and development, and results of self-assessment and peer reviews, to help to ensure that emerging ageing issues will be addressed.

2.22. Time limited ageing analyses (also called ‘safety analyses that use time limited assumptions’) should demonstrate that the analysed ageing effects will not adversely affect the capability of a structure or component to perform its intended function(s) throughout an assumed period of operation (see paras 5.64–5.69).

2.23. Time limited ageing analyses involve two types of parameter. The first parameter is the time dependent variable used in the analysis. Examples of this parameter are the neutron fluence, the operating time or the number of thermal cycles a structure or component undergoes. The second parameter is the ageing effect associated with the first parameter, which could be the neutron embrittlement of vessel material, the cumulative fatigue usage factor or the thermal embrittlement of cast austenitic stainless steel, respectively. Both

parameters should be evaluated and compared with a regulatory limit or criterion to determine the acceptability of the structure or component for continued service.

2.24. The effectiveness of ageing management should be periodically reviewed to maintain plant safety and to ensure feedback and continuous improvement (see paras 5.54–5.63).

MANAGEMENT OF OBSOLESCENCE

2.25. Nuclear power plant safety can be impaired if the obsolescence of SSCs is not identified in advance and corrective actions are not taken before the associated decrease in the reliability or availability of SSCs occurs.

2.26. Management of obsolescence is part of the general approach for enhancing nuclear power plant safety through ongoing improvements in both the performance of SSCs and safety management.

2.27. There are several types of obsolescence. The subject, manifestation, consequences and management approaches for three types of obsolescence are shown in Table 1.

2.28. Recommendations on the management of technological obsolescence (also called ‘the obsolescence of technology’) are provided in Section 6.

2.29. Conceptual aspects of obsolescence, such as obsolescence of knowledge and compliance with current regulations, codes and standards, are addressed in Requirements 5 and 12 of SSR-2/2 (Rev. 1) [2], which deal with safety policy and periodic safety review, and in safety factors 2 and 8 of SSG-25 [7], which deal with actual conditions of SSCs important to safety and safety performance. Recommendations on these aspects of obsolescence are not provided in this Safety Guide.

PROGRAMME FOR LONG TERM OPERATION

2.30. Long term operation of a nuclear power plant is operation beyond an established time frame defined by the licence term, the original plant design, relevant standards or national regulations. Long term operation should be justified by safety assessment and, depending on the State, this justification may take place within a broader regulatory process, such as licence renewal or a

TABLE 1. TYPES OF OBSOLESCENCE

Subject of obsolescence	Manifestation	Consequences	Management
Technology	Lack of spare parts and technical support Lack of suppliers Lack of industrial capabilities	Declining plant performance and safety due to increasing failure rates and decreasing reliability	Systematic identification of useful service life and anticipated obsolescence of SSCs Provision of spare parts for planned service life and timely replacement of parts Long term agreements with suppliers Development of equivalent structures or components
Regulations, codes and standards	Deviations from current regulations, codes and standards for structures, components and software Design weaknesses (e.g. in equipment qualification, separation, diversity or capabilities for severe accident management)	Plant safety level below current regulations, codes and standards (e.g. weaknesses in defence in depth or higher risk of core damage (frequency))	Systematic reassessment of plant safety against current regulations, codes and standards (e.g. through periodic safety review) and appropriate upgrading, back fitting or modernization
Knowledge	Knowledge of current regulations, codes and standards and technology relevant to SSCs not kept current	Opportunities to enhance plant safety missed	Continuous updating of knowledge and improvement of its application

periodic safety review (see SSG-25 [7]). Among the topics covered by the safety assessment, specific consideration should be given to adequate management of the ageing processes that can affect the SSCs within the scope of the evaluation for long term operation and to ensuring that those SSCs will retain their capability to perform their intended safety functions throughout the planned period of long term operation.

2.31. The plant programme for long term operation is a set of activities, including evaluations, assessments, maintenance, inspections and testing, aimed at justifying and demonstrating plant safety for the planned period of long term operation. The programme for long term operation should be based on national regulatory requirements, should consider international best practices, operating experience and research findings and should include an implementation plan, as described in Section 7.

2.32. If a decision is taken to pursue long term operation, justification of the adequacy of ageing management for the planned period of long term operation should be provided, based on the results of the periodic safety reviews [7] or the results of an adequate evaluation process (that includes scope setting, ageing management review, and revalidation of time limited ageing analyses, as described in this Safety Guide), and this justification should be evaluated for adequacy by the regulatory body.

3. AGEING MANAGEMENT THROUGHOUT THE LIFETIME OF THE NUCLEAR POWER PLANT

3.1. The ageing of in-scope SSCs (see paras 5.14–5.21) should be managed with foresight and anticipation throughout the entire lifetime of the plant (i.e. design, construction, commissioning, operation (including long term operation and suspended operation) and decommissioning), with consideration given to the associated techniques, costs and exposure of workers. The management of ageing effects should be considered during all associated activities, such as engineering, procurement, fabrication, transport and installation.

3.2. Regulatory requirements for ageing management should be established and guidance should be developed to ensure that the operating organization of the nuclear power plant implements effective ageing management at each stage of the lifetime of the nuclear power plant.