Technical Safety Review (TSR) Service guidelines

Periodic Safety Review (PSR)

IAEA Working Document

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Foreword

The IAEA's Technical Safety Review (TSR) peer review service supports the enhancement of nuclear safety for nuclear power plants and is based entirely on the IAEA safety standards. The service addresses the needs of Member States at most stages of development and implementation of a nuclear power programme, including the conceptual design, pre-licensing and licensing phases, nuclear power plant construction, operation and plant modifications including periodic safety reviews and lifetime extension. The TSR peer review service encompasses six technical subject areas: accident management, design safety, national safety requirements, generic reactor safety, periodic safety review and probabilistic safety assessment. A major outcome is recommendations to enhance nuclear safety in areas that may need improvements to adhere to the IAEA safety standards.

The Technical Safety Review of Periodic Safety Review (TSR-PSR) is conducted to review the periodic safety review programme against the IAEA General Safety Requirements on Safety Assessment for Facilities and Activities (IAEA Safety Standards Series No. GSR Part 4 (Rev.1)) and Specific Safety Requirements on Safety of Nuclear Power Plants: Commissioning and Operation (IAEA Safety Standards Series No. SSR-2/2 (Rev. 1)) supported by the Safety Guide on Periodic Safety Review of Nuclear Power Plants (IAEA Safety Standards Series No. SSG-25). Over the years, SSG-25 has been substantially enlarged and provides more comprehensive guidance to the Member States on how to conduct a periodic safety review of their nuclear facilities.

The TSR peer review service provides assistance to regulatory bodies, plant operating organizations, vendors and technical support organizations in their technical evaluations as well as in the development of national safety requirements. After a formal request to the IAEA, the TSR peer review service is prepared and provides a tailored, independent evaluation of the safety documentation submitted to the IAEA.

These TSR-PSR review guidelines were developed with the objective of providing a consolidated basis for the services provided by the IAEA to Member States and they aim to streamline, harmonize and formalize the process of conducting TSRs. These review guidelines can also be used to support the review of PSR programme or its elements within the OSART and SALTO peer review services.

Contents

1. Introduction

1.1 Background

IAEA Service Series No. 41 [1] have been prepared to provide a basic structure and common approach to the terms of reference across the various technical subject areas covered by a technical safety review (TSR) peer review service. Ref. [1] provides a basic structure and common approach to the terms of reference across the various technical subject areas covered by a TSR peer review – and they provide guidance on how to prepare for and conduct a TSR peer review service, and are addressed to:

- The Member State and/or organization requesting the TSR peer review (the Requesting Party);
- The technical team members of the TSR peer review.

TSRs address specific technical or regulatory aspects to assess whether they are consistent with the IAEA safety standards.

The Technical Safety Review of Periodic Safety Review (TSR-PSR) is conducted to review the periodic safety review programme against the IAEA General Safety Requirements on Safety Assessment for Facilities and Activities (IAEA Safety Standards Series No. GSR Part 4 (Rev.1)), Ref. [2] and Specific Safety Requirements on Safety of Nuclear Power Plants: Commissioning and Operation (IAEA Safety Standards Series No. SSR-2/2 (Rev. 1)), Ref. [3] supported by the Safety Guide on Periodic Safety Review of Nuclear Power Plants (IAEA Safety Standards Series No. SSG-25), Ref. [4].

The PSR is a comprehensive and systematic safety review of all important aspects of safety, carried out at regular intervals, typically every ten years. PSR is considered an effective way to obtain an overall view of actual plant safety, and to determine reasonable and practicable modifications that should be made in order to ensure that a high level of safety is maintained during continued operation.

PSR can also be used to identify life limiting features of the plant in order to determine if there is a need to modify, refurbish or replace certain SSCs for the purpose of extending the operating lifetime of the nuclear power plant.

According to the Requirement 12 of Ref. [3], a systematic safety assessment of the plant, in accordance with the regulatory requirements, shall be performed by the operating organization throughout the plant's operating lifetime, with due account taken of operating experience and significant new safety related information from all relevant sources. The IAEA Specific Safety Guide on Periodic Safety Review of Nuclear Power Plants [4] provides recommendations and guidance on the conduct of a PSR for an existing nuclear power plant.

The PSR may be used in support of the decision-making process for licence renewal or long-term operation, or for restart of a nuclear power plant following a prolonged shutdown. As the typical interval between PSRs is ten years, this means that the third or fourth PSR will possibly evaluate the safety factors related to operation beyond the original planned or licensed lifetime, usually referred to as 'long term operation' (LTO). For example, the scope of the safety factor relating to ageing need to be expanded to include an evaluation of the safety analyses with time limited assumptions and assessments of ageing effects. In the review, increased importance is given to ageing mechanisms and ageing management programmes. Long term operation has to be justified by safety assessment, with consideration given to the life limiting processes and features of structures, systems and components (SSCs) important to safety.

The IAEA TSR-PSR service intends to assist Requesting Party in establishing, implementing and regulatory supervision of PSR programme to assure high level of safety of nuclear facilities throughout the following period of operation (typically next 10 years).

1.2 Objective

The key objectives of the TSR-PSR service are to provide the Requesting Party with:

- An objective review of the documentation presented to the technical team with respect to the IAEA safety standards;
- An opportunity to review its conformance with the IAEA Safety Standards by conducting a self-assessment and identify possible self-identified issues during the preparation phase prior to the mission;
- Recommendations in those areas needing improvements to be consistent with the IAEA safety standards;
- An objective assessment of the status of ageing management and the preparedness for LTO with respect to the IAEA Safety Standards.
- An opportunity of key staff of the Requesting Party to discuss their practices with experts who have experience in the same field;
- An opportunity to broaden their experience and knowledge of their own field;
- Information regarding good practices identified in the course of TSR-PSR reviews.

1.3 Scope

This publication provides detailed technical review guidelines on a specific technical subject area provided in Section 3.6 of Ref. [5] on periodic safety review (PSR).

The subject of the review could be focused on the following subjects:

- PSR methodology documentation (PSR Bases Document and review criteria);
- Results of the review of particular safety factors;
- Global assessment.

Where PSR is used in support decision making process for long term operation, the review should pay particular attention to the following plant programmes and documentation, as these are of significant importance for continued safe operation:

- Plant programmes to support the safety factors relating to plant design, the actual condition of SSCs important to safety, equipment qualification and ageing;
- A management system that addresses quality management and configuration management;
- Safety analyses involving time limiting assumptions relating to the proposed lifetime;
- Programmes for promoting safety culture focused on the pursuit of excellence in all aspects of safety management and human factors.

1.4 Structure

Section 2 provides a framework for conducting the TSR-PSR review service. Section 3 provides detailed review guidelines for the review of PSR programme, methodology, safety factors and global assessment. Section 4 describes documentation of the review results. Appendix provides an example of a review sheet.

2. Conduct of the TSR-PSR review service

2.1 Support to different PSR project phases

The overall process for undertaking the PSR for a nuclear facility consist of parallel but independent activities of the operating organizations and of the regulatory body. The PSR project is a human resource and time-consuming project, involving many technical disciplines, which typically requires several years to complete.

The TSR-PSR service can support different PSR project phases, for example:

1) During the initial phase, to conduct a training workshop that includes:
   - Development on PSR basis document, review of criteria and methodologies for evaluation of pilot safety factors;
   - Methodology for global assessment and pilot of global assessment and integrated safety improvement plan.
2) During the implementation phase, to review different topics of the PSR project, for example:
   - PSR methodology documentation (e.g. PSR bases document and review criteria);
   - Methodology and criteria for the particular safety factors;
   - Methodology for global assessment.
3) In order to support a decision making process for long term operation, the review should pay particular attention to the following plant programmes and documentation, as these are of significant importance for continued safe operation:
   - Plant programmes to support the safety factors relating to plant design, the actual condition of SSCs important to safety, equipment qualification and ageing;
   - A management system that addresses quality management and configuration management;
   - Safety analyses involving time limiting assumptions relating to the proposed lifetime;
   - Programmes for promoting safety culture focused on the pursuit of excellence in all aspects of safety management and human factors.

2.2 Scope of the review

Reference [4] recommends that PSR programme includes a comprehensive review of the 14 safety factors that are grouped in five topical areas as follows:

Safety factors relating to the plant

1) Plant design;
2) Actual condition of structures, systems and components (SSCs) important to safety;
3) Equipment qualification;
4) Ageing.

