

IAEA Safety Standards

for protecting people and the environment

Ageing Management for Research Reactors

Specific Safety Guide

No. SSG-10



IAEA

International Atomic Energy Agency



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AGEING MANAGEMENT FOR RESEARCH REACTORS

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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-10

AGEING MANAGEMENT FOR RESEARCH REACTORS

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2010

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FOREWORD

The IAEA's Statute authorizes the Agency to establish safety standards to protect health and minimize danger to life and property — standards which the IAEA must use in its own operations, and which a State can apply by means of its regulatory provisions for nuclear and radiation safety. A comprehensive body of safety standards under regular review, together with the IAEA's assistance in their application, has become a key element in a global safety regime.

In the mid-1990s, a major overhaul of the IAEA's safety standards programme was initiated, with a revised oversight committee structure and a systematic approach to updating the entire corpus of standards. The new standards that have resulted are of a high calibre and reflect best practices in Member States. With the assistance of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its safety standards.

Safety standards are only effective, however, if they are properly applied in practice. The IAEA's safety services — which range in scope from engineering safety, operational safety, and radiation, transport and waste safety to regulatory matters and safety culture in organizations — assist Member States in applying the standards and appraise their effectiveness. These safety services enable valuable insights to be shared and all Member States are urged to make use of them.

Regulating nuclear and radiation safety is a national responsibility, and many Member States have decided to adopt the IAEA's safety standards for use in their national regulations. For the contracting 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 designers, manufacturers and operators around the world to enhance nuclear and radiation safety in power generation, medicine, industry, agriculture, research and education.

The IAEA takes seriously the enduring challenge for users and regulators everywhere: that of ensuring a high level of safety in the use of nuclear materials and radiation sources around the world. Their continuing utilization for the benefit of humankind must be managed in a safe manner, and the IAEA safety standards are designed to facilitate the achievement of that goal.

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.

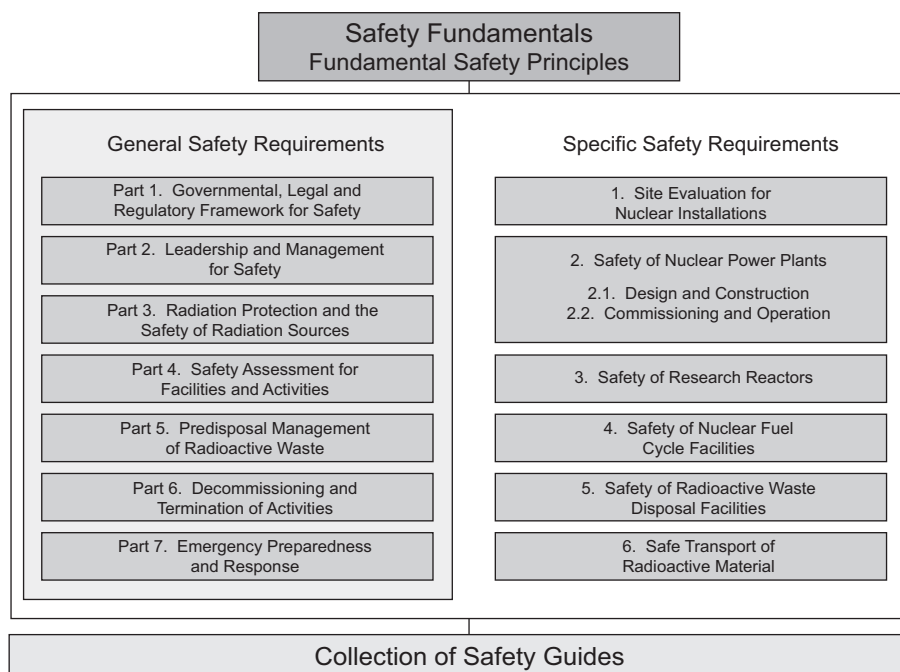


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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).

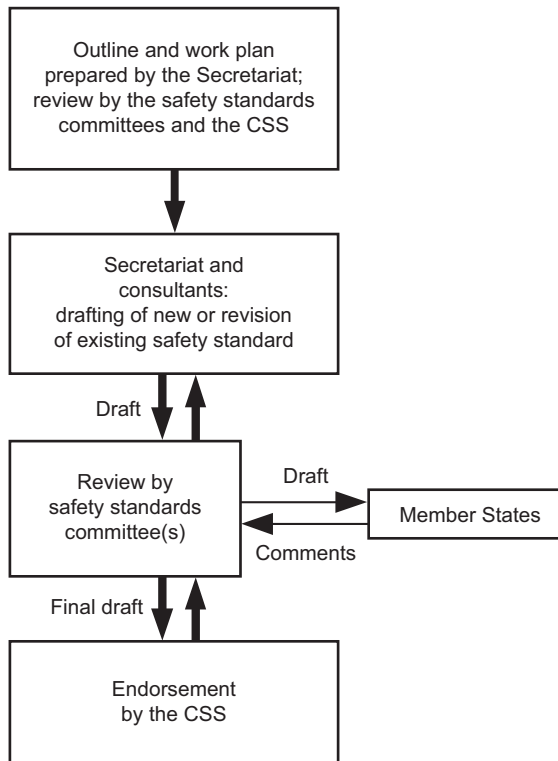


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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. This Safety Guide was developed under the IAEA programme for safety standards for research reactors, which covers all the important areas of research reactor safety. It supplements and elaborates upon the safety requirements for ageing management of research reactors that are established in paras 6.68–6.70 and 7.109 of the IAEA Safety Requirements publication, *Safety of Research Reactors* [1].

