

IAEA Safety Standards

for protecting people and the environment

Maintenance, Testing, Surveillance and Inspection in Nuclear Power Plants

Specific Safety Guide

No. SSG-74



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IAEA SAFETY STANDARDS

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

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

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

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

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Reports on safety in nuclear activities are issued as **Safety Reports**, which provide practical examples and detailed methods that can be used in support of the safety standards.

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Security related publications are issued in the **IAEA Nuclear Security Series**.

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MAINTENANCE, TESTING,
SURVEILLANCE AND INSPECTION
IN 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-74

MAINTENANCE, TESTING, SURVEILLANCE AND INSPECTION IN NUCLEAR POWER PLANTS

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

by Rafael Mariano Grossi
Director General

The IAEA's Statute authorizes it to "establish...standards of safety for protection of health and minimization of danger to life and property". These are standards that the IAEA must apply to its own operations, and that States can apply through their national regulations.

The IAEA started its safety standards programme in 1958 and there have been many developments since. As Director General, I am committed to ensuring that the IAEA maintains and improves upon this integrated, comprehensive and consistent set of up to date, user friendly and fit for purpose safety standards of high quality. Their proper application in the use of nuclear science and technology should offer a high level of protection for people and the environment across the world and provide the confidence necessary to allow for the ongoing use of nuclear technology for the benefit of all.

Safety is a national responsibility underpinned by a number of international conventions. The IAEA safety standards form a basis for these legal instruments and serve as a global reference to help parties meet their obligations. While safety standards are not legally binding on Member States, they are widely applied. They have become an indispensable reference point and a common denominator for the vast majority of Member States that have adopted these standards for use in national regulations to enhance safety in nuclear power generation, research reactors and fuel cycle facilities as well as in nuclear applications in medicine, industry, agriculture and research.

The IAEA safety standards are based on the practical experience of its Member States and produced through international consensus. The involvement of the members of the Safety Standards Committees, the Nuclear Security Guidance Committee and the Commission on Safety Standards is particularly important, and I am grateful to all those who contribute their knowledge and expertise to this endeavour.

The IAEA also uses these safety standards when it assists Member States through its review missions and advisory services. This helps Member States in the application of the standards and enables valuable experience and insight to be shared. Feedback from these missions and services, and lessons identified from events and experience in the use and application of the safety standards, are taken into account during their periodic revision.

I believe the IAEA safety standards and their application make an invaluable contribution to ensuring a high level of safety in the use of nuclear technology. I encourage all Member States to promote and apply these standards, and to work with the IAEA to uphold their quality now and in the future.

THE IAEA SAFETY STANDARDS

BACKGROUND

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

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

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

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

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

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

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property, and to provide for their application.

