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Periodic Safety Review of Nuclear Power Plants

DRAFT SAFETY GUIDE
DS426

Revision of NS-G-2.10 Safety Guide

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CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. This Safety Guide supplements the IAEA Fundamental Safety Principles, SF-1 [1], the Safety Requirements publications Safety of Nuclear Power Plants: Operation, NS-R-2 [2] and Safety Assessment for Facilities and Activities, GSR Part 4 [3]. It supersedes the Safety Guide, NS-G-2.10, Periodic Safety Review of Operational Nuclear Power Plants, issued in 2003 [4]. The technical terms used in this Safety Guide are described in the IAEA Safety Glossary (SP-9)

1.2. Routine reviews of nuclear power plant (NPP) operation (including modifications to hardware and procedures, significant events, operating experience, plant management and personnel competence) and special reviews following major events of safety significance are the primary means of safety verification. In addition, some States have initiated systematic safety reassessments, termed periodic safety review (PSR), to assess the cumulative effects of plant ageing and plant modifications, operating experience, technical developments and siting aspects. The reviews include an assessment of plant design and operation against applicable (SP-10) current safety standards and practices, and they have the objective of ensuring a high level of safety throughout the plant's operating lifetime. ~~They~~ The periodic safety reviews are complementary to the routine and special safety reviews and do not replace them. (UK-9)

OBJECTIVE

1.3. The purpose of this Safety Guide is to provide recommendations and guidance on the conduct of a PSR for an existing nuclear power plant. The Safety Guide is intended for use by operating organizations, regulatory bodies and their technical support organizations, consultants and advisory bodies. (CAN O-1-Rejected)

SCOPE

1.4. This Safety Guide deals with the PSR of an ~~existing~~ operating (ENISS-3) nuclear power plant. A PSR is a comprehensive safety review of all important aspects of safety, carried out at regular intervals, typically every ten years. PSR could be used as support in the decision making process for licence renewal and for long term operation, or for restart of an NPP following prolonged shutdown. (CAN A-1)

1.5. The review process described in this Safety Guide is valid for NPPs of any age, but may have a wider applicability with a graded approach, for example, to research reactors and

radioactive waste management facilities. For an operating NPP, a PSR is not intended to deal with the safety issues during the decommissioning phase; however, documentation resulting from a PSR is an important input for planning decommissioning.

STRUCTURE

1.6. A rationale for and the objective of the PSRs of operational nuclear power plants and general recommendations are given in Section 2. Long term operation aspects are described in section 3. Section 4 presents the general review methodology and the strategic considerations relating to the conduct of a PSR. Important aspects of the safety of an operational nuclear power plant that are addressed in a PSR are defined as safety factors and these are described in Section 5. Recommendations on Global assessment are presented in section 6. The roles and responsibilities of the plant operating organization, the regulatory body and external consultants in the conduct of a PSR are defined in Section 7. Section 8 presents a recommended review process. Section 9 deals with post-review activities. Finally, the Appendix A describes the interfaces between the safety factors and Appendix B gives recommendations on the content of different PSR documents and reports.

2. RATIONALE, OBJECTIVE AND GENERAL RECOMMENDATIONS FOR A PERIODIC SAFETY REVIEW

RATIONALE FOR A PSR

2.1. Since operation of the first generation of commercial NPPs started in the 1950s there have been substantial developments in safety standards and practices, and in technology, resulting from new scientific and technical knowledge. ~~Better analytical methods and lessons have been learnt from operating experiences.~~ Lessons have been learnt from operating experience, together with the development of better analytical methods. (UK-12). These developments should (SP-11) be considered by operating organizations and regulatory bodies in the interests of continuous safety improvement.

2.2. Ref. [2] requires: "Systematic safety reassessments of the plant in accordance with the regulatory requirements shall be performed by the operating organization throughout its operational lifetime, with account taken of operating experience and significant new safety information from relevant sources". Although operational NPPs are subject to routine and special safety reviews, these reviews are generally not sufficiently comprehensive to meet this requirement of Ref. [2]. For example, routine and special reviews do not always take into account the improvements in safety standards and operating practices, the cumulative effects of plant ageing, modifications, the feedback of operating experience, wider developments in science and technology or look forward to future planned operation. Thus, it is common international practice for operating organizations to undertake proactive, strategic, detailed and comprehensive PSRs. ~~in order to complement their routine and special review processes.~~(UK-8)

2.3. In numerous Member States, PSR forms part of the regulatory system while the scope and contents of the PSR, the way of the PSR implementation and the regulatory activities relevant to the PSR vary depending on their national rules. (JAP-1) PSRs provide a means for regulating the safety of plant operation in the longer term and for addressing requests by licensees for authorization to continue plant operation beyond an established licensed term or for a further period established by a safety evaluation. A recent PSR provides reassurance that there continues to be a valid licensing basis taking account of, for example, plant ageing and current safety standards.

2.4. A Periodic Safety Review provides an effective way to obtain an overall view of actual plant safety, the quality of the safety documentation and to determine reasonable and practical modifications to improve or ensure safety to an appropriate high level. To do this, the Periodic Safety Review needs to identify any lifetime limiting features at the plant in order to plan future modifications and to determine the timing of future reviews.

2.5. Based on international experience, it is reasonable to perform a Periodic Safety Review after about ten years from the start of plant operation and then undertake subsequent Periodic Safety Reviews at ten years intervals until the end of operation. Ten years is considered to be an appropriate interval for such reviews in view of the likelihood, within this period, of the following:

- changes in national and international safety standards, technology, underlying scientific knowledge or analytical techniques;
- the potential for the cumulative effects of plant modifications to adversely affect safety or the accessibility and usability of the safety documentation;
- identification of significant ageing effects or trends;
- accumulation of relevant operational experience;
- changes to how the plant is, or will be, operated;
- changes in the natural, industrial or demographic environment of the plant;
- changes in staffing levels or in the experience of staff; (GER-1)
- changes in the management structures and procedures of the plant operating organization.