1.2. The safety of a research reactor requires that provisions be made in its design to facilitate ageing management. Throughout the lifetime of a research reactor, including its decommissioning, ageing management of its structures, systems and components (SSCs) important to safety¹ is required, to ensure continued adequacy of the safety level, reliable operation of the reactor, and compliance with the operational limits and conditions.

1.3. Managing the safety aspects of research reactor ageing requires implementation of an effective programme for the monitoring, prediction, and timely detection and mitigation of degradation of SSCs important to safety, and for maintaining their integrity and functional capability throughout their service lives.

1.4. Ageing management is defined as engineering, operation, and maintenance strategy and actions to control within acceptable limits the ageing degradation of SSCs [2]. Ageing management includes activities such as repair, refurbishment and replacement of SSCs, which are similar to other activities carried out at a research reactor in maintenance and testing or when a modification project takes place. However, it is important to recognize that effective management of ageing

¹ Items important to safety: An item that is part of a safety group and/or whose malfunction or failure could lead to radiation exposure of the site personnel or members of the public. Items important to safety include:

- (a) Those SSCs whose malfunction or failure could lead to undue radiation exposure to site personnel or members of the public;
- (b) Those SSCs that prevent anticipated operational occurrences from leading to accident conditions;
- (c) Those features that are provided to mitigate the consequences of malfunction or failure of SSCs [2].

requires the use of a methodology that will detect and evaluate ageing degradation as a consequence of the service conditions², and involves the application of countermeasures for prevention and mitigation of ageing degradation.

OBJECTIVE

1.5. The objective of this Safety Guide is to provide recommendations on managing ageing of SSCs important to safety at research reactors on the basis of international good practice. This Safety Guide is intended for use by operating organizations in establishing, implementing and improving ageing management programmes for research reactors. It may be used by regulatory bodies in verifying that ageing of research reactors is being effectively managed.

1.6. While the intention is not to recommend ways in which to make the operation of a research reactor more effective or more efficient, the recommendations provided in this Safety Guide on managing ageing of SSCs to ensure safety will undoubtedly contribute to the enhancement of their long term reliability and availability.

SCOPE

1.7. This Safety Guide covers all aspects relating to the establishment, implementation and continuous improvement of an ageing management programme. It not only focuses on managing the physical ageing of SSCs important to safety but also provides guidance on safety aspects of managing obsolescence (non-physical ageing).

1.8. In formulating the recommendations in this Safety Guide, consideration has been given to the recommendations in the IAEA Safety Guide, Ageing Management for Nuclear Power Plants [3]. Where appropriate, in consideration of differences in hazard potential and complexity of systems between nuclear power plants and research reactors, certain provisions of Ref. [3] have been adopted.

² Service conditions are actual physical states or influences during the service lives of SSCs, including operating conditions (normal and erroneous included), design basis event conditions, and conditions following a design basis event [2].

1.9. The recommendations provided in this Safety Guide are intended to be applicable to research reactors having limited hazard potential to the public and the environment. It deals with all types of heterogeneous, thermal spectrum, research reactors having a power rating of up to several tens of megawatts. Additional guidance may be necessary for research reactors of higher power, specialized reactors (e.g. fast spectrum reactors and homogeneous reactors) and reactors with specialized facilities (e.g. hot or cold neutron sources, or high pressure and high temperature test loops).

1.10. Research reactors having a power rating of up to several tens of kilowatts and critical assemblies may need a less comprehensive ageing management programme than that outlined here. While consideration should be given to all the recommendations made in this Safety Guide, some may not be applicable to these low power research reactors. For these reasons, the recommendations in this Safety Guide should be graded³ for their applicability to the specific research reactor under consideration (see Ref. [1], paras 1.11–1.14).

1.11. A graded approach may be applied in determining the appropriate frequency of inspections, in selecting detection methods, as well as in establishing measures for prevention and mitigation of ageing effects. The graded approach may be based on the estimated service lives of the SSCs, their complexity and their ease of replacement. A graded approach may also be applicable to the resources necessary to implement the ageing management programme. While a dedicated organizational unit may be needed to implement the ageing management programme for higher power research reactors, the ageing management activities for research reactors having a low power may be performed by the maintenance personnel. A Safety Guide on the use of a graded approach in the application of the safety requirements for research reactors is in preparation.