Safety factors relating to safety analysis

5) Deterministic safety analysis;
6) Probabilistic safety assessment;
7) Hazard analysis.

Safety factors relating to performance and feedback of experience

8) Safety performance;
9) Use of experience from other plants and research findings.

Safety factors relating to management

10) Organization, the management system and safety culture;
11) Procedures;
12) Human factors;
13) Emergency planning.

Safety factors relating to the environment

14) Radiological impact on the environment.

The outcome of a PSR programme is a global assessment of a nuclear facility which may identify gaps and safety issues that have to be corrected for the next PSR term. For that purpose, the operating organization prepares an integrated implementation plan of safety improvements which is subject to regulatory approval.

2.3 Documentation for review

The assessment of the PSR programme is primarily based on the review of PSR documentation. The review team may need to have access to complementary information such as relevant parts of final safety analysis report (FSAR), supporting technical documentations used to review individual safety factors, plant programmes, documentation and P&ID, records, reports as necessary.

The review is based on the PSR documentation as delivered by the Requesting Party in accordance with the schedule. The scope of PSR documentation and the date of submission will follow the process established in Ref. [1].

PSR documentation may contain large volume of information, or the documentation may contain proprietary information that is not convenient to transfer to the reviewers; in these cases the Requesting Party may provide and advanced in formation package (AIP) that contains information to allow reviewers to familiarize with the PSR project, methodology and criteria used, summary results of the review of safety factors and global assessment and a proposal for safety improvements. Reviewers will be provided with access to the full scope of documentation for review during the review mission at the site. In addition, the reviewers may be assisted by the plant personnel to provide clarification or additional information as necessary.

2.4 Review methodology

The scope of TSR-PSR service, its implementation and timing will follow the process established in Ref. [1]. In general, three methods are available to the team members in the process of the review to derive their conclusions and findings. These are:

- Review of written material;
- Discussion with counterparts during the kick-off meeting, discussion meetings and the exit meeting;
- Direct observations/walk down (where appropriate and needed).

TSR-PSR Service consists of the assessment of a number of individual topics. It is very important to precisely define what is being reviewed and against which criteria it is being judged. Therefore, a clear definition of the topic being reviewed is stated in this sub-section.

TSR-PSR service may be implemented by the technical team in their home locations and the IAEA, with a short mission to the site to allow for final discussion and presentations of review results.

Alternatively, the entire TSR-PSR service can be implemented through a review mission on site. The duration of the mission can be adjusted according to local conditions such as airport transfer times, local rules and the needs of the hosting organization but is typically 4-7 days.

2.5 References to the IAEA Safety Standards

The review is performed against the criteria provided in the IAEA Safety Standards. A set of the IAEA requirements, guides and other documents being used for this process need to be documented at the end of the evaluation of each topic.

All references for all topics should be collected and listed at the end of the Final TSR Report.

2.6 Documnetation of review results

Results of the review will be documented in review sheets (see Annex I), which will be filled in by the individual team members and handed over to the team leader. The Review Sheets will have the following structure:

- Topic/areas to be reviewed;
- Observations/Review results supported by facts;
- Reference to the IAEA Safety Standards;
- Counterpart response to the observation/review results made by the review team;
- Resolution of the review results, considering the counterpart response, by the review team.

Following delivery of the Review Sheets from the team members, the team leader will discuss with the entire team to:

- Ensure a consistent approach is followed in the development of the review sheets;
- Ensure consistency among issues and recommendations made;
- Resolve any open questions;
- Capture any cross-cutting issues.

The team leader will then take the lead in preparing the draft TSR Report with the review sheets being part of it. This report will then be given to the requesting Member State to:

- Assure that all facts are accurately captured;
- Assure that there is a common understanding of its content;
- Respond to the review observations/findings.

The Requesting Party has the opportunity to respond to each observation or comment, and those responses will be captured in the Review Sheets under the section: Counterpart response" and returned back to the IAEA team leader.

Completed review sheets will then be given by the team leader to relevant team members to complete the last section on the Review Sheet "Resolution by the review team".

The Team Leader will finalize the TSR-PSR report, capturing the review results presented in the Review Sheets. The draft TSR-PSR report will be provided to the Requesting Party for review.

The Requesting Party should then collect comments from all institutions involved in the creation of the material which was reviewed. Comments should however be limited only to the factual correctness of the written draft TSR Report. Collected comment should be sent to the IAEA shortly after the receipt of the draft TSR Report but in any case, within the agreed time frame in order to allow the IAEA to prepare the final TSR Report. The team leader will in consultation with other team members assess the comments received by the counterpart and issue the Final TSR Report two months after the receipt of the counterpart's comments or in any agreed time frame.

The Final TSR Report is submitted to the Requesting Party through the official channels with a limited distribution.

Based on the recommendations in the final TSR Report, the Requesting Party is expected to prepare an action plan to address those aspects that generated the recommendations. The progress of implementing the action plan can then be verified during a follow-up TSR (upon request from the Requesting Party).

3. Guidance for reviewers

3.1 Review of periodic safety review programme

According to Requirement 24 of Ref. [1] systematic safety assessments of the plant, in accordance with the regulatory requirements, shall be performed by the operating organization throughout the plant's operating lifetime, with due account taken of operating experience and significant new safety related information from all relevant sources.

Subjects to be reviewed:

- A PSR programme of the requesting Member State;
- Reports on the review of each safety factor;
- A report documenting the results of the global assessment;
- The final PSR report, including information on the proposed safety improvements and integrated implementation plan and a summary of the reports on safety factors and the global assessment.

A PSR should provide a comprehensive assessment of the safety of the nuclear power plant. Since the complex process of conducting a PSR can be aided by appropriate subdivision of tasks, this Safety Guide sets out these tasks in accordance with 14 safety factors. These safety factors have been selected on the basis of international experience and are intended to cover all aspects important to the safety of an operating nuclear power plant. This subdivision is, however, not unique. In cases where the number of safety factors used and/or their grouping is different (for example, to meet the specific needs of the operating organization or regulatory body or owing to particular aspects of the nuclear power plant under review), the comprehensiveness of the PSR should be ensured by other means.

The review of the PSR documentation should determine whether:

- Safety reviews are carried out at regular intervals;
- The scope of the PSR includes all safety aspects of a nuclear installation and has been agreed with the regulatory body;
- The scope of the PSR includes all facilities and SSCs on the site covered by the operating licence (including, if applicable, waste management facilities, on-site simulators, etc.) and their operation, together with the operating organization and its staff;
- Safety reviews address, in an appropriate manner, the consequences of the cumulative effects of plant ageing and plant modification, equipment requalification, operating experience, current standards, technical developments, and organizational and management issues, as well as siting aspects.
- The operating organization reports to the regulatory body as required, in a timely manner, the confirmed findings of the safety review that have implications for safety.
- The scope of the safety review includes all safety related aspects of an operating plant. To complement deterministic safety assessment, probabilistic safety assessment (PSA) can be used for input to the safety review to provide insight into the contributions to safety of different safety related aspects of the plant.
- Based on the results of the systematic safety assessment, the operating organization implements any necessary corrective actions and reasonably practicable modifications for compliance with applicable standards aiming at enhancing the safety of the plant.

References for review:

- GSR Part 4 (Rev.1), para 4.42;
- SSR 2/2, (Rev.1), paras 4.44–4.47;
- SSG-25, paras 2.12; 2.15–2.18;
- SSG-25, paras 4.1–4.28.

3.2 Review of PSR bases document

The PSR basis document is an essential instrument that governs the conduct of the PSR and the regulatory review of the PSR results. The basis document identifies the scope, major milestones, including cut-off dates (beyond which changes to codes and standards and new information will not be

considered), and methodology of the PSR, the safety factors to be reviewed, the structure of the documentation and the applicable national and international standards, codes and practices. The process for categorizing, prioritizing and resolving findings should also be agreed upon and set out in the basis document.

Documentation for review:

- PSR Bases document with applicable review criteria.