2.6. Extending the period between PSRs beyond about ten years could lead to a loss of the direct knowledge and experience gained during previous reviews and to a loss of continuity.

2.7. ~~On average, the PSR review process takes about 3 years.~~ To provide a timely input the PSR review process should be completed within 3 years or less for the second or subsequent PSRs. (GER-2) The length of the review process may depend on the availability and retrievability of relevant information and the organizational structure of NPP. (SP-13)

2.8. It is recognized that some Member States prefer alternative arrangements to Periodic Safety Reviews. For example, some Member States utilise routine comprehensive safety assessment programmes that deal with specific safety issues, significant events and changes in safety standards and practices as they arise. Such programmes can, if applied with appropriate scope,

frequency, depth and rigour, achieve the same standards of review as from a Periodic Safety Review. They allow safety to be improved on a continuous basis and avoid the need for a large programme of corrective actions arising at the same time from a Periodic Safety Review. (UK-14) This Safety Guide is not intended to discourage such alternative arrangements. However, when an alternative approach is followed, it is important that it satisfies the objectives for a Periodic Safety Review, together with the objectives of other licensing, regulatory and operational processes. (UK-15)

OBJECTIVE OF A PSR

2.9. The objective of a Periodic Safety Review is to determine by means of a comprehensive reassessment:

- ~~The extent to which the safety documentation remains valid;~~(UK 17, moved to the end)
- The adequacy and effectiveness of the arrangements and equipment (UK-16) that are in place to ensure plant safety until the next Periodic Safety Review or, where appropriate (FIN-1), until the end of planned operation. (i.e. if the NPP will stop operation before the next PSR in the 10-year cycle is due).
- The extent to which the plant conforms to current national and/or international safety standards and practices;
- The safety improvements that need to be implemented within the specified schedule (CAN A-10); and
- The extent to which the licensing basis remains valid. (UK-17)

2.10. The PSR process can be used for different purposes:

- Systematic safety reassessments in a ten year interval as required by Ref. [2];
- Support the decision making process for licence renewal; and
- Support the decision making process for long term operation.

GENERAL RECOMMENDATIONS FOR A PERIODIC SAFETY REVIEW

2.11. The operating organization should have the prime responsibility for ensuring that an adequate Periodic Safety Review is performed.

2.12. The PSR should provide a comprehensive reassessment of the safety of the NPP. The comprehensive assessment of overall plant safety is a complex task, and can be aided by

appropriate sub-division of tasks within the overall. (UK-19) This safety guide recommends the use of 14 safety factors. However, the number of safety factors and/or their grouping may be different according to the specific needs of the operating organization and the particulars of the nuclear power plant. (GER-4) When the concept of safety factors or the number of the safety factors is different, the comprehensiveness of the review should be ensured by other means according to the national rules. (JAP 2)

2.13. The 14 PSR safety factors (described in detail in Section 5), were selected based on international experience and are the following:

Plant

(1) Plant design,

(2) Actual condition of structures, systems and components (SSCs) (UK-20)

(3) Equipment qualification,

(4) Ageing.

Safety analysis

(5) Deterministic safety analysis,

(6) Probabilistic safety assessment ~~analysis~~, (CAN A-6)

(7) Hazard analysis.

Performance and feedback of experience

(8) Safety performance,

(9) Use of experience from other plants and research findings.

Management

(10) Organisation, Management system and Safety culture,

(11) Procedures,

(12) The human factor,

(13) Emergency planning.

Environment

(14) Radiological impact on the environment.

The grouping, order and numbering of the safety factors listed above does not indicate an order of importance.

2.14. A review of the physical security of nuclear installations is not included in the PSR because of the sensitivity of the subject and the need to ensure confidentiality. The effectiveness of security arrangements to prevent unauthorized actions that could jeopardize nuclear safety should be reviewed periodically by the appropriate national authorities. It may also be desirable by some operating organizations to review physical security as a separate safety factor within the PSR. Guidance on nuclear security measures may be found in the IAEA Nuclear Security Series.

2.15. The safety factor review should identify findings of the following types:

- ~~Strength: the result is a good practice in comparison to current codes and standards or industry practices, and~~ (UK-21)
- *Positive findings* (i.e. strengths): where current practice is equivalent to good practice in comparison to current codes and standards or (UK-21)
- ~~Deviation: the result is difference between current codes and standards or industry practices and the current licensing basis, operating plant documentations or procedures.~~ (UK-22)
- *Negative findings* (i.e. deviations): where current practices are not of a standard equivalent to current codes and standards or industry practices and the current licensing basis, operating plant documentations or procedures. (UK-22) (CAN A-8)

2.16. The PSR should look forward over this period until the next PSR, or where appropriate, until the end of planned operation, and review whether there are any foreseeable circumstances that could threaten safe operation of the NPP. If such circumstances are identified, then the operating organization should take appropriate action to ensure that the licensing basis remains valid.

2.17. To integrate the results of the reviews of individual safety factors, (UK-24) the operating organisation should perform a global assessment of the plant safety taking into consideration all findings, proposed improvements for each safety factor and interfaces between different safety factors.

2.18. The Periodic Safety Review should be executed in four distinct phases (as further discussed in Section 8), which may overlap or be further sub-divided as appropriate:

- Preparation of the PSR project – which should include an agreement with the regulatory body with regard to the scope and timing of the review and the codes and standards that will be used;
- PSR review – where the operating organization performs the review in accordance with an agreed PSR Basis Document (as described in paragraph 4.6). (RU-1) This review should identify findings (which may be positive (strength) or negative (deviation)) and propose safety improvements and an integrated implementation plan;
- Regulatory review – where the regulatory body reviews the operating organization's PSR reports and proposed safety improvements, identifies any regulatory issues (e.g. whether further safety improvements need to be considered), reviews the proposed integrated implementation plan and determines whether the licensing basis for the NPP remains valid;
- Finalization of the integrated implementation plan-where the integrated implementation plan, comprising of reasonable and practicable safety improvements and timescales agreed with the regulatory body, is finalized.