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

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

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

Safety Fundamentals

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

Safety Requirements

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

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

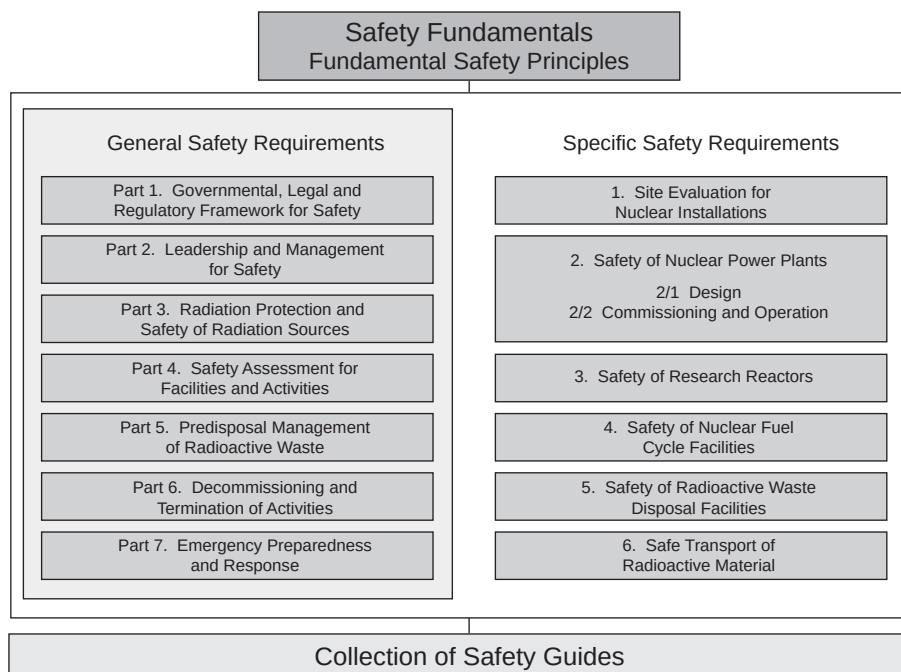


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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 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.

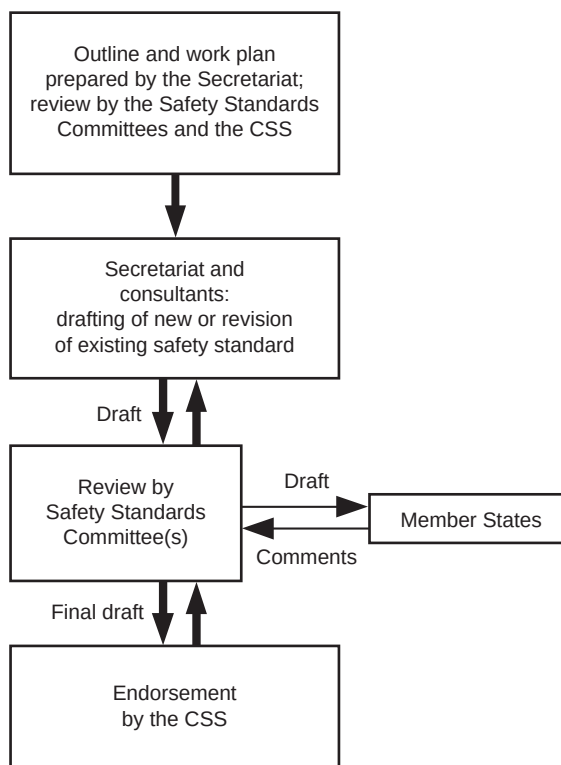


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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 <https://www.iaea.org/resources/safety-standards/safety-glossary>). 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. Requirements for the operation of nuclear power plants are established in IAEA Safety Standards Series No. SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation [1], while requirements for the design of nuclear power plants are established in IAEA Safety Standards Series No. SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design [2].

1.2. This Safety Guide provides specific recommendations on maintenance, testing, surveillance and inspection activities — hereinafter collectively referred to as ‘MTSI activities’ — to ensure that the levels of reliability and availability of all structures, systems and components (SSCs) important to safety remain in accordance with the assumptions and intent of the design, and also that the safety of the plant is not adversely affected after the commencement of operation.

1.3. This Safety Guide was developed in parallel with six other Safety Guides on the operation of nuclear power plants, as follows:

- IAEA Safety Standards Series No. SSG-70, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants [3];
- IAEA Safety Standards Series No. SSG-71, Modifications to Nuclear Power Plants [4];
- IAEA Safety Standards Series No. SSG-72, The Operating Organization for Nuclear Power Plants [5];
- IAEA Safety Standards Series No. SSG-73, Core Management and Fuel Handling for Nuclear Power Plants [6];
- IAEA Safety Standards Series No. SSG-75, Recruitment, Qualification and Training of Personnel for Nuclear Power Plants [7];
- IAEA Safety Standards Series No. SSG-76, Conduct of Operations at Nuclear Power Plants [8].

A collective aim of this set of Safety Guides is to support the fostering of a strong safety culture in nuclear power plants.

1.4. The terms used in this Safety Guide are to be understood as defined and explained in the IAEA Safety Glossary [9].

1.5. This Safety Guide supersedes IAEA Safety Standards Series No. NS-G-2.6, Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants¹.

OBJECTIVE

1.6. The purpose of this Safety Guide is to provide recommendations on MTSI activities in nuclear power plants, in order to meet Requirements 28, 31 and 32 of SSR-2/2 (Rev. 1) [1]. These activities are necessary to ensure that SSCs are available to perform their functions in accordance with the assumptions and intent of the design. Recommendations are also provided on maintaining equipment qualification and on MTSI activities, in order to meet Requirements 13 and 31 of SSR-2/2 (Rev. 1) [1], respectively.