1.12. Although managing succession for the personnel of research reactors and knowledge management are important issues in relation to safety at research reactors, they are outside the scope of this Safety Guide. Recommendations relating to the ageing of research reactor personnel are provided in Ref. [4].

³ The recommendations should be graded, for example, by considering — using sound engineering judgement — the operational importance of the item or activity, its importance to safety, and its maturity and complexity.

STRUCTURE

1.13. This Safety Guide consists of seven sections and two annexes. Section 2 covers the management system for ageing management. Section 3 presents the basic concepts and explanations of the terms used in this Safety Guide, and an overview of ageing effects and their relation to safety at research reactors. Section 4 provides recommendations on proactive considerations on ageing during the various stages of the lifetime of a research reactor. Section 5 sets out the elements of a systematic ageing management programme, and provides advice on implementation of the associated actions or activities. Section 6 presents recommendations on management of SSCs during their obsolescence. Section 7 discusses different technical aspects relating to ageing management, such as maintenance, periodic testing and inspection, periodic safety review, equipment qualification, design basis reconstitution, configuration management and continued safe operation. Annex I presents ageing mechanisms and their effects for different categories of service conditions. Annex II provides an example of screening of SSCs for ageing management for open pool, light water and heavy water moderator research reactors.

2. MANAGEMENT SYSTEM FOR AGEING MANAGEMENT⁴

GENERAL

2.1. A documented management system that integrates the safety, health, environmental, security, quality and economic objectives of the operating organization of a research reactor is required to be in place [5]. The documentation of the management system should describe the system that controls the planning and implementation of all activities at the research reactor throughout its lifetime, including ageing management activities. Approval of the management system (or parts thereof) by the regulatory body may be required. The management system should cover four functional categories: management responsibility; resource

⁴ The recommendations provided in this section can also be used, as applicable, to establish a management system for managing the obsolescence of SSCs.

management; process implementation; and measurement, assessment and improvement. In general:

- (1) Management responsibility includes the support and commitment of management necessary to achieve the objectives of the operating organization.
- (2) Resource management includes the measures necessary to ensure that the resources essential to the implementation of strategy and the achievement of the objectives of the operating organization are identified and made available.
- (3) Process implementation includes the activities and tasks necessary to achieve the goals of the organization.
- (4) Measurement and assessment provide an indication of the effectiveness of management processes and work performance compared with objectives or benchmarks; it is through measurement and assessment that opportunities for improvement are identified.

The requirements for the management system are established in Ref. [1], paras 4.5–4.13, and in Ref. [5], and further recommendations are provided in Ref. [6].

2.2. As part of the integrated management system, a system for ageing management should be established and put into effect by the operating organization. For a new research reactor project, the management system for ageing management should be established early on in the design stage. The system should cover all items, services and processes important to safety and should include a means of establishing control over ageing management activities, thereby providing confidence that they are performed according to the established requirements. In determining how the requirements of the management system for ageing management are to be applied, a graded approach based on the relative importance to safety of each item or process should be used.

2.3. The objective of the management system as applied to ageing management is to ensure that the facility meets the requirements for safety as derived from:

- The requirements of the regulatory body;
- Design requirements and assumptions;
- The safety analysis report;
- Operational limits and conditions;
- The administrative requirements established by the management of the research reactor.

2.4. The management system should support the development, implementation and enhancement of a strong safety culture in all aspects of the ageing management programme.

MANAGEMENT RESPONSIBILITY

2.5. The management system for ageing management should provide a framework for managing, performing and assessing the activities necessary to prevent, detect, monitor, assess and mitigate ageing effects. The documentation of the management system for ageing management should include descriptions of the organizational structure, functional responsibilities, levels of authority and interactions of those managing, performing and assessing the adequacy of the ageing management activities. It should also cover other management measures, including planning, scheduling, resource allocation and human factors.

2.6. The management system for ageing management should be outlined in a description of the ageing management programme and should be documented in operating procedures. The operating procedures should address all applicable requirements specified in the integrated management system established by the operating organization.

2.7. The ageing management activities should be planned and performed, and their results recorded, in accordance with approved procedures and instructions, which should be included in the documentation of the management system for ageing management.

2.8. Successful implementation of the ageing management programme requires:

- (a) Planning and prioritization of work;
- (b) Addressing all relevant regulatory requirements, codes and standards;
- (c) Addressing the requirements derived from the operational limits and conditions, and from the safety analysis report;
- (d) Ensuring the availability of spare parts, special tools and equipment;
- (e) Following up inspection and test results in a timely fashion;
- (f) Ensuring the provision of qualified personnel with suitable skills;
- (g) Establishing appropriate operating procedures following relevant standards, including procedures for assessing and correcting non-conforming items;
- (h) Identifying, disseminating and using information on good practices from designers, manufacturers and other operating organizations;
- (i) Performing and adequately documenting the required inspections and tests;