The implementation phase of the safety improvements is considered a post-PSR activity.

3. PSR INPUT IN ASSESSING LONG TERM OPERATION OR LICENCE RENEWAL

3.1. Continuing the operation of a NPP beyond the time frame originally anticipated for their operation (typically 30-40 years) has become a priority for many operating organization. Long term operation of a NPP may be defined as operation beyond an established time frame ~~set forth~~ (UK-25) (e.g. by license term, design, standards, license, and/or regulations, etc), which has been justified by safety assessment, considering life limiting processes and features for Structures Systems and Components of a NPP. Refs. [5], [6] and [7]

3.2. PSRs are considered an effective way to obtain an overall view of actual plant safety, to determine reasonable and practical modifications that should be made in order to ensure a high level of safety. PSRs can be used as a mean to identify time limiting features of the plant in order to determine if there is a need to modify, refurbish or replace certain systems, structures or components (SSCs) in order to ensure that (US-1) the designed lifetime of an NPP can be extended.

The intent of this Safety Guide is not to provide recommendations for the activities performed during the long term operation. However, the Periodic Safety Review process can be used to support the decision making process for long term operation or licence renewal.

3.3. It is recognised that some Member States utilise alternate processes, equally adequate as PSRs, for justifying an NPP lifetime extension. In these cases the necessary plant modifications and related evaluations justifying a licence renewal will be performed separately. However, when an alternative approach is followed, attention should be given to the scope and objectives of the safety assessments which should be agreed with the regulatory body. (FIN-5)

3.4. Where the Periodic Safety Review process is used to support the decision making process prior to entering long term operation (Ref. [8]], the Periodic Safety Review should identify any necessary safety improvements to ~~re-assure~~ ensure (US-2) that the licensing basis remains valid during the period of long term operation. ~~This~~ These improvements (UK-27) might include refurbishment, additional systems, structures and components and/or additional safety analysis and engineering justifications.

3.5. In addition, the scope of the review of the PSR safety factors should be adapted to determine the feasibility of long term operation. For example, the scope of the ageing effect safety factor should be expanded to include an evaluation of the time limited ageing analyses.

During the review, increased importance should be given to ageing mechanisms and ageing management programmes Ref. [8].

3.6. If a Periodic Safety Review is used ~~for~~ to account (SP-16) long term operation or license renewal, the proposed new lifetime period should be evaluated as a whole, not only the next 10-year operating cycle. (GER-5). Furthermore, if the long term operation or licence renewal is approved, consistent with the guidance in this document, Periodic Safety Reviews should be performed in a 10-year cycle after the approval of the new end of plant life or at the frequency required by the national regulatory authority. (US-3)

3.7. The existing NPP documentation and ongoing programmes are essential in developing the basis for successful long term operation. The existence of the following NPP programmes and documentation, which impact SSCs and areas of safe plant operation, should be reviewed and considered as a precondition for long term operation:

- Plant programmes required to support the plant design, actual condition of SSCs, equipment qualification, and ageing management safety factors;
- Management systems that address quality assurance and configuration management;
- Safety analyses involving lifetime limiting assumptions.
- Safety culture improvement programs focused on the pursuit of excellence in all aspects of safety management and human factor activities.

3.8. Each of the previous preconditions should be properly documented in the updated Final Safety Analysis Report for long term operation and/or (ENISS-4) in other licensing basis documents and should clearly and adequately describe the current licensing ~~basis~~ documents (ENISS-4) or the current design basis requirements for nuclear power plant operation.

3.9. The necessary safety improvements for long term operation (JAP-30) identified in the Periodic Safety Review should be an input, ~~beside economic arguments~~, (GER-6) to the decision whether to enter long term operation.

4. REVIEW STRATEGY AND GENERAL METHODOLOGY

4.1. The scope of a PSR should include all safety aspects of a nuclear power plant agreed with the Regulatory Body. (SP-17) For this purpose, a plant consists of all facilities and structures, systems, and components (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 staff and the operating organization.

4.2. In a PSR for an NPP with several units:

- Aspects such as radiological protection, emergency planning and radiological impact on the environment could be covered in safety factors that are common to all units.
- Other safety factors (for example, the actual condition of SSCs, ageing and safety performance) are specific to each unit, and this should be taken into account.

4.3. The performance of one PSR for multiple standardized units could decrease the needed resources or effort since the plant designs are similar and some aspects of the review can be dealt on a generic basis. But if the units are located at different sites the site-specific, organisational and human aspects should be taken into (GER-7) account separately.

4.4. ~~For a comprehensive periodic safety review, this safety guide recommends that 14 safety factors, grouped in 5 areas (listed in Section 2) should be used.~~ This safety guide recommends that 14 safety factors should be used which are described in detail in the Section 5. However, the number of safety factors and/or their grouping may be different according to the specific needs of the operating organization and the particulars of the nuclear power plant (covering the scope described in 4.1). (GER-8) (Armenia-4)

4.5. The precise approach and the review process adopted should be customized to the national legal context and relevant regulatory processes. A Member State may wish to extend the list of safety factors, for example, by considering radiological protection or other issues as separate safety factors or they may combine or group the safety factors differently. ~~A Member State may also extend the scope of PSR to consider non-radiological impact of NPP.~~ (ENISS-5)

4.6. Before the review work is started, a number of prerequisites should be satisfied. The main prerequisite is an agreement between the operating organization and the regulatory body as to the scope and objectives of the PSR including current national and international standards and

codes to be used. This agreement is documented in the PSR Basis Document which should be developed by operating organization and approved by the regulatory body. (RU-2)

4.7. The PSR Basis document is an essential instrument that governs the conduct of the PSR and regulatory review of the PSR results. The Basis Document should identify the scope, major milestones, including cut-off dates, and methodology of the PSR, the safety factors to be reviewed, and the national and international applicable standards, codes and practices. The process for categorizing, prioritizing and resolving findings should be agreed upon as well.