1.7. The recommendations provided in this Safety Guide are aimed primarily at operating organizations of nuclear power plants and regulatory bodies.

SCOPE

1.8. It is expected that this Safety Guide will be used primarily for land based stationary nuclear power plants with water cooled reactors designed for electricity generation or for other production applications (such as district heating or desalination).

1.9. This Safety Guide covers the establishment and implementation of preventive and corrective maintenance programmes; testing, surveillance and inspection; the repair of defective plant equipment; the provision of related facilities and equipment; procurement; and generating and retaining records of maintenance activities.

1.10. Detailed technical advice in relation to particular items of plant equipment is outside the scope of this Safety Guide.

1.11. Regulatory inspection (i.e. an inspection undertaken by or on behalf of the regulatory body) is outside the scope of this Safety Guide.

¹ INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-2.6, IAEA, Vienna (2002).

STRUCTURE

1.12. Recommendations relating to maintenance, testing, surveillance and inspection are provided in Section 2. Section 3 provides recommendations on the functions and responsibilities of the operating organization, contractors and design and manufacturing organizations. Section 4 provides recommendations on the organizational aspects and administrative procedures for establishing programmes of MTSI activities. Sections 5 and 6 provide recommendations on the implementation of such programmes and on the analysis of results and operating experience. Sections 7, 8, 9 and 10 provide recommendations on specific aspects of MTSI activities that need to be given special consideration.

2. MAINTENANCE, TESTING, SURVEILLANCE AND INSPECTION PROGRAMMES AT NUCLEAR POWER PLANTS

2.1. Paragraph 8.1 of SSR-2/2 (Rev. 1) [1] states:

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

MAINTENANCE

2.2. The maintenance programme for a nuclear power plant should include all the administrative and technical measures that are necessary to detect and mitigate the degradation of a functioning SSC or to restore to an acceptable level the performance of design functions of a failed SSC.

2.3. The plant maintenance programme should also address the safety provisions for accident conditions (with or without significant fuel degradation) and

the systems and equipment that could be necessary to respond to an accident, including a severe accident. The operating organization is specifically required to establish maintenance programmes for non-permanent equipment to be used for accidents more severe than design basis accidents, in order to maintain high reliability of this equipment (see para. 8.14A of SSR-2/2 (Rev. 1) [1]).

2.4. The purpose of maintenance activities is also to enhance the reliability of the equipment at the plant.

2.5. The maintenance activities within the maintenance programme include testing and calibration, inspection, servicing, overhaul, and repair and replacement of parts, as appropriate.

Types of maintenance

2.6. While there are various conceptual approaches to maintenance, the relevant activities should be divided into preventive maintenance and corrective maintenance.² Many maintenance activities are performed while the plant is shut down; however, maintenance may be performed during power operation provided that adequate defence in depth and redundancy are maintained, taking into account risk considerations and the results of probabilistic safety assessment as appropriate (see para. 8.13 of SSR-2/2 (Rev. 1) [1]).

2.7. Preventive maintenance should include periodic, predictive and planned maintenance activities performed before the failure of an SSC, as follows:

- (a) Periodic maintenance activities should be performed on a routine basis and should include a combination of external inspections, alignments or calibrations, internal inspections, overhauls, and replacements of components or equipment, as appropriate.
- (b) Predictive (condition based) maintenance should involve continuous or periodic monitoring and diagnosis in order to predict equipment failure. Not all equipment conditions and failure modes can be monitored; therefore, predictive maintenance activities should be selectively applied, where appropriate. Such activities include condition monitoring, reliability centred maintenance and similar techniques.

² Various categorizations may be applied to maintenance activities. For example, the IAEA Safety Glossary [9] includes definitions for corrective maintenance, periodic maintenance, planned maintenance, predictive maintenance, preventive maintenance and reliability centred maintenance.