The review should verify whether:

- The process and methodology for conducting the periodic safety review is consistent with Ref. [4];
- The PSR basis document should outline or reference the project management and quality management processes to be followed in carrying out the PSR so as to ensure a complete, comprehensive, consistent and systematic approach;
- The criteria selected for the evaluation of the individual safety factors are consistent with general and specific safety requirements and supporting safety guides;
- Applicable national and international standards, codes and practices are included;
- The process for categorizing, prioritizing and resolving findings is set out in the basis document;
- All relevant operating and accident conditions, using current national and applicable international safety standards and operating practices are identified;
- The review method applied is systematic and independent of the ongoing regulatory oversight of the plant;
- A project plan identifies all the activities to be performed during the review, together with associated timelines and responsibilities
- A realistic and reasonable schedule is present for the conduct of the PSR, including sufficient allowance for completion of reviews by the regulatory body;
- The PSR takes account of existing ongoing processes, such as configuration management and ageing management, and the results of and/or trend analyses from these processes are reviewed to evaluate their effectiveness.

Reference for review:

- SSR-2/2 (Rev.1):
  - Requirement 12, para 4.44–4.45;
  - Requirement 16, para 4.54;
- SSG-48, para 4.6; 7.40;
- SSG-25, paras 4.5–4.6; 6.6–6.9.

3.3 Use of PSR for a decision making for long term operation

A periodic safety review, which relies on a systematic and comprehensive process whereby up-to-date standards and technological developments are considered to provide assurance of the continued viability of the plant's licensing basis, given the cumulative aspects of emerging national and international standards, evolving regulatory requirements, plant ageing, operating experience, and technological development. PSR thus provides an effective way to obtain an overall view of actual plant safety and the quality of the safety documentation, and to determine reasonable and practical modifications to ensure or improve safety. Specifically, the assessment for long term operation documents the following:

- The extent to which the plant conforms to modern standards and practices;
- The extent to which the (updated) licensing basis will remain valid to the end of the plant's proposed extended operating life;
- The adequacy of the arrangements that are in place to maintain plant safety for long term operation;
- The improvements to be implemented to resolve the safety issues that have been identified.

As the typical interval between PSRs is ten years, this means that the third or fourth

PSR will possibly evaluate the safety factors related to operation beyond the original planned or licensed lifetime, usually referred to as 'long term operation' (LTO).

When PSR is used to justify a decision making for LTO, the scope of the review of the safety factors should be adapted to determine the feasibility of long term operation. For example, the scope of the safety factor relating to ageing should be expanded to include an evaluation of the safety analyses with time limited assumptions and assessments of ageing effects. In the review, increased importance is given to ageing mechanisms and ageing management programmes.

Documentation for review:

The following plant programmes and documentation, as these are of significant importance for continued safe operation:

- Plant programmes to support the safety factors relating to plant design, the actual condition of SSCs important to safety, equipment qualification and ageing;
- A management system that addresses quality management and configuration management;
- Safety analyses involving time limiting assumptions relating to the proposed lifetime;
- Programmes for promoting safety culture focused on the pursuit of excellence in all aspects of safety management and human factors.

The review should verify whether:

- The scope of national and international requirements, codes and standards, as well as practices has been used in the PSR appropriate and identified in the PSR basis document [SSG-25: paras 4.6–4.9; SSG-48: para 4.6];
- The policy, principles and concept for AM and/or LTO has been adequately documented in the PSR report [SSG-25: 3.7] [SSG-48: 4.3, 5.74, 7.2, 7.7, 7.38];
- PSR provides comprehensive information on ageing management, equipment qualification and LTO (e.g. assumptions, activities, evaluations, assessments and results of the plant programme for AM, equipment qualification and LTO) [SSG-48: 4.3, 4.6-4.8, 5.73, 7.37] [SSG-25: 3.8, 5.29, 5.42-5.44, 5.49-5.51];
- The scope of PSR review identifies life limiting features of the plant in order to determine if there is a need to modify, refurbish or replace certain SSCs for the purpose of extending the operating lifetime of the nuclear power plant [SSG-25; 3.2, 3.5] [SSG-48: 1.7, 7.15, 7.40];
- PSR provides a justification of the adequacy of ageing management for the planned period of long term operation focus on safety factors 1–4 (plant design, actual condition of SSCs important to safety, equipment qualification, ageing) and considers also adequately safety factors 8, 9, and 10 (safety performance, use of experience from other plants and research findings, and management system that addresses quality management and configuration management) [SSG-25: 3.6, 3.8] [SSG-48: 4.6, 4.8];
- PSR review identifies trends of reported events and their possible connection with degradation of SSCs that would require modification of existing plant programmes so that they can be credited for LTO [SSG-25: 2.5, 5.94, 5.95] [SSG-48: 2.7, 3.35, 4.8, 5.56, 7.40];
- LTO is properly justified by safety assessment (that includes scope setting, ageing management review and revalidation of time limited ageing analysis), with consideration given to the life limiting processes and features of SSCs in scope of the evaluation [SSG-25: 3.1, 3.2, 3.6] [SSG-48: 2.30, 2.31, 5.61];
- Global assessment provides safety justification for proposed long term operation by evaluating the cumulative effects of both ageing and obsolescence on the safety and reflecting the combined effects of all safety factors (findings and proposed improvements) [SSG-25: 2.17, 4.21, 4.26-27, 6.6-6.9, 6.12, Appendix II.5] [SSG-48: 2.5, 2.30, 2.32];

- The PSR prepared (e.g. development of a “basis document”) and conducted in co-operation with the regulatory body and whether the PSR report that demonstrates safety for long term operation has been provided to the regulatory body for review and approval at a level of detail, and in a manner adequate for this purpose [SSG-25: 4.5, 4.6, 6.6-6.9] [SSG-48: 7.40];
- PSR review determines reasonable and practicable modifications to be made in order to ensure that a high level of safety is maintained during long term operation [SSG-25: 3.5, 3.6, 3.10, 4.26-4.27, 5.12, 6.6-6.9, 8.14] [SSG-48: 1.7, 7.15, 7.40].

References for review:

- GSR Part 4 (Rev.1), GSR Part 4 (Rev.1), Requirement 24;
- SSR-2/2 (Rev.1):
  - Requirement 12, paras 4.44; 4.47; 4.50;
  - Requirement 16, para 4.53.

The IAEA peer review service on safety aspects of long term operation (SALTO), Ref. [5] is recommended for a detailed review of the following areas:

- Management of physical ageing;
- Management of technological obsolescence;
- Programme for long term operation;
- Periodic safety review aspects related to ageing management and LTO justification;
- Records and reports;
- Human resources, competence and knowledge management for LTO.

Reference [5] provides a basic structure and common reference for peer reviews of ageing management and preparedness for safe LTO as well as useful information to the regulatory authorities the operating organizations of nuclear power plants (NPPs) and research reactors and technical support organizations for carrying out their own self-assessments or comprehensive programme reviews and to the hosting organization preparing for a SALTO peer review mission.

3.4 Review of safety factors

3.4.1 Safety Factor 1: Plant design

Plant SSCs important to safety should be appropriately designed and configured in such a way that there is a high degree of confidence that they will meet the requirements for safe operation of the plant and for performance in compliance with design characteristics, including the prevention and mitigation of events that could jeopardize safety (i.e. fulfilment of their safety functions). Adequate design information, including information on the design basis, should be made available to provide for the safe operation and maintenance of the plant and to facilitate plant modifications.

Documentation for review:

- PSR Bases document;
- Report on the review of safety factor#1;
- A report documenting the results of the global assessment;
- Relevant chapters of the final safety analysis report:
  - The site evaluation (from the final safety analysis report or similar safety document);
  - The list of SSCs important to safety and their safety classification;
  - The documented design basis (original or reconstituted and updated) including the list of postulated initiating events;
  - The environmental design of SSC;
  - The detailed description of the plant design, supported by drawings of the layout, systems and equipment;
  - Technical specifications;
  - Results of tests in the commissioning phase;
- Review compliance with plant design specifications.