4.8. Priority should be given to meeting the current national safety regulations, standards. Other documents such as international safety standards and practices, and national or international guides should be met to the extent practicable. The selection and hierarchy of safety standards and practices should be clearly stated in the PSR Basis Document. Special attention should be paid to the Safety Standards by the State of origin of the technology. (SP-18)

4.9. If there are no adequate national standards, the reference should be made to international codes and standards (such as those of the IAEA, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)) or, where appropriate, codes and standards of a recognized organization of a particular State (e.g. the American Society of Mechanical Engineers (ASME), the Kerntechnische Ausschuss, (GER-9) (FRA) or the Institute of Electrical and Electronics Engineers (IEEE)). (SP-19)

4.10. The practices of international organizations, such as the good practices of World Association of Nuclear Operators (WANO) and IAEA as well as the information generated by Owners Groups (SP-20), could also be relevant and should be taken into account.

4.11. 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 processes used to conduct the PSR and produce the review documents should comply with the requirements of relevant national or international standards.

4.12. The PSR Basis document should provide or reference a project plan that identifies all the activities to be performed for the PSR, the timelines and the responsibilities. This should present a realistic and reasonable project schedule for the conduct of the PSR, including sufficient allowances for completion of reviews by the regulatory body. The typical content of a PSR Basic document is presented in Appendix B.

4.13. The schedule should take into account that the review of the safety factors is an iterative process and that the interface between factors also has to be taken into account. (UK-32) The teams reviewing different Safety Factors should communicate during the review process starting from the preparation phase of PSR. Certain findings identified during the review of a safety factor need to be considered during the review of other safety factors. ~~The outputs of certain safety factors are inputs among other input information, for other safety factors.~~ The outputs from the review of some safety factors can be relevant as inputs to the review of other safety factors. (UK-33) (US-4) Typical lists of input and output information of each safety factor are provided in Appendix A.

4.14. Unless otherwise stated in the national regulation, the starting point of the PSR should be the time of the agreement between the operating organization and the regulatory body; the end point is the agreement/ or approval of an integrated implementation plan by the regulatory body.

4.15. In the case of a first PSR, experience has shown that for a large number of NPPs, with poor or limited documentation, the design bases should be recovered, and the design documentation updated in accordance with actual configuration and a proper justification (e.g. renewal of obsolete or incomplete Final Safety Analysis Report (FSAR) (UK-35) ~~For the plants, with modern configuration management and safety analysis, the first PSR request much less efforts.~~ For a modern plant, constructed and put into operation with an up-to-date safety analysis and for the plants with effective configuration management, the effort committed for the first PSR may be less than experienced on NPPs that require the recovery of the design basis. (UK-36 (US-5)

4.16. The effort required to carry out a second or subsequent PSRs of NPPs can often be ~~significantly~~ considerably (FRA) reduced compared to the first PSR. In general, the review work of subsequent PSRs should focus on changes in requirements, plant conditions, operational experiences and new information, rather than repeat the activities of previous reviews. However, the review should consider explicitly whether the earlier review work continues to remain valid (e.g. in light of the time elapsed since it was performed).

4.17. The Periodic Safety Review should take account of existing ongoing processes, such as configuration management, ageing management, etc. and should review the results and/or trend analyses of these processes to evaluate their effectiveness.

4.18. When a Final Safety Analysis Report (Ref. [9]) is part of the safety and/or licensing documentation of the NPP, this report should be utilized for the Periodic Safety Review.

4.19. Since the configuration management programme is aimed at ensuring that the operation, maintenance, testing, refurbishments and modifications of the NPP are in accordance with the design requirements, NPP safety documentation should be kept updated on an ongoing basis and should maintain consistency throughout the operational life-cycle. Therefore, the effectiveness of the existing configuration management programme should be confirmed during the Periodic Safety Review. Experience has shown that licensees with good configuration management programmes find it easier to perform the Periodic Safety Review.

4.20. Some of the safety factors or part of a safety factor could be assessed continuously in other contexts and by different means but the method and the results, including trends, should be assessed within the PSR.

4.21. Experiences from Member States have shown that, if the operating organizations do not have an overall plant technical database, it is reasonable to establish a common set of databases for the review of the 14 safety factors and the global assessment.

4.22. The safety factors should be reviewed for all operating conditions (including accident conditions) if applicable (ENISS-6) and be assessed against current national and applicable international safety standards and practices as identified in the PSR Basis Document. The review method should be systematic.

4.23. As part of the review of each safety factor all the documents listed in the PSR Basis Document should be evaluated for completeness.

4.24. Findings from the safety factor reviews should be evaluated and the timing of proposed safety improvements determined. The proposed plan should recognise the need to implement safety improvements as soon as reasonable and practicable in accordance with the global assessment (Section 6). In cases where there is an immediate and significant risk to safety, the operating organization should study prompt action, immediately propose it to the Regulatory Body and not wait until the PSR process concludes. (SP-22)

4.25. The level of plant safety should be determined by a global assessment reflecting, among other things, the combined effects of all safety factors. It is possible that a deviation in one safety factor can be compensated for by strength in another safety factor. Section 6 provides further recommendations on global assessment. (ENISS-8) (GER-10_ to delete 5.4)

4.26. If the design basis is not currently documented for an NPP, the operating organization should re-establish the design basis requirements early during the Periodic Safety Review.

4.27. The results of relevant studies, routine and special safety reviews, as well as licensing, compliance or operational activities should be utilized, as appropriate, as input into the PSR to minimize any duplication of effort. The source of all information should be referenced appropriately and an explanation be provided of how each reference has been used. (UK-38)

4.28. The safety improvements should be implemented in accordance with the Integrated Improvement Plan submitted by the operating organization and agreed/or approved by the regulatory body. For PSRs for multiple units, the safety improvements may be implemented in a lead unit and lessons learned used for the implementation of the safety improvements in the remainder of the units.