- (c) Planned maintenance activities should be performed before unacceptable degradation or equipment failure occurs and should be initiated on the basis of results of predictive or periodic maintenance, vendor recommendations or operating experience.

2.8. Corrective maintenance includes repair, overhaul or replacement to restore the capability of a failed SSC to perform its defined function.

Systematic approach to maintenance

2.9. The approach to preventive maintenance activities for SSCs important to safety should include the following elements:

- (a) A systematic evaluation of the purpose and functions of each SSC, to determine the relevant safety requirements and the necessary maintenance activities;
- (b) A focus on long term maintenance objectives, and the establishment of a proactive (as opposed to a reactive) maintenance programme;
- (c) A reliability centred approach to maintenance;
- (d) Planning and scheduling of maintenance on the basis of the objectives of the overall maintenance programme.

2.10. A systematic evaluation should be undertaken to establish which maintenance tasks are to be performed on which SSCs, and at what intervals, in order to optimize the use of resources allocated for maintenance and to ensure the safety and availability of the plant. In addition to maintenance based on a predetermined time interval, the maintenance activities should also be undertaken on the basis of the condition of SSCs, in order to ensure their ability to perform their safety functions. This approach should be used in establishing a preventive maintenance programme and for optimization of the ongoing maintenance programme. Condition monitoring should also be used to determine where unnecessary maintenance work and failures induced by errors in maintenance can be avoided. If a probabilistic safety assessment has been performed, its results should be taken into account.

2.11. Programmes of maintenance activities should be optimized such that the available resources are sufficient to maintain the safe operation of the plant and that they are efficiently deployed in the best way. The operating organization should ensure that this optimization process does not adversely affect the safety of the plant.

2.12. The operating organization should monitor the performance and/or condition of SSCs against the goals it has established, in order to provide reasonable assurance that the SSCs are capable of performing their intended functions. Such goals should comply with regulatory requirements and, where practicable, industry-wide operating experience should be taken into account. When the performance or condition of an SSC does not meet the established goals, appropriate corrective actions should be taken.

2.13. An adequate condition monitoring programme should be established in support of the maintenance programme and should be based on the following assumptions:

- (a) The monitored parameters are appropriate indicators of the condition of the SSCs;
- (b) Acceptance criteria are clearly defined;
- (c) All potential failure modes are addressed;
- (d) The behaviour of the potential failure is traceable and predictable.

2.14. The scope of the condition monitoring programme should include the following:

- (a) SSCs that ensure operation of the plant within the established operational limits and conditions, or whose failure could challenge a safety function.
- (b) SSCs that are relied on to remain functional following a design basis accident to ensure the continued performance of safety functions, or whose failure could prevent safety related SSCs from performing their functions.
- (c) SSCs that are used in emergency operating procedures or are relied on to mitigate the consequences of transients or accidents. Further recommendations are provided in IAEA Safety Standards Series No. SSG-54, Accident Management Programmes for Nuclear Power Plants [10].

2.15. For predictive maintenance, diagnostic methods and techniques should be used in support of a condition monitoring programme. The following tools should be considered for use in a condition monitoring programme:

- (a) Vibration monitoring;
- (b) The shock pulse method;
- (c) Oil analysis;
- (d) Wear debris analysis and ferrography;
- (e) Acoustic leakage monitoring;
- (f) Thermography;

- (g) Computer modelling for analysis of erosion and corrosion;
- (h) Motor analysis techniques;
- (i) Motor operated valve testing;
- (j) Cable condition monitoring;
- (k) Fault detection;
- (l) Noise analysis;
- (m) Visual inspection;
- (n) Performance monitoring;
- (o) Specific non-destructive testing methods (e.g. radiography, ultrasound, ground penetrating radar);
- (p) Chemical analysis;
- (q) Petrography (for civil engineering structures).

2.16. Paragraph 8.7 of SSR-2/2 (Rev. 1) [1] states:

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

Any changes intended to optimize maintenance programmes should be analysed to assess the effects of the changes on system availability and the overall risks to the plant in all operational states and in accident conditions.