The review should determine whether:

- The list of SSCs important to safety is completeness and adequate;

- That design and other characteristics are appropriate and meet the requirements for plant safety and performance for all plant conditions and the applicable period of operation, including:
  - The prevention and mitigation of events (faults and hazards) that could jeopardize safety;
  - The application of defence in depth and engineered barriers for preventing the dispersion of radioactive material (integrity of fuel, cooling circuit and containment building);
  - Safety requirements (for example, on the dependability, robustness and capability of SSCs important to safety);
  - Design codes and standards.
- Differences are identified between standards met by the nuclear power plant's design (for example, the standards and criteria in force when it was built) and modern nuclear safety and design standards;
- The design basis documentation is adequate;
- Design complies with plant design specifications;
- The safety analysis report or licensing basis is updated for plant modifications and in light of their cumulative effects and updates to the site characterization;
- Plant SSCs important to safety ensure that they have appropriate design characteristics and are arranged and segregated in such a way as to meet modern requirements for plant safety and performance, including the prevention and mitigation of events that could jeopardize safety;
- The strategy for the spent fuel storage and conduct of an engineering assessment of the condition of the storage facilities, the records management and the inspection regimes are implemented.

References for review:

- GSR Part 4 (Rev.1) (Rev.1):
  - Assessment of site characteristics, paras 4.22, 4.23;
  - Use of operating experience, para 4.27;
  - Design principles, paras 4.28; 4.31–4.37;
  - Safety classification, para 4.30.
- SSR 2/1 (Rev.1):
  - Safety in design, paras 2.8–2.11;
  - The concept of defence in depth, paras 2.12–2.14;
  - Maintaining the integrity of design of the plant throughout the lifetime of the plant, paras 2.15–2.18;
  - Requirement 4: Fundamental safety functions;
  - Requirement 18: Engineering design rules;
  - Requirement 22: Safety classification;
  - Requirement 27: Support service systems
- SSG-30, paras 2.3–2.7; 3.1.–3.27; 4.1.–4.7;
- SSG-25, paras 5.15–5.26.

3.4.2 Safety Factor 2: Actual condition of SSCs important to safety

The objective of the review of this safety factor is to determine the actual condition of SSCs important to safety and so to consider whether they are capable and adequate to meet design requirements, at least until the next PSR. In addition, the review should verify that the condition of SSCs important to safety is properly documented, as well as reviewing the ongoing maintenance, surveillance and in-service inspection programmes, as applicable.

Documentation for review:

- PSR Bases document;
- Plant specific documents:
  - The list of SSCs important to safety and their safety classification;
  - Information about the integrity and functional capability of SSCs important to safety, including material case histories;
  - Descriptions of the actual condition of SSCs important to safety;
  - The assessment methods applied by the operator;

  - Technical specification of the SSCs important to safety;
  - Equipment qualification results;
  - Description of the support facilities available to the plant both on and off the site, including maintenance and repair shops;
  - Reports of walkdowns;
  - Maintenance records;
  - Inspection results;
  - Findings of tests that demonstrate the functional capability of SSCs important to safety;
  - Operational data history and trends;
  - Outstanding maintenance and modifications;
  - Maintenance data, including data on periodic maintenance and corrective maintenance and reports of obsolescence;
  - Records of modifications.
- Report on the review of safety factor#2;
- A report documenting the results of the global assessment.

In addition, the following plant documents should be available for the review:

- The list of SSCs important to safety and their safety classification;
- Information about the integrity and functional capability of SSCs important to safety, including material case histories;
- Descriptions of the actual condition of SSCs important to safety;
- The assessment methods applied by the operator;
- Technical specification of the SSCs important to safety;
- Equipment qualification results;
- Description of the support facilities available to the plant both on and off the site, including maintenance and repair shops;
- Reports of walkdowns;
- Maintenance records;
- Inspection results;
- Findings of tests that demonstrate the functional capability of SSCs important to safety;
- Operational data history and trends;
- Outstanding maintenance and modifications;
- Maintenance data, including data on repeated maintenance and corrective maintenance and reports of obsolescence;
- Records of modifications.

The review should determine whether the actual condition of the SSCs important to the safety include examination of the following aspects for each SSC:

- Existing or anticipated ageing processes;
- Operational limits and conditions;
- Current state of the SSC with regard to its obsolescence;
- Implications of changes to design requirements and standards on the actual condition of the SSC since the plant was designed or since the last PSR (for example, changes to standards on material properties);
- Plant programmes that support ongoing confidence in the condition of the SSC;
- Significant findings from tests of the functional capability of the SSC;
- Results of inspections and/or walkdowns of the SSC;
- Maintenance and validity of records;
- Evaluation of the operating history of the SSC;
- Dependence on obsolescent equipment for which no direct substitute is available;
- Dependence on essential services and/or supplies external to the plant;
- The condition and operation of spent fuel storage facilities and their effect on the spent fuel storage strategy for the nuclear power plant;
- Verification of the actual state of the SSC against the design basis.

References for review:

- GSR Part 4 (Rev.1) (Rev.1), paras 4.48; 4.61;
- SSR 2/2 (Rev.1):
  - Requirement 9: Monitoring and review of safety performance, paras 4.33–4.37;
  - Requirement 10: Control of plant configuration, para 4.38;
  - Requirement 11: Management of modifications, paras 4.39–4.43;
  - Requirement 13: Equipment qualification, paras 4.48–4.49;
  - Requirement 14: Ageing management, paras 4.50–4.51;
  - Requirement 15: Records and reports, para 4.52;
  - Requirement 24: Feedback of operating experience, paras 5.27–5.33;
  - Requirement 28: Material conditions and housekeeping, paras 7.10–7.12;
  - Requirement 29: Chemistry programme, paras 7.13–7.17;
  - Requirement 31: Maintenance, testing, surveillance and inspection programmes, paras 8.1–8.17;
- SSG-48, paras 3.1–3.6;
- SSG-25, paras 5.27–5.36.

3.4.3 Safety Factor 3: Equipment qualification

Plant equipment important to safety (that is, SSCs) should be properly qualified to ensure its capability to perform its safety functions under all relevant operational states and accident conditions, including those arising from internal and external events and accidents (such as loss of coolant accidents, high energy line breaks and seismic events or other vibration conditions) for the period until at least the next PSR. The qualification should adopt a graded approach consistent with the safety classification of the SSC and should be an ongoing activity.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#3;
- Plant specific documents:
  - The site evaluation (from the final safety analysis report or similar safety document);
  - The list of SSCs important to safety and their safety classification;
  - The documented design basis (original and updated) including the list of postulated initiating events and specific environmental parameters;
  - The list of equipment covered by the equipment qualification programme and the procedure for control of this list;
  - Equipment qualification report and other supporting documents (for example, equipment qualification specifications and qualification plan);
  - Records of all qualification measures taken during the installed service life of the equipment.
- A report documenting the results of the global assessment.

The review should determine whether:

- A formalized process is in place that includes generating, documenting and retaining evidence that equipment can perform its safety functions during its installed service life;
- Standards and requirements in use for equipment qualification at the plant are valid, with particular attention to:
  - Adequate assurance of the required equipment performance was initially provided;
  - Current equipment qualification specifications and procedures are still valid (for example, initial assumptions regarding the service life of equipment and the environmental conditions);
  - Equipment performance is being preserved by ongoing application of measures such as scheduled maintenance, condition monitoring, testing and calibration and whether such

programmes have been properly documented that installed equipment meets the qualification requirements;

- The records of equipment qualification are complete and up to date;
- Procedures exist for updating and maintaining qualification throughout the service life of the equipment;
- Procedures exist ensuring that modifications and additions to SSCs important to safety do not compromise their qualification;
- Surveillance programmes and feedback procedures are used to ensure that ageing degradation of qualified equipment remains insignificant;
- Monitoring of actual environmental conditions and identification of 'hot spots' of high activity or temperature is regularly performed.

References for review:

- GSR-Part 4, (Rev.1);
  - Requirements 7;
  - Requirements 9;
- SSR 2/1, (Rev.1):
  - Requirement 13;
  - Requirement 32;
- SSG-25, SF-3, paras 5.37–5.44;
- SSG-48, Ref. [7], paras 4.13–4.31;
- DS514, Ref. [8].

3.4.4 Safety Factor 4: Ageing

All SSCs important to the safety of nuclear power plants are subject to some form of physical change caused by ageing, which could eventually impair their safety functions and service lives.

This safety factor should include the review of ageing management programme established at the nuclear power plant. The review should evaluate both programmatic and technical aspects. It should be determined whether ageing aspects affecting SSCs important to safety are being effectively managed and whether an effective ageing management programme is in place so that all required safety functions will be delivered for the design lifetime of the plant and, if it is proposed, for long term operation.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#4;
- Plant specific documents:
  - Manuals on ageing management used by the operating organization;
  - Documentation on the method and criteria for identifying SSCs important to safety covered by the ageing management programme;
  - The list of SSCs important to safety covered by the ageing management programme and records that provide information in support of the management of ageing;
  - Data for assessing ageing degradation, including baseline data and operating and maintenance histories.
- A report documenting the results of the global assessment.