4.29. ~~A global assessment of any shortcomings that cannot be reasonably and practicably corrected is made, account being taken of all the corrective actions and/or safety improvements and the strengths of the nuclear power plant.~~ A global assessment should evaluate the position achieved at the end of the PSR process, and justify the case for any shortcomings that cannot be reasonably and practicably corrected. (UK-39) The global assessment should take into account all the corrective actions and/or safety improvements and the strengths of the nuclear power plants. (US-6) (Armenia-5)

The risks associated with the unresolved shortcomings should be assessed and an appropriate justification for continued operation should be provided. ~~Section 6 on Global assessment in Section 8, on PSR reviews, discuss in detail about safety improvements, prioritization, ranking, etc.~~ Section 6 provides further discussion on the content of the global assessment, and on the prioritization and categorisation of safety improvements. (UK-40) (GER-11)

4.30. The results of the review should be documented in reports to be produced by the operating organization and submitted to the regulatory body, if required. (JAP-3).

~~- Safety Factor Report as identified in the PSR Basis Document~~

~~- Global assessment report documenting the results of the global assessment~~

~~- PSR Final Report including the proposed safety improvements and integrated implementation plan and a summary of the safety factors and global assessment reports.~~

The structure of documentation should be described in the PSR Basis Document, along with the programme for submission to the regulatory body. An example structure may be:

- Safety Factor Report;
- Global assessment report documenting the results of the global assessment; and

- PSR Final Report including the proposed safety improvements and integrated implementation plan and a summary of the safety factors and global assessment reports.

The contents of these documents within this structure are described in Appendix B. (UK-41)

5. SAFETY FACTORS IN A PERIODIC SAFETY REVIEW

5.1. All important aspects of the safety of an operational nuclear power plant that are addressed in a PSR are defined as safety factors and these are described in Section 4. ~~The 14 PSR safety factors, their individual objective, scope and tasks and also the specific methodology are defined and explained in this section.~~ The general methodology should lead to the adoption of a common plan of presentation of recommendations for 14 PSR safety factors. (ENISS-9) The 14 PSR safety factors, their individual objective, scope and tasks and also the specific methodology are defined and explained in this section. Information on interfaces between safety factors is given in Appendix A and the information on relevant inputs, outputs and references for each safety factor are given in Annex. The content of the typical safety factor report is listed in Appendix B.

5. 2. The method of the review should be systematic independent from the ongoing oversight process by the regulator. For some requirements and standards a high level or programmatic review could be performed but should be addressed in the PSR basis document. (ENISS-10)

5.~~2~~ 3. For a comprehensive periodic safety review, this safety guide recommends 14 safety factors (listed in Section 2) that should be applied to activities covered by the operating licence for a particular nuclear power plant. (ENISS-11) However, the number of safety factors may vary according to the specific needs of the operating organization and the particulars of the nuclear power plant and with the agreement of the regulatory body. (SP-23) (Armenia-6)

5.~~3~~ 4. Radiological protection is not regarded as a separate safety factor since it is related to most of the other safety factors. The arrangements for radiological protection and their effectiveness should generally be reviewed as specific aspects of the safety factors: plant design, actual condition of SSCs, safety performance and procedures of the NPP. However, it may be desirable by some operating organizations to review radiological protection as a separate safety factor. (See para. 4.5) (Armenia-6)

5.4. ~~The level of plant safety should be determined by a global assessment (Section 6) reflecting, among other things, the combined effects of all safety factors. A deviation concerning a specific subject in a safety factor can be compensated by strength of this subject in another safety factor.~~ (ENISS-12) (GER-12) (Armenia-7)

5.5. Findings from individual safety factor assessments may indicate that plant safety is acceptable, however their ~~combined effect~~ interaction with other safety factors related to a specific subject should be reviewed for acceptability in the global assessment. (ENISS-13) (GER-13)

5.6. The review should determine the status of each safety factor at the time of the PSR and whether potential failures or deviations from normal operation are capable of being identified, prevented or mitigated before they could cause a radiological incident at least until the next PSR. Age related degradation mechanisms that could lead to failures of SCCs important to safety (UK-46) or (UK-47) that could potentially limit the plant operating lifetime should be identified to the extent possible.

5.7. The level of effort necessary to review a safety factor is dependent on the quality, (SP-24) availability and retrievability of relevant information.

5.8. As paragraph 4.7. recommends, prior to the review of safety factors all related documents should be listed in the PSR Basis document, but during the review process additional documents could be identified. As part of the review of each safety factor all the documents listed in the PSR Basis Document or identified later should be evaluated for completeness. (Armenia-7)

5.9. The outputs from the review of safety factor (9) „Use of experience from other plants and research findings" could be early inputs to the reviews of other safety factors except that of safety performance. Therefore, the majority of the tasks in this review should be addressed early in the PSR for input into the other safety factor reviews.

5.10. Prior to the review of different safety factors methods to assess, categorize, rank and prioritize findings should be established before their reviews start and it should be documented in the safety factor review reports. (ENISS-15) (SP-26)

5.11. ~~The safety factor review should identify strengths and deviations~~ The safety factor reviews identify strengths and deviations (see para. 2.15.) which should should be documented in the safety factor review report. If there are no changes in Safety Standards or in the plant a statement should be made in the report. (ENISS-16) (SP-27)

5.12. Deviations can be categorized as follows:

- deviations for which no improvement is necessary or no improvement can be identified, or
- deviations for which safety improvements are necessary.