2.17. A periodic review of maintenance programmes should be performed and should incorporate operating experience, including new failure modes and data. In the review, attention should be paid to maintaining the necessary reliability of SSCs and adequate safety margins. Probabilistic safety assessment methods should be considered to monitor the impact of changes in maintenance and testing strategies, provided that the model used is sufficiently comprehensive, and that adequate data on any changes to the reliability of SSCs are available.

2.18. See also paras 8.1–8.7 on the prioritization of maintenance activities.

SURVEILLANCE

2.19. Paragraph 8.2 of SSR-2/2 (Rev. 1) [1] states:

“The operating organization shall establish surveillance programmes for ensuring compliance with established operational limits and conditions and

for detecting and correcting any abnormal condition before it can give rise to significant consequences for safety.”

The abnormal conditions that are of relevance to the surveillance programme include deficiencies in SSCs and in software performance, procedural errors and human errors, as well as abnormal trends within the accepted limits, an analysis of which may indicate that the plant is deviating from the design intent.

2.20. The surveillance programme should verify that SSCs important to safety are ready to operate at all times and are able to perform their safety functions as intended in the design. Such a surveillance programme will also help to detect trends in ageing in support of the ageing management programme at the plant (see Requirement 14 of SSR-2/2 (Rev. 1) [1]).

2.21. The surveillance programme should include the following activities:

- (a) Monitoring plant parameters and system status;
- (b) Functional testing;
- (c) Checking and calibrating instrumentation;
- (d) Testing and inspecting SSCs important to safety;
- (e) Evaluating the results of these activities and identifying trends.

INSPECTION

2.22. Over the operating lifetime of the plant, the operating organization should inspect SSCs for possible degradation so as to determine whether they are acceptable for continued safe operation or whether corrective actions should be taken. Emphasis should be placed on inspection of the pressure boundaries of the primary and secondary coolant systems, because of their importance to safety and the potentially severe consequences of their failure.

2.23. Baseline data should be collected for future use. These data are normally collected in the pre-service inspections before the start of plant operation, including inspections performed during manufacturing, whenever applicable. Baseline data provide information on initial conditions and supplement data from manufacturing and construction to provide a basis for comparison with the data from subsequent inspections. In the pre-service inspections, the methods, techniques and types of equipment used should be the same as those planned to be used for the in-service inspections. Whenever an SSC has been repaired

or replaced, a pre-service inspection should be performed before it is put into operation (see also para. 8.10 of SSR-2/2 (Rev. 1) [1]).

2.24. When new inspection methods are introduced, a comparison with the previous methods should be made to provide a revised baseline for future inspections. If a risk-informed approach is used for in-service inspection, it should be ensured that such an approach in no way leads to a reduction in the level of safety at the plant.

TESTING

2.25. Testing includes post-maintenance testing, surveillance testing and inspection testing, as appropriate. The purpose of the tests is to confirm that SSCs continue to meet the design intent. In this Safety Guide, testing is addressed in the sections on maintenance, surveillance and inspection. Further recommendations on testing are provided in IAEA Safety Standards Series No. GS-G-3.5, The Management System for Nuclear Installations [11].

INTERRELATIONSHIP BETWEEN MAINTENANCE, TESTING, SURVEILLANCE AND INSPECTION

2.26. Maintenance, testing, surveillance and inspection have the common objective of ensuring that the plant is operated in accordance with the design assumptions and intent, and in compliance with the operational limits and conditions. Results of surveillance or inspection should be compared with acceptance criteria. If the results fall outside the acceptance criteria, corrective actions should be initiated. Such actions should include corrective maintenance measures such as adjustment, repair or replacement of defective items to prevent recurrence. Maintenance should always be followed by testing.

2.27. MTSI activities should be planned and coordinated effectively. A maintenance database should be established in order to share relevant data, results and evaluations among the organizations involved in the planning and implementation of MTSI activities.

3. RESPONSIBILITIES FOR MAINTENANCE, TESTING, SURVEILLANCE AND INSPECTION ACTIVITIES AT NUCLEAR POWER PLANTS

THE OPERATING ORGANIZATION

3.1. Requirement 31 of SSR-2/2 (Rev. 1) [1] states that **“The operating organization shall ensure that effective programmes for maintenance, testing, surveillance and inspection are established and implemented.”** These programmes should be established prior to fuel loading, and full details of the programmes should be made available to the regulatory body. Operational limits and conditions are required to be taken into account in such programmes (see paras 8.2, 8.10, 8.14 and 8.19 of SSR-2/2 (Rev. 1) [1]). The operating organization should review the programmes of MTSI activities, as necessary, taking into account operating experience and recent scientific and technological advances.