The review should determine whether:

- A systematic, effective and comprehensive ageing management programme is in place;
- The ageing management programme ensures timely detection and mitigation of ageing mechanisms and/or ageing effects;
- The ageing management programme involves all SSCs important to safety as well as any non-safety classified SSCs whose failure might inhibit or adversely affect a safety function are addressed to an adequate extent;
- The ageing management programme addresses all relevant ageing degradation mechanisms are identified, and the models used to predict the evolution and advancement of ageing degradation are properly supported in accordance with current accepted practices pertaining to ageing degradation;
- The effectiveness of operating and maintenance policies and/or procedures for managing the

ageing of replaceable components is regularly evaluated;

- Evaluation and documentation of potential ageing degradation that may affect the safety functions of SSCs important to safety is performed;
- Adequate measures are taken to monitor and control ageing processes;
- Management of the effects of ageing on those parts of the nuclear power plant that will be required for safety when the nuclear reactor has ceased operation, for example the spent fuel storage facilities is included;
- Performance indicators are established;
- Record keeping is regularly performed;
- The ageing management programme will ensure continued safe operation for at least the period until the next PSR.

References for review:

- SSR 2/1 (Rev.1):
  - Requirement 14;
  - Requirement 31;
- SSG-25, paras 5.45–5.51;
- SSG-48, Ref. [7].

When PSR is used for decision making for LTO, the scope of this safety factors should be enlarged in accordance with Section 3.3 and includes the review of the following topics:

- Ageing management review for long term operation [SSG-48, paras 7.21–7.25];
- Review of plant programmes and ageing management programmes for long term operation [SSG-48 paras 7.26, 7.27];
- Revalidation of time limited ageing analyses [SSG-48, paras 7.28];
- Documentation in support of long term operation [SSG-48, paras 7.29–7.38];
- Regulatory review and approval [SSG-48 paras 7.39, 7.40];
- Implementation of the programme for long term operation [SSG-48 para 7.41].

Alternatively, the process of ageing management review described in Ref. [7] that may be supported by IAEA peer review service on safety aspects of long term operation (SALTO), Ref. [5] is recommended for a detailed review this safety factor. Reference [5] provides a basic structure and common reference for peer reviews of ageing management and preparedness for safe LTO as well as useful information to the regulatory authorities the operating organizations of nuclear power plants (NPPs) and research reactors and technical support organizations for carrying out their own self-assessments or comprehensive programme reviews and to the hosting organization preparing for a SALTO peer review mission.

3.4.5 Safety Factor 5: Deterministic safety analysis

Deterministic safety analysis should be conducted for each nuclear power plant, in order to confirm the design basis for SSCs important to safety and to evaluate the plant behaviour for postulated initiating events.

Deterministic safety analysis should provide a systematic re-examination of how operating experience feedback, new knowledge (for example, of physical phenomena) and changes in analysis and modelling techniques affect safety at the nuclear power plant

The existing deterministic safety analysis should be reviewed against the current national and international requirements, standards and good practices to verify that the design basis for SSCs important to safety is correct and that plant behaviour for postulated initiating events is properly addressed to a current standard.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#5;
- Current national and international guidelines for deterministic safety analysis, including guidelines for application of the single failure criterion and for redundancy, diversity and separation of SSCs important to safety;

- Plant specific documents:
  - The final safety analysis report, Chapter 15 on accident analysis;
  - Compilation of the existing deterministic safety analysis and the assumptions used;
  - Operational limits and conditions and permitted operational states of the plant;
  - Anticipated operational occurrences, including the list of all postulated initiating events that could affect the safety of the plant;
  - Analytical methods and computer codes used in deterministic safety analysis and comparable current methods (e. g. those for use for a modern nuclear power plant), including their validation;
  - Calculated radiation doses and limits on releases of radioactive material for design basis accident conditions.
- A report documenting the results of the global assessment.

The review should determine whether:

- To what extent the existing deterministic safety analysis is complete and remains valid when the following aspects have been taken into account:
  - The actual plant design, including all modifications of SSCs since the last update of the safety analysis report or the last PSR;
  - Current operating modes and fuel management;
  - The actual condition of SSCs important to safety and their predicted state at the end of the period covered by the PSR;
  - The use of modern, validated computer codes;
  - Current deterministic methods;
  - Current safety standards and knowledge (including research and development outcomes);
  - The existence and adequacy of safety margins.

References for review:

- GSR Part 4 (Rev.1): Requirement 15;
- SSR 2/1 (Rev.1): Requirement 42;
- SSG-25, paras 5.51–5.60;
- SSG-2, Ref. [9].

3.4.6 Safety Factor 6: Probabilistic safety assessment

A review of the probabilistic safety assessment (PSA) should be conducted to identify weaknesses in the design and operation of the plant and, as part of the global assessment, to evaluate and compare proposed safety improvements.

The PSA should be reviewed to confirm that the modelling reflects the current design and operating features, takes account of all relevant operating experience, includes all modes of operation and, where relevant, has a scope agreed with the regulatory body.

The PSA should be reviewed for completeness against an appropriate set of postulated initiating events and hazards.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#6;
- Plant specific documents:
  - Existing PSA documentation and models, including those used in risk informed applications of the PSA;
  - Postulated initiating events (those used for the existing PSA and a comparable list for a modern nuclear power plant);
  - Reports of external peer reviews and/or independent reviews;
  - A compilation or selection of guidelines, assessment principles, standards, regulatory requirements, etc. that represent what is considered the ‘current standard’ in performance of the PSA and the best practices known, available and applicable (all these should be used to derive criteria for the review of PSA);

  - The accident management programme for design extension conditions together with results of the PSA.
- A report documenting the results of the global assessment.

The review should determine whether:

- The extent to which the existing PSA study remains valid as a representative model of the nuclear power plant;
- The results of the PSA show that the risks are sufficiently low and well balanced for all postulated initiating events and operational states;
- The scope (which should include all operational states and identified internal and external hazards), methodologies and extent (i.e. Level 1, 2 or 3) of the PSA are in accordance with current national and international standards and good practices;
- The existing scope and application of PSA are sufficient.
- The review of the PSA includes the following aspects:
  - Assumptions used, the fault schedule, the representations of operator actions and common cause events, the modelled plant configuration and consistency with other aspects of the safety case;
  - Accident management programmes for accident conditions (design basis accident conditions and design extension conditions) are consistent with PSA models and results;
  - Scope and applications of the PSA are sufficient;
  - Status and validation of analytical methods and computer codes used in the PSA;
  - Results of PSA show that risks are sufficiently low and well balanced for all postulated initiating events and operational states and meet relevant probabilistic safety criteria.
- The existing scope and application of the PSA are sufficient for its use to assist the PSR global assessment, for example, to compare proposed improvement options.

References for review:

- GSR Part 4 (Rev.1): Requirement 15;
- SSR 2/1 (Rev.1): Requirement 42;
- SSG-25, paras 5.60–5.72;
- SSG-3, Ref. [11];
- SSG-4, Ref. [12].

3.4.7 Safety Factor 7: Hazard analysis

Requirement 17 of Ref. [6] requires that all foreseeable internal hazards and external hazards, including the potential for human induced events directly or indirectly to affect the safety of the nuclear power plant, shall be identified and their effects shall be evaluated. Hazards shall be considered for determination of the postulated items important to safety for the plant.

Requirement 8 of Ref. [2] requires that an assessment of the site characteristics relating to the safety of the facility or activity shall be carried out.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#7;
- Plant specific (and site specific) documents:
  - Results of previous hazards analyses;
  - Flood risk assessments;
  - Climate change assessments;
  - Seismic assessments and records;
  - Fire protection plans;
  - PSA assumptions (where used);
  - Emergency plans;
  - Local patterns or trends of aircraft movement and records of overflight incidents;
  - Recent planning applications (future changes in industrial or transport activity near the plant);
  - Records of wind speeds and direction;
  - Records of volcanic activity and hazards;

  - Records of ambient and sea and river temperature;
  - Records of river and sea levels;
  - Records of meteorological hazards;
  - Records of hydrological hazards.
- Operating experience:
  - Operating experience from similar plants or sites, both in the State and in other States;
  - Records of hazard incidents affecting the plant.
- A report documenting the results of the global assessment.