5.13. Deviations ~~for which no improvement is necessary, or no improvement can be identified,~~ should be justified by the operating organisation and agreeded to the regulatory body consistent with national legal requirements or similar. (UK-49) (CAN B-5) (ENISS-18) (Armenia-7)

5.14. Deviations which need safety improvements, including updating/or extending plant documentation, including operating procedures, should be with categorised (by safety significance) and prioritized. The approach for the categorising (UK-50) and prioritization of safety improvements can be based on deterministic analyses, probabilistic safety assessment, engineering judgement, ~~cost benefit analysis,~~ etc. (GER-14) (JAP 11) (SP-28) (ENISS-19)

These safety improvements, along with the safety improvements resulting from the global assessment, should be included in the integrated implementation plan.

5.15. ~~As it is stated in paragraph 4.24. if the safety factor review team identifies a finding that poses an immediate significant risk to health and safety to workers or the public, implementation should not await the completion of the PSR but the operating organization should take a prompt corrective action.~~ As it is stated in paragraph 4.24. if the safety factor review team identifies a finding that poses an immediate significant risk to health and/or safety to workers, the public or environment, implementation should not await the completion of the PSR but the operating organization should study and submit to agreement of Regulatory Body corrective actions to reduce the immediate significant risk. (SP-29) (ENISS-20)

5.16. Findings which have interface with other safety factor should be discussed immediately with the related review team.

5.17. Findings identified as a result of the safety factors review should be documented in a safety factors report.

Plant

SAFETY FACTOR 1 - PLANT DESIGN

5.18. Plant SSCs important to safety should have appropriate characteristics and should be configured in such a way as to meet the requirements for plant safe operation and performance in compliance with design characteristics (UKR-2) including the prevention and mitigation of events that could jeopardize safety. The safety requirements for design are given in Ref. [5] and [10]. Adequate design information, including information on the design basis, should be

available to provide for the safe operation and maintenance of the plant and to facilitate plant modifications.

Objective

5.19. The objective of the review of this safety factor is to (Armenia-11) determine the adequacy of the design of the NPP and its documentation in an assessment against current licensing basis (FRA 26) and national, international standards, requirements and practices.

Scope and Tasks

5.20. The review of the NPP (including site characteristics) should include the following tasks:

- Review the list of SSCs important to safety for completeness and adequacy
- Review appropriate characteristics to meet the requirements for plant safety and performance for all plant conditions and applicable operating period, including:
    - the prevention and mitigation of events (faults and hazards) that could jeopardize safety,
    - the application of defence in depth levels (reference documents required), engineered barriers for preventing the dispersion of radioactive materials (integrity of fuel, cooling circuit and containment building) (FIN-8)
    - safety requirements (e.g. dependability, robustness, and capacity), and
    - design codes and standards.
- Identify differences between the previous standards (fulfilled by the present plant design) and current nuclear safety and design standards
- Review of the adequacy of the design basis documentation. (UK-52)
- Review compliance with plant design specifications.
- Review the safety analysis report or licensing basis documents (inclusion of all plant modifications and their cumulative effects and update the site characterization).
- Review plant SSCs important to safety to ensure that they have appropriate design (SP-30) characteristics and are combined and segregated in such a way as to meet the requirements for plant safety and performance, including the prevention and mitigation of events (current list of events to be considered in design and severe accidents) that could jeopardize safety.

- Review the spent fuel storage pool strategy and carry out an engineering assessment of the condition of the storage facilities, the records management and the inspection regimes being used. (UK-53)

This review will have a specific scope depending on the changes in licensing bases standards. (SP-31) (ENISS-24)

5.21. IAEA safety requirements for design, site or design related aspects are given in Ref. [3], [5], [10], and recommendations related to the safety analysis report are given in Ref. [9]. The recommendations for design of radiation protection systems are in Refs. [11] and [12].

Methodology

5.22. The method of the review should be systematic by performing a clause-by-clause review of national and international requirements and standards for compliance where applicable. (SP-32) (ENISS-26)

Methods to consider include to:

- subdivide the review into topics by plant systems, such as reactor core, reactor coolant system, containment system, instrumentation and control systems, electrical power systems and auxiliary systems, or
- perform a comparison of standards and requirements to identify changes between versions and the effect on plant design.

In some cases, the national requirements and standards may be best addressed by a high-level or programmatic review. If this approach is to be adopted, the PSR Basis Document needs to clearly indicate this intention. (UK-54)

For some ~~requirement~~ standards, a high level or programmatic review could be performed and agreed to by the regulatory body. (CAN A-22) (ENISS-26)

5.23. ~~The review of the plant design should confirm that there is an adequate list of SSCs important to safety (the current version of the safety analysis report may be helpful in performing this activity).~~ The review of the plant design should confirm an adequate list of SSCs important to safety to identify the differences in plant design as assessed against current safety standards (including relevant design codes) and to determine their safety significance. If a list of SSCs is not available, the operating organization should develop one for the PSR. ~~The list should identify the differences in plant design as assessed against current safety standards~~

~~(including relevant design codes) and determine their safety significance.~~ (ENISS-27) (SP-33 Separate) (Hungary-1)

5.24. Application of the defence in depth concept in the design (review of the safety function of SSCs to prevent or mitigate the identified events) should be considered. Adequacy of the application of principles, such as redundancy, separation and diversity, ensuring the plant safety should be reviewed. The independency of defense in depth levels should also be reviewed. (FIN-10) (ENISS-28)

5.25. Where the plant has undergone many modifications over its lifetime or in the period since the last PSR, the cumulative effects of all modifications on the design should be considered (e.g. the loading on electrical supplies or post trip cooling demands on water supplies)

5.26. A PSR should confirm that significant documentation relating to the original/reconstituted design basis has been obtained, securely stored and updated to reflect all the modifications made to the plant since its commissioning. Recommendations on meeting the requirements of Ref. [13] for document control are presented in Ref. [14].