3.2. The operating organization should ensure that the scope and frequency of MTSI activities are sufficient to ensure that the reliability and functionality of SSCs remain in accordance with the design assumptions and intent throughout the operating lifetime of the plant (see also para. 8.5 of SSR-2/2 (Rev. 1) [1]).

3.3. Paragraph 8.13 of SSR-2/2 (Rev. 1) [1] states:

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

The operating organization should also ensure that the programmes of MTSI activities for SSCs important to safety are based on maintaining the independence of each level of defence in depth and an adequate reliability of each level during operation. The influence of human and organizational factors on one or more levels of defence in depth should be taken into account in all MTSI activities, to avoid any negative impact on the reliability of these levels or on the independence of the levels.

3.4. MTSI activities are required to be performed in accordance with properly approved procedures that have been prepared in accordance with the management system (see para. 8.3 of SSR-2/2 (Rev. 1) [1]). Such procedures should be prepared

by competent personnel. In addition, adequate independent safety assessments and verifications should be performed for different MTSI activities, to ensure that such activities are reliably completed.

3.5. The operating organization should periodically evaluate the condition and performance of SSCs. The operating organization should also periodically review these monitoring activities in relation to the goals of the programmes of MTSI activities. In doing this, the operating organization should take into account — and, where practicable, contribute to sharing — operating experience within the nuclear industry. Adjustments should be made, as necessary, to ensure that the objective of preventing failures of SSCs by means of MTSI activities is appropriately balanced against the objective of minimizing the unavailability of those SSCs due to performing these activities. An assessment of all plant equipment that is out of service should be made, and the overall effect of this unavailability on the performance of safety functions should be determined and taken into account.

CONTRACTORS

3.6. The operating organization may delegate the implementation of one or more MTSI activities to other organizations, but it is required to retain overall responsibility for the safety of such delegated work (see para. 3.1 of SSR-2/2 (Rev. 1) [1] and para. 4.33 of IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [12]).

3.7. The operating organization should ensure that an effective group or department is established for MTSI activities, which should perform the administrative, technical and supervisory functions necessary in mobilizing and supervising on-site and off-site resources for MTSI activities.

3.8. Staff of vendors and contractors should be subject to the same expectations as personnel employed by the operating organization, particularly in the areas of professional competence, adherence to procedures and evaluation of performance. Suitable arrangements are required to be made to ensure that contractors adhere to safety requirements and meet the operating organization's expectations with regard to the safe conduct of MTSI activities (see para. 4.3 of SSR-2/2 (Rev. 1) [1] and para. 4.36 of GSR Part 2 [12]).

3.9. Activities performed by contractors and other personnel who are not permanent employees of the operating organization should be controlled by

means of an established management system (see IAEA Safety Standards Series No. GS-G-3.1, Application of the Management System for Facilities and Activities [13] and GS-G-3.5 [11]). The management system should cover the training and qualification of contractor personnel (see para. 4.23 of GSR Part 2 [12] and para. 4.20 of SSR-2/2 (Rev. 1) [1]), radiation protection, familiarity with and adherence to procedures, understanding of plant systems and associated administrative procedures for operational states and for accident conditions, as appropriate.

3.10. Contractor personnel should be made aware of their responsibilities in relation to the safety of the plant and the equipment they maintain; however, this does not diminish the prime responsibility of the operating organization for plant safety. The operating organization is required to ensure that the contractors' work is of the necessary quality (see para. 4.34 of GSR Part 2 [12]). A formal system for evaluating and documenting the performance of contractors should be established.