The objective of the assessment of the review results for this safety factor is to determine whether:

- The delivery of required safety functions and operator actions is ensured;
- SSCs important to safety, including the control room and the emergency control centre, are adequately protected against relevant internal and external hazards;
- For each internal or external hazard identified, the PSR evaluates the adequacy of the protection, with account taken of the following:
  - The credible magnitude and associated frequency of occurrence of the hazard;
  - Current safety standards;
  - Current understanding of environmental effects;
  - The capability of the plant to withstand the hazard as claimed in the safety case, based on its current condition and with allowance given to predicted ageing degradation;
  - The appropriateness of procedures to cover operator actions claimed to prevent or mitigate the hazard.
- A list of relevant internal and external hazards that may affect plant safety is established and contains representative internal and external hazards;
- The nuclear power plant is protected against internal and external hazards, with account taken of the plant design, site characteristics, the actual condition of the SSCs important to safety and their predicted state at the end of the period covered by the PSR.

References for review:

- GSR Part 4 (Rev.1), Requirement 8;
- SSR 2/1 (Rev.1), Requirement 17;
- SSG-25, paras 5.72–5.83.

3.4.8 Safety Factor 8: Safety performance

Requirement 9 of ref. [3] requires that the operating organization shall establish a system for continuous monitoring and periodic review of the safety of the plant and of the performance of the operating organization.

Safety performance is determined from assessment of operating experience, including safety related events, and records of the unavailability of safety systems, radiation doses and the generation of radioactive waste and discharges of radioactive effluents.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#8;
- Plant specific documents:
  - Records of operating experience relevant to safety, including the following:
    - Frequency of unplanned trips while the reactor is critical;
    - Frequency of unplanned operator actions in the interests of safety and their success rate;
    - Selected actuations of and/or demands on safety systems;
    - Failures of safety systems;
    - Unavailability of safety systems;
    - Trends in causes of failures (for example, operator errors, hardware faults);

- The backlog of outstanding maintenance and configuration management;
- The extent of repeat maintenance;
- The extent of corrective (breakdown) maintenance;
- The integrity of physical barriers for the containment of radioactive material;
- Radiation doses to persons on the site (including collective doses);
- Data from off-site radiation monitoring;
- The annual rate of generation of radioactive waste and the quantity of waste stored on the site;
- Quantities of radioactive effluents produced;
- Reports on the routine analysis of safety performance indicators;
- Procedures, documentation and outputs from the plant's routine processes for the review of operating experience.

- A report documenting the results of the global assessment.

The review should determine whether:

- The plant has in place appropriate processes for the routine recording and evaluation of safety related operating experience, including:
  - Safety related incidents, low level events and near misses;
  - Safety related operational data;
  - Maintenance, inspection and testing;
  - Replacements of SSCs important to safety owing to failure or obsolescence;
  - Modifications, either temporary or permanent, to SSCs important to safety;
  - Unavailability of safety systems;
  - Radiation doses (to workers, including contractors);
  - Off-site contamination and radiation levels;
  - Discharges of radioactive effluents;
  - Generation of radioactive waste;
  - Compliance with regulatory requirements.
- The trends over the operating lifetime of the plant or since the last PSR have been reviewed to identify potential future safety concerns (for example, precursors to accidents) or deteriorating safety performance.
- The results of the previous PSR have been examined to detect any long term trends in deteriorating safety performance The delivery of required safety functions and operator actions is ensured;
- PSR carried out a full review of relevant operating experience at the plant over the review period, especially for cases where there were significant findings relating to the effectiveness of the feedback process.

References for review:

- GSR Part 4 (Rev.1), Requirement 19, para 4.61;
- SSR 2/2 (Rev.1), Requirement 9, paras 4.33–4.37;
- SSG-25, paras 5.84–5.102.

3.4.9 Safety Factor 9: Use of experience from other plants and research findings

Requirement 24 of Ref. [3] requires that the operating organization shall establish an operating experience programme to learn from events at the plant and events in the nuclear industry and other industries worldwide. This should include information from other plants for which the operating organization is responsible and wider experience in the State and in other States, including relevant information from non-nuclear facilities.

The review of this safety factor is closely related to the review of safety performance (safety factor 8). However, unlike the review of safety performance, the review of the use of experience from other plants and research findings should seek to identify good practices and lessons learned elsewhere and take advantage of improved knowledge derived from research.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#9;
- Plant specific documents:
  - The review of the use of experience from other plants and research finding should include, in
  - particular, the following plant specific inputs:
  - Reports from the operating organization's routine assessment of operating experience at other plants;
  - Procedures and documentation governing the operating organization's process for the review of operating experience at other plants;
  - Assessments from the operating organization's review of emerging research findings;
  - Procedures and documentation governing the operating organization's routine process for the assessment of research findings;
  - Independent internal or external audits and self-assessments regarding operating experience and research findings.
- A report documenting the results of the global assessment.

The review should determine whether:

- The plant has appropriate processes for the operating experience feedback in place;
- Operating experience reports and other information that may be important to nuclear safety at other plants are available in the operating organization
- Relevant experience and national and international research findings from nuclear and non-nuclear facilities both in the State and in other States are collected and evaluated;
- The timely feedback of operating experience and for their output is implemented;
- The processes for assessing and, if necessary, implementing research findings and findings from operating experience relevant to safety are timely implemented.
- PSR carried out a full review of relevant operating experience at the plant over the review period, especially for cases where there were significant findings relating to the effectiveness of the feedback process.

References for review:

- GSR Part 4 (Rev.1), Requirement 19, para 4.61;
- SSR 2/1 (Rev.1), Requirement 24, paras 5.27–5.33;
- SSG-25, paras 5.102–5.110;
- SSG-50, Ref. [13].

3.4.10 Safety Factor 10: Organization, the management system and safety culture

The operating organization shall establish, implement, assess and continually improve an integrated management system.

The operating organization is required to have in place a management system that ensures that policies and objectives are implemented in a safe, efficient and effective manner. Similarly, the organization should have a strong safety culture so that all individuals carry out duties important to safety correctly, with alertness, due thought, full knowledge, sound judgement and a proper sense of accountability.

The review of this safety factor is closely related to the review of safety performance (safety factor 8). However, unlike the review of safety performance, the review of the use of experience from other plants and research findings should seek to identify good practices and lessons learned elsewhere and take advantage of improved knowledge derived from research.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#10;
- Plant specific documents:
  - The operating organization's safety policy and related documentation;

  - Procedures and documentation of the management system (for example, on quality management, configuration management and ageing management);
  - Outputs from application of management system procedures, including quality plans;
  - Records (for example, on training, commissioning, maintenance, testing);
  - Documentation describing the organizational structure and safety related roles and responsibilities of individuals and groups;
  - Corrective action programme and processes for reporting;
  - Surveys of safety culture.
- A report documenting the results of the global assessment.

The review should determine whether:

- The organization, management system and safety culture are adequate and effective for ensuring the safe operation of the nuclear power plant;
- The management system includes a review of the following elements or programmes against national and international standards:
  - Policy statements of the operating organization;
  - The documentation of the management system;
  - The adequacy of arrangements for managing and retaining responsibility for activities or processes important to safety that have been outsourced (for example, maintenance and engineering services and safety analysis);
  - The roles and responsibilities of individuals managing, performing and assessing work;
  - The processes and supporting information that explain how work is to be specified, prepared, reviewed, performed, recorded, assessed and improved
- Regular and systematic reviews of the management system are performed to ensure that the safety policies, goals and objectives of the organization are being met as required.
- These reviews include evaluation of how the following tasks were undertaken and completed:
  - There are adequate processes in place for managing organizational change;
  - There is a human resource management process in place that ensures the availability of adequate, qualified human resources, including succession planning;
  - There is adequate control of documents, products and records and this information is readily retrievable;
  - There is adequate control of purchasing of equipment and services where this affects plant safety;
  - There are adequate communication policies in place;
  - There are adequate facilities for training and training programmes are well structured;
  - There are formal arrangements in place for employing suitably qualified internal and external technical, maintenance or other specialized staff;
  - There are adequate processes in place for feedback of operating experience to the staff, including experience relating to organizational and management failures;
  - There are suitable arrangements in place for maintaining the configuration of the nuclear power plant and operations are carried out in accordance with the safety analysis of the plant;
  - There are programmes in place for ensuring continuous improvement, including self-assessment and independent assessment.
  - The review of safety culture is an assessment of commitment to safety.
- Regular management system reviews have been conducted at sufficient intervals and whether the following have been covered:
  - Outputs from all forms of assessment (audits, self-assessments and task observations);
  - Results delivered and objectives achieved by the operating organization and its processes;

  - Non-conformances and corrective and preventive actions;
  - Lessons learned from other organizations;
  - Opportunities for improvement.
- Weaknesses and obstacles have been identified, evaluated and remedied in a timely manner;
- The need to make changes to, or improvements in, policies, goals, strategies, plans, objectives and processes has been properly identified in the management system reviews.