5.27. A design re-evaluation should be undertaken:

- If design information is inadequate and there is uncertainty over the adequacy of the SSC to carry out its safety function; *or*,
- If there is a potential for a component to result in an increased risk for the hazard, eg steam release or internal flooding. (UK-55)

~~Where design information is inadequate and there is uncertainty over the adequacy of the SSC important to safety to carry out its safety function or if there is a potential for component to lead an increased risk of a hazard (e.g. steam release or internal flooding), a design re-evaluation should be undertaken.~~ (ENISS-30)

SAFETY FACTOR 2 - ACTUAL CONDITION OF SYSTEMS, STRUCTURES AND COMPONENTS IMPORTANT TO SAFETY (ENISS-32)

5.28. ~~Knowledge of the actual condition of the SSCs of the nuclear power plant is of prime importance to safety and whether it is adequate for them to meet their design requirements. This includes knowledge of any existing or anticipated obsolescence of plant systems and equipment. In addition, the condition of the SSCs needs to be properly documented~~. The actual condition of SSCs within the nuclear power plant is an important factor in any

assessment of the adequacy of SSCs to meet design requirements. Hence, it is important to document thoroughly the condition of a SSC. Additionally, knowledge of any existing or anticipated obsolesce of plant systems and equipment should also be taken into account. (UK-56)

Objective

5.29. The objective of the review is to determine the actual condition of SSCs important to safety whether ~~it is~~ they are capable (Slovakia 1) and adequate ~~for them~~ to meet their design requirements until at least the next PSR. In addition, the review should confirm that the condition of SSCs is properly documented, including the on-going programs of maintenance, surveillance and in-service inspection, as applicable.

Scope and tasks

5.30. The review of the condition of the SSCs of the nuclear installation important to safety should consider the following aspects for each SSC:

- Existing or anticipated ageing process,
- Operating conditions and limits,
- Current state of obsolescence ,
- Implications of changes to design standards as they relate to the actual condition of the plant since the plant was designed or since the last PSR (e.g. changes to material properties),
- Plant programmes required to support the actual condition of SSCs, (Slovakia 2)
- Significant findings of tests that demonstrate the functional capability, (UK-57)
- Results of significant inspections, (UK-57)
- Maintenance and validity of records ,
- Evaluation of operating history ~~and operational occurrences~~ (FRA31) related to the given SSC,
- Verification of the actual state of the SSC against the design basis,
- Dependency on obsolescent equipment for which no direct substitute is available, (UK-59)

- Dependency on essential services/supplies external to the facility under consideration, (UK-60)
- The condition and operation of the spent fuel storage facilities and their effects upon the spent fuel storage strategy for the NPP, (UK-58)

Methodology

5.31. The actual condition of the SSCs of the nuclear power plant should be reviewed using knowledge of any existing or anticipated ageing process, ~~operating~~ modification history (UK-61)**,** operating history or obsolescence of plant systems and equipment. The implications of changes to design standards since the plant was designed or since the last PSR should be considered in the review of plant condition.

5.32. The inputs to the review of the actual condition of the SSCs should be available from the operating organizations ageing management processes; however, if such processes do not provide adequate information, these should be derived at an early stage of the PSR.

5.33. Where data are lacking, they should be generated or derived by performing special tests, plant walk downs and inspections as necessary. The validity of existing records should be checked to ensure that they accurately represent the actual condition of the SSCs, including any significant findings from ongoing maintenance and inspection.

5.34. It may not be possible to determine the actual condition of some areas of the plant, due to, for example, plant layout or operating conditions that preclude a necessary inspection. Such areas should be highlighted and their safety significance considered. It may be possible to use evidence from similar components from other plants or facilities, which are subject to similar conditions, and knowledge of the ageing processes and operating conditions to judge the current condition of the plant.

5.35. For practical purposes and to ensure completeness, the SSCs may be grouped according to functional systems, or to similarities in the particular types of component.

5.36. After determining the current condition of the SSCs important to safety, each SSC should be assessed against its current design basis (updated design basis due to plant modifications or other changes) to confirm that the design basis assumptions have not been significantly challenged and will remain unchallenged until the next PSR.

5.37. Where consistency with the design basis has been significantly affected, corrective action proposals should be made and considered in the global assessment. This may include additional inspections, and (CAN O-10) safety analysis or, in some cases, component replacements.

SAFETY FACTOR 3 - EQUIPMENT QUALIFICATION

5.38. Plant equipments important to safety should be properly qualified to ensure their capability to perform its safety functions under postulated service conditions, including those arising from external events and accidents (such as loss of coolant accidents, high energy line breaks and seismic or other vibration conditions) in a manner consistent with the safety classification. The qualification should be followed and maintained during the plant operation. (FIN-12)

Objective

5.39. The objective of the review is to determine whether the plant and equipment ~~with roles/functions which are important to each defence in depth level~~ important to safety (Slovakia-3) (CAN O-11), have been properly qualified (including for environmental conditions) ~~and separated~~ and that this qualification is being maintained through adequate data records, maintenance, inspection and testing during the period until at least the next PSR. (FIN-13)

Scope and tasks

5.40. The review of this safety factor should include the review of the effectiveness of an equipment qualification program which should ensure that the equipments (including cables) are capable to fulfil their safety function (CAN O-12) for the period until at least the next PSR, the requirements for performing safety functions while subject to the environmental conditions (e.g. seismic, vibration, temperature, pressure, jet impingement, electromagnetic interference, irradiation, corrosive atmosphere and humidity, hydrogen fire and combinations thereof (Egy-2) prevailing (under normal and where appropriate, accident conditions) with account taken of the ageing degradation of the equipment that occurs during service and possible changes in the environmental conditions. (FIN-14)

5.41. Qualification of plant equipment important to safety should be (UK-64) (CAN O-13) formalized using a process that includes generating, documenting and ensuring evidence that

equipment can perform its safety functions during its installed service life. This should be an ongoing process, from the plant design to the end of service life. This process should take into account plant ageing, modifications, repairs and refurbishment, equipment failures and replacements, and abnormal operating conditions. Although many parties (such as plant designers, equipment manufacturers and consultants) are involved in the equipment qualification process, the operating organization has the ultimate responsibility for the development and implementation of a plant specific equipment qualification programme that includes generating and maintaining the documentation demonstrating qualification. (Armenia-13)

5.42. Plant equipments (i.e. SSCs) qualified to perform their safety functions should be reviewed to ensure it continues to perform its safety functions under postulated service conditions, including those arising from external events and accidents (such as loss of coolant accidents, high energy line breaks, exposure to moisture and seismic or other vibration conditions) and severe accident in a manner consistent with the safety classification [5], [7], [15], [16], [17].