3.11. The operating organization should ensure that contractors selected for specific safety related work provide documentary evidence that their staff have the appropriate training and qualification and, where appropriate, the necessary authorizations (see para. 4.16 of SSR-2/2 (Rev. 1) [1]) or certification (e.g. for some categories of welders). This information should be obtained prior to involvement of contractor personnel in maintenance activities. In addition, confirmation of relevant experience in performing similar work should be requested from the contractor.

3.12. The operating organization should contain an adequate number of personnel who possess the knowledge, training and skills necessary to select, supervise and evaluate the work of contractors and temporary support staff. Such personnel should be clearly identified within the operating organization's management system.

OTHER ORGANIZATIONS, INCLUDING DESIGNERS AND MANUFACTURERS

3.13. The operating organization should maintain a close relationship with designers and manufacturers throughout the lifetime of the plant, to ensure that the programmes of MTSI activities are based on a clear understanding of the design philosophy and the manufacturer specifications, and to facilitate and optimize MTSI activities. It is essential that, if plant faults occur or modifications are necessary, effective and timely assistance from the design or manufacturing

organization is ensured. Design and manufacturing organizations can also contribute effectively to the training of staff of the operating organization.

3.14. The operating organization should arrange for feedback of operating experience and reliability data to designers and manufacturers.

COORDINATION BETWEEN DIFFERENT ORGANIZATIONS

3.15. Coordination is required to be maintained between different groups involved in or affected by MTSI activities (see para. 8.11 of SSR-2/2 (Rev. 1) [1]). There should be a clear understanding of the division of responsibilities between all organizational groups participating in MTSI activities (see also paras 5.45–5.49). In particular, the interface between the operating organization and contractors should be clearly specified, with clear arrangements for the control of plant configuration (see Requirement 10 of SSR-2/2 (Rev. 1) [1]) to ensure safety during and after the contracted work.

3.16. Further recommendations on managing the interfaces between different organizations are provided in GS-G-3.1 [13] and GS-G-3.5 [11].

4. ORGANIZATIONAL ASPECTS OF MAINTENANCE, TESTING, SURVEILLANCE AND INSPECTION ACTIVITIES AT NUCLEAR POWER PLANTS

4.1. The design and the design objectives of a nuclear power plant will have a strong influence on the programmes of MTSI activities; consequently, the development of these programmes should be initiated early in the design phase. These programmes should be taken into account in the final design and construction specifications, and in the safety analysis report for the plant. The operating organization should arrange for experienced personnel to consult regularly with the designers of the plant.

4.2. The goals, objectives and priorities of the programmes of MTSI activities should be defined. These should be consistent with the strategy, policies and programmes of the plant and should be communicated to operating personnel. Appropriate safety performance indicators (see para. 4.34 of SSR-2/2 (Rev. 1) [1])

should be established and used to monitor and enhance the quality of MTSI activities. Senior management should encourage effective and high quality performance of MTSI activities. Results and feedback from the performance of MTSI activities should be reviewed and used in establishing goals and objectives for future MTSI activities.

4.3. The programmes of MTSI activities should be fully integrated with activities for plant operation and for modification of the plant. The programmes should be routinely reviewed and updated as necessary to take into account on-site and off-site operating experience, modifications to the plant or its operating regime, plant ageing, and methods (both deterministic and probabilistic) for safety assessment.

4.4. Documentation and records associated with MTSI activities are required to be kept (see paras 4.52 and 8.4 of SSR-2/2 (Rev. 1) [1]). Procedures for MTSI activities are required to be prepared, reviewed, modified, validated, approved and distributed in accordance with the management system (see para. 8.3 of SSR-2/2 (Rev. 1) [1]).

4.5. If a plant previously operating at base load is modified to allow a load following operating regime as part of the plant modification programme (see Requirement 11 of SSR-2/2 (Rev. 1) [1]), the operating organization should address the implications for the programmes of MTSI activities. Any MTSI activities that involve performance in steady state conditions should be re-evaluated and carefully incorporated into the new operating regime. This should include changes to the monitoring and maintenance schedules, as appropriate. The impact of the load following operating regime on ageing assessments and other supporting engineering analyses should also be evaluated and addressed by the operating organization.