References for review:

- GSR Part 4 (Rev.1), para 4.42;
- SSR 2/1 (Rev.1), Requirement 12, paras 3.4–3.7;
- SSG-25, paras 5.111–5.120;
- SSG-50.

3.4.11 Safety Factor 11: Procedures

Requirement 26 of Ref. [3] requires that operating procedures shall be developed that apply comprehensively (for the reactor and its associated facilities) for normal operation, anticipated operational occurrences and accident conditions, in accordance with the policy of the operating organization and the requirements of the regulatory body.

The review of this safety factor involves procedures important to the safety of the nuclear power plant to verify they are comprehensive, validated, formally approved, appropriately distributed and subject to rigorous management control. In addition, the procedures are unambiguous and relevant to the actual plant (with modifications taken into account); they reflect current operating practices and due consideration should be given to human factor aspects (for example, whether they are user friendly).

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#11;
- Plant specific documents:
  - Plant operating procedures for normal operation, fault conditions and symptom-based emergency operating procedures for restoring critical safety functions;
  - Procedures supporting plant operating procedures (for example, for their development, validation, acceptance, modification withdrawal);
  - Audits and self-assessments that question adherence to plant procedures.
- A report documenting the results of the global assessment.

The review should determine whether:

- Operating organization's processes for managing, implementing and adhering to operating and working procedures and for maintaining compliance with operational limits and conditions and regulatory requirements are adequate and effective and ensure plant safety;
- The review of this safety factor focused on those procedures that have the highest safety significance and need not necessarily include a full review of every procedure; the following types of procedures are included in the scope of review:
  - Operating procedures for normal and abnormal conditions (including anticipated operational occurrences, design basis accident conditions and post-accident conditions);
  - Procedures for the management of design extension conditions, including accidents with significant core degradation (for example, symptom-based emergency operating procedures);
  - Maintenance, testing and inspection procedures;
  - Procedures for issuing work permits;
  - Procedures for controlling modifications to the plant design, procedures and hardware, including the updating of documentation;
  - Procedures for controlling the operating configuration;

  - Procedures for radiation protection, including procedures for on-site transport of radioactive material;
  - Procedures for management of radioactive effluents and waste.
- There is an effective process in place for formal approval and documentation of all safety related procedures;
- There is a formal system in place for development and modification of any procedure governing activities affecting safety, including adequate arrangements for tracking changes;
- Audits, self-assessments, safety performance and events are evaluated to determine whether there is adequate understanding and acceptance of these procedures by managers and staff.
- Procedures are followed;
- Adequacy of these procedures is evaluated in comparison with good practices;
- Arrangements for regular review and maintenance of these procedures are in place and are adequate;
- Procedures are structured and written with consideration given to human factors. For example, it should be checked whether the procedures are user friendly and can be readily understood and implemented by all staff who need to use them.
- Processes to update procedures are evaluated to allow for changes in the assumptions made and/or the limits and conditions arising from the safety analysis, plant design and operating experience;
- The analysis and justification of the accident management procedures are documented;
- An appropriate process is in place for the categorization of procedures in accordance with their significance to safety.
- There is adequate involvement in the development of procedures by the staff who will use them;
- The distribution process for the control, copying and removal of obsolete versions of procedures, so that only the last approved edition is used.

References for review:

- SSR 2/2 (Rev.1), Requirement 24, paras 7.1–7.6;
- NS-G-2.14, Ref. [14];
- GS-G-3.1, Ref. [15];
- SSG-50;
- SSG-25, paras 5.121–5.126.

3.4.12 Safety Factor 12: Human factors

Requirement 32 of Ref. [6] requires that systematic consideration of human factors, including the human–machine interface, shall be included at an early stage in the design process for a nuclear power plant and shall be continued throughout the entire design process.

Paragraph 4.38 of Ref. [2] requires that the safety of facilities and activities will depend on actions carried out by the operating personnel, and all such human interactions with the facility or activity are to be assessed.

Human factors influence all aspects of the safety of a nuclear power plant. The review should examine the human factors at the plant and within the operating organization to determine whether these correspond to accepted good practices and to verify that they do not present an unacceptable contribution to risk. In particular, the review should determine whether operator actions claimed to be in support of safety are feasible and properly supported.

Documentation for review:

- Report on the review of safety factor#12;
- Plant specific documents:
  - Policy to maintain the know-how of the plant staff;
  - Training records, also for training in safety culture, particularly for staff in management positions;
  - Staffing records;
  - Fitness for duty requirements;

  - Programmes for the feedback of operating experience for failures and/or errors in human performance that have contributed to safety significant events and their causes, and consequent corrective actions and/or safety improvements;
  - Audits and self-assessments of hours of work and time records.
- A report documenting the results of the global assessment.

The objective of the assessment of the review results for this safety factor is to determine whether:

- Various human factors that may affect the safe operation of the nuclear power plant and to seek to identify improvements that are reasonable and practicable have been considered;
- Adequate staffing levels exist for operating the plant, with due recognition given to absences, shift working and restrictions on overtime;
- Qualified staff are available on duty at all times;
- Adequate programmes are in place for initial training, refresher training and upgrading training, including the use of simulators;
- Operator actions needed for safe operation have been assessed to confirm that assumptions and claims made in safety analyses (for example, PSA, deterministic safety analysis and hazard analysis) are valid;
- Human factors in maintenance are assessed to promote error-free execution of work;
- Adequate competence requirements exist for operating, maintenance, technical and managerial staff;
- Staff selection methods (for example, testing for aptitudes, knowledge and skills) are systematic and validated;
- Appropriate fitness for duty guidelines exists relating to hours, types and patterns of work, good health and substance abuse;
- Policies exist for maintaining the know-how of staff and for ensuring adequate succession management in accordance with good practices;
- Adequate facilities and programmes are available for staff training;
- The following aspects of the human–machine interface was reviewed:
  - Design of the control room and other workstations relevant to safety;
  - Human information requirements and workloads;
  - Clarity and achievability of procedures.

References for review:

- SSR 2/1 (Rev.1), Requirement 32, paras 5.55–5.61;
- GSR-Part 4, para 4.38;
- SSG-25, paras 5.126–5.134;
- SSG-51, Ref. [16].

3.4.13 Safety Factor 13: Emergency planning

Paragraph 3.16 of Ref. [16] requires that operators, the national coordinating authority and other appropriate organizations shall periodically conduct a review in order to ensure that all practices or situations that could necessitate an emergency intervention are identified and shall ensure that an assessment of the threat is conducted for such practices or situations. This review shall be undertaken periodically to take into account any changes to the threats within the State and beyond its borders, and the experience and lessons from research, operating experience and emergency exercises.

Emergency planning for the possibility of such releases is a prudent and necessary action, not only for the operating organization but also for local and national authorities. The PSR should include an overall review to check that emergency planning at the plant continues to be satisfactory and to check that emergency plans are maintained in accordance with current safety analyses, accident mitigation studies and good practices. The PSR should verify that the operating organization has given adequate consideration to significant changes at the site of the nuclear power plant and in its use,

organizational changes at the plant, changes in the maintenance and storage of emergency equipment and developments around the site that could influence emergency planning.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#13;
- Plant specific documents:
  - The emergency planning manual of the operating organization;
  - Strategy, procedures and organization for emergencies;
  - Studies of the mitigation of consequences of accidents;
  - Procedures for the management of design extension conditions and accident
  - management guidelines.
- A report documenting the results of the global assessment.

The objective of the assessment of the review results for this safety factor is to determine whether:

- The operating organization has in place adequate plans, staff, facilities and equipment for dealing with emergencies;
- The operating organization's arrangements have been adequately coordinated with the arrangements of local and national authorities and are regularly exercised;
- On-site equipment and facilities for emergencies are available and are adequate;
- On-site technical and operational support centres are available and are adequate;
- The efficiency of communications in the event of an emergency, in particular the interaction with organizations outside the plant was evaluated;
- The content and efficiency of emergency training and exercises and check records of experience from such exercises was evaluated;
- Arrangements for the regular review and updating of emergency plans and procedures were evaluated;
- Changes in the maintenance and storage of emergency equipment were examined;
- The effects of any recent residential and industrial developments around the site were evaluated.

References for review:

- GSR Part 7, Ref. [16], paras 3.1-3.2; 3.16;
- GSG-2, Ref. [18];
- SSG-25, paras 5.127–5.145.

3.4.14 Safety Factor 14: Radiological impact on the environment

The operating organization should have in place an established and effective monitoring programme that provides data on the radiological impact of the nuclear power plant on its surroundings.

The review should establish whether the monitoring programme is appropriate and sufficiently comprehensive. In particular, the review should verify that the radiological impact of the plant on the environment is not significant compared with that due to other sources of radiation.

Documentation for review:

- PSR Bases;
- Report on the review of safety factor#14;
- Plant specific documents:
  - Potential sources of radiological impact;
  - Release limits for effluents;
  - Off-site monitoring for contamination levels and radiation levels;
  - Availability of alarm systems to respond to unplanned releases of effluents from on-site facilities;
  - Recent and future changes in the use of areas around the site;
  - Records of effluent releases;
  - Records from off-site environmental monitoring;
  - Published environmental data.

- A report documenting the results of the global assessment.

The review should determine whether:

- The operating organization has an adequate and effective programme for monitoring the radiological impact of the plant on the environment, which ensures that emissions are properly controlled and are as low as reasonably achievable.
- Radiological monitoring data were compared with the values measured before the nuclear power plant was put into operation and/or historical values examined in the last PSR;
- In the event of significant deviations, an explanation was provided by the operating organization, with account taken of relevant factors external to the nuclear power plant;
- The review looks for potential new sources of radiological impact by examining relevant plant modifications and the actual conditions of SSCs important to safety.

References for review:

- GSR Part 4 (Rev.1), paras 4.19; 4.24–4.26;
- SSG-25, paras 5.128–5.153;
- NS-G-1.13, Ref. [19].

3.4.15 Global assessment

The global assessment should evaluate the impact on safety based on the findings from all the separate safety factors and so needs to be performed after completion of all the individual safety factor reviews.

The global assessment should highlight interface issues and should identify overlapping issues between the various safety factor reviews, thus ensuring that such issues are appropriately and fully addressed.

PSR global assessment intends to arrive at a judgement of the nuclear power plant's suitability for continued operation on the basis of a balanced view of the findings from the reviews of the separate safety factors. This judgement account of the safety improvements considered in the global assessment as necessary (which may relate to the plant, or to the operating organization) together with any positive findings (strengths) identified in the safety factor reviews.

Documentation for review:

- PSR Bases;
- A list of safety improvements for the next PSR cycle;
- A report documenting the results of the global assessment.

The review should determine whether:

- An analysis of the interfaces between the various safety factors was carried out as part of the global assessment;
- Supporting information were considered such as documents on the scope and methodology of the PSR, regulatory requirements, feedback from the regulatory body on previously submitted PSR documents, particular issues raised by the regulatory body and additional reference material;
- An interdisciplinary team (that include members who are independent from the safety factor review), with appropriate expertise in operation, design and safety at the plant, including an appropriate number of participants from the safety factor reviews;
- A method for assessing, categorizing, ranking and prioritizing safety improvements to address negative findings was established prior to performing the global assessment;
- The risks associated with negative findings was assessed and an appropriate justification for continued operation should be provided;
- The global assessment reviewed the extent to which safety requirements relating to the concept of defence in depth and the fundamental safety functions (reactivity control, core cooling and the confinement of radioactive material) are fulfilled;

- The following aspects of global assessment were examined:
  - The time necessary for implementing corrective actions and/or safety improvements;
  - The PSA was used to estimate the risk posed by a negative finding;
  - Measures are in place if a modification is necessary on the grounds of unacceptable risk;
  - The total effect of the negative findings, safety improvements and positive findings (strengths) identified in the PSR was examined using deterministic methods to ensure that the overall level of plant safety is adequate.

When PSR is used for decision making for LTO, the review should verify whether:

- PSR global assessment provide safety justification for proposed long term operation by evaluating the cumulative effects of both ageing and obsolescence on the safety and reflecting the combined effects of all safety factors (findings and proposed improvements) [SSG-25: 2.17, 4.21, 4.26-27, 6.6-6.9, 6.12, Appendix II.5]; [SSG-48: 2.5, 2.30, 2.32].
- PSR determines reasonable and practicable modifications to be made in order to ensure that a high level of safety is maintained during long term operation? Is justification for any improvements that cannot reasonably and practicably be made provided [SSG-25: 3.5, 3.6, 3.10, 4.26-4.27, 5.12, 6.6-6.9, 8.14] [SSG-48: 1.7, 7.15, 7.40].
- The integrated implementation plan has been, or will be developed, considering reasonable and practicable safety improvements [SSG-25: 2.18, 4.25, 6.7, 8.23, 9.1] [SSG-48: 1.7, 7.15, 7.40].

References for review:

- GSR Part 4 (Rev.1), paras 4.42; 4.45–4. 48; 4.57; 4.61;
- SSR 2/2 (rev.1):
  - Requirement 2, para 3.7.
  - Requirement 12, para 4.47
  - Requirement 16, paras 4.53–4.54;
- SSG-25, paras 6.1–6.12.

4. Documentation of review results

Preparation and delivery of the Final TSR-PSR Report follows the process established in Sections 2.3.5 to 2.3.8 of Ref. [1].

The results of a TSR peer review presented in the final TSR-PSR Report at the end of the review process are summarized and formulated as recommendations to the Requesting Party. The summary describes the scope of the review, the basis for the review, the composition of the technical team and the review process. The summary also identifies positive aspects observed during the review and the most important areas where supplementing information or modification is needed to adhere to the IAEA safety standards. Recommendations are formulated as defined in Section 2.2.1.5 (Deliverables) of Ref. [1]. The review sheets will be attached to the final TSR-PSR report.

Annex

AN EXAMPLE OF A REVIEW SHEET

1. ISSUE IDENTIFICATION		**Issue Number: 1**
Requesting Party: [Name]	**Unit:** [unit number, when performed for a specific NPP]	
Reviewed Area:		
1.1 – ISSUE TITLE:		
1.2 – FUNDAMENTAL OVERALL PROBLEM:		
2. ASSESSMENT OF THE STATUS		**Date:** D1/M1/YYY1
2.1 – FACTS: F1) F2) F3) F4)		
2.2 – SAFETY CONSEQUENCE:		
2.3 – RECOMMENDATION/SUGGESTION: **R)** The plant should…. **S)** The plant should consider …		
2.4 – IAEA BASIS:		
2.5 – DOCUMENTS REVIEWED: – Format: ID, Rev. XX (where appropriate), Title, Date (at least year);		
3. REQUESTING PARTY ACTIONS TO RESOLVE ISSUE		**Date:** D2/M2/YYY2
3.1 – RESULTS OF THE ISSUE ANALYSIS: n.a.		
3.2 – CORRECTIVE ACTIONS: n.a.		
3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION: n.a.		
4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM		**Date:** D3/M3/YYY3
4.1 – FACTS: F1) n.a.		
4.2 – DOCUMENTS REVIEWED: n.a.		
4.3 – RESOLUTION DEGREE:		
1.	**Insufficient progress to date**	n.a.
2.	**Satisfactory progress to date**	n.a.
3.	**Issue resolved**	n.a.

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[15] INTERNATIONAL ATOMIC ENERGY AGENCY, Application of the Management System for Facilities and Activities, Safety Standards Series, Safety Guide GS-G-3.1, Vienna (2006).

[16] INTERNATIONAL ATOMIC ENERGY AGENCY, Human Factors Engineering in the Design of Nuclear Facilities, IAEA Safety Standards Series No. SSG-51, Vienna (2019).

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