4.6. The operating organization is required to ensure suitable organizational arrangements and sufficient numbers of suitably qualified and experienced personnel for the programmes of MTSI activities (see Requirements 3 and 4 of SSR-2/2 (Rev. 1) [1]). This includes MTSI activities during outages and supervision of the work of contractors, as appropriate.

4.7. In planned shutdowns or during reduced power operations the opportunity should be taken to undertake MTSI activities, where appropriate. In the event of an unplanned shutdown, it should be considered whether it would be useful to undertake MTSI activities. Refuelling activities should be taken into account in

the schedules for MTSI activities. Suitable schedules for MTSI activities should be prepared for unplanned shutdowns as well as for planned shutdowns.

4.8. Control room operators are directly responsible for the day to day safe operation of the plant, including its continued configuration control. Control room operators should be informed (e.g. by means of a work permit procedure) of all MTSI activities before they are commenced, of any changes to the plant that this work entails, and of the return of plant systems into service (see also para. 8.10 of SSR-2/2 (Rev. 1) [1]). During the performance of such activities, adequate communication should be maintained between the relevant personnel and control room operators.

4.9. Supplementary work in the plant (e.g. cleaning, painting, erection of scaffolding, installation of temporary lead shielding), and any work outside the plant (e.g. construction, excavation or dredging near the coolant water intake) that might affect safety, should only be performed if approved by the managers of the operations department (see SSG-76 [8]). The operations department should be notified of the commencement of such activities and informed about any changes to the planned work.

4.10. A specific safety review and special procedures are required for non-routine maintenance activities (e.g. infrequently performed activities, unforeseen repairs, activities not covered by typical maintenance procedures) (see para. 4.27 of SSR-2/2 (Rev. 1) [1]). Specific attention should be paid to the coordination and scheduling of such activities. Any non-routine maintenance activities should be carefully planned and prepared and their potential consequences reviewed, with special emphasis on safety and compliance with regulatory requirements.

4.11. The level of surveillance and maintenance necessary in the transitional phase prior to decommissioning should be determined on the basis of the changes in the safety analysis report. For example, the revised safety analysis could indicate that it is acceptable to cease or reduce the frequency of some MTSI activities. Alternatively, for systems that support decommissioning activities (e.g. ventilation), MTSI activities may need to increase. An important objective during this transition should be to effectively maintain an appropriate surveillance and maintenance regime that links with both the previous operational phase and the decommissioning phase (see also para. 9.6 of SSR-2/2 (Rev. 1) [1]).

ORGANIZATIONAL STRUCTURE

4.12. To establish the organizational structure for MTSI activities, the following should be taken into consideration:

- (a) The operating organization's policy and practices for the conduct of operations (see SSG-76 [8]);
- (b) The type of reactor;
- (c) The refuelling mode;
- (d) The frequency of periodic outages.

4.13. The operating organization is required to assign authorities and responsibilities for MTSI activities, both within its own organizational structure and to other organizations (see para. 4.11 of GSR Part 2 [12] and (for outages) para. 8.21 of SSR-2/2 (Rev. 1) [1]). Lines of communication should also be specified.

4.14. The operating organization is required to make available sufficient resources in terms of personnel and equipment to implement the appropriate programmes of MTSI activities satisfactorily (see Requirement 9 of GSR Part 2 [12]).

4.15. The operating organization should ensure the timely conduct of MTSI activities, their documentation and reporting, and the evaluation of results. Any deviation from the established frequency and extent of these activities should be justified, reviewed and reported to the regulatory body, as appropriate.

4.16. The detailed organizational structure for MTSI activities should be determined on the basis of the types of personnel used; that is, in terms of plant personnel, corporate level personnel, suppliers and contractors (see also para. 4.22 of GSR Part 2 [12]). The use of human resources should take into account factors such as the type of plant, the number of reactors on the site, the mode of operation of the reactors, the availability of suitable staff locally and any regulatory requirements relating to the employment of off-site personnel.

4.17. In plants designed for on-load refuelling, refuelling activities are routine and frequent and are usually performed by operating personnel. The organizational structure for MTSI activities in plants of this type should be designed to ensure that there are sufficient operating personnel to deal effectively with a steady flow of maintenance, testing, surveillance and inspection work, with minimal assistance from off the site.