5.43. The adequacy of the qualification procedure used to ensure and confirm that the equipment is capable of meeting its safety function, for the period until at least the next PSR, should be reviewed.

5.44. As part of this safety factor the following should also be reviewed:

- Installed equipment meets the qualification requirements.
- Adequacy of the equipment qualification record
- Procedures to maintain qualification throughout the installed service life of the equipment.
- Procedures which ensure SSC modifications and additions do not compromise equipment qualification.
- Surveillance programs and feedback procedures 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. (FIN-15)
- Protection of qualified equipment from adverse environmental conditions.

- Physical condition of qualified equipment (to be confirmed by walk downs where practicable see also previous safety factor) (FRA 38).

Methodology

5.45. Based on the existing safety standards plant equipments were classified, designed, manufactured and qualified according to their importance to safety. As a minimum, the review should confirm that the related equipment qualification requirements remain valid. This review should also include assessment of the following: (UK-66)

- the changes in the equipment classification resulted from design modifications;
- qualification for the environmental conditions;
- availability status of equipment serving the safety functions; ~~to be considered in safety analyses;~~ (CAN B-10)
- quality management provisions to maintain qualification measures are in place.

5.46. The review of equipment qualification should determine (a) whether assurance of the required equipment performance capability was initially provided and (b) whether equipment performance has been preserved by ongoing application of measures such as scheduled maintenance, condition monitoring, (US-7) testing and calibration and that it has been clearly documented.

(a) whether assurance of the required equipment performance capability was initially provided, (b) whether equipment qualification specification is still valid (e.g. initial assumptions on lifetime and environmental conditions), and

(c) whether equipment performance has been preserved by ongoing application of measures such as scheduled maintenance, testing and calibration and that it has been clearly documented. (FIN-16)

5.47. The review should evaluate the results of walk downs of the installed qualified equipment to identify any differences from the qualified configuration (abnormal conditions such as missing or loose bolts and covers, exposed wiring or damaged flexible conduits). This should verify that the installed equipment matches the required qualification and should also determine whether the procedures for maintaining qualification are adequate.

SAFETY FACTOR 4 - AGEING

5.48. All SSCs of nuclear installations are subject to some form of physical changes caused by ageing which could eventually impair their safety function and service lifetime.

Objective

5.49. The objective of the review is to determine whether ageing of all SSCs important to safety is being effectively managed and whether an effective ageing management programme is in place for designed life time so that the required safety functions are maintained and if it is planned, for long term operation. (Slovakia-4)

Scope and tasks

5.50. The scope of this safety factor should be the review of the comprehensive ageing management programme established at the nuclear installation. The review should evaluate programmatic and technical aspects. The following aspects of the ageing management programme should be evaluated: (UK-68)

- The Ageing management programme for timely detection and mitigation of ageing mechanisms and/or ageing effects,
- Effectiveness of operational and maintenance policies and/or procedures in managing ageing of replaceable components.
- Evaluation and documentation of potential ageing degradation that may affect the safety functions of SSCs.
- Establish the effects of ageing on the long term safety features of the NPP plant beyond shutdown, for example the spent fuel storage facility. (UK-69)
- ~~Organization, staffing and resources~~ (ENISS-32)
- Performance indicators
- Record keeping

5.51. The review should evaluate the following technical aspects:

- Ageing management methodology,
- Operating organization understanding of dominant ageing mechanisms and phenomena including actual safety margins,

- Availability of data for assessing ageing degradation, including baseline, operating and maintenance history,
- Acceptance criteria and required safety margins for SSCs,
- Operating guidelines aimed at controlling the rate of ageing degradation,
- Ageing detection and mitigation methods, and
- Awareness of physical condition of SSCs, and any features that would limit service life.
- Ageing of all materials (including consumables, such as lubricants) and SSCs that could impair their safety functions should therefore be understood and controlled,
- Obsolescence of the technology.

Methodology

5.52. The ageing management programme should be reviewed to ensure it allows the detection and prediction of ageing degradation that might affect the safety functions and lifetimes of SSCs, (UK-70) and identifies appropriate measures for the maintenance of these functions. Program descriptions, evaluation and technical bases; plans for the reliability and availability of SSCs; the detection and mitigation of ageing; and actual physical conditions of the structures and components should be considered. The review should focus on the integrated system performance for the systems important to safety and on the results of periodic inspection programs and trends in certain important safety parameters

5.53. The review should consider whether effective control of ageing degradation is achieved by means of a systematic ageing management process as required by Ref. [2] and [5], and recommended by Ref. [7], consisting of the following ageing management tasks, based on the understanding of ageing of SSCs:

- Operation within operating guidelines with the aim of minimizing the rate of degradation;
- Inspection and monitoring consistent with the applicable requirements with the aim of the timely detection and characterization of any degradation;
- Assessment of the observed degradation in accordance with appropriate guidelines to assess integrity and functional capability;

- Maintenance (repair or replacement of parts) to prevent or remedy unacceptable degradation.

5.54. The review should assess that:

- A systematic and effective comprehensive ageing management programme is in place
- The comprehensive ageing management programme covers SSCs important to safety (RU-3), and also any non-safety related SSCs whose failure might inhibit or adversely affect a safety function
- All degradation mechanisms are identified, and the models used to predict the evolution and advancement of degradation are supported in accordance with current accepted practices pertaining to age related degradation
- Adequate measures are taken to monitor and control the ageing processes
- The comprehensive ageing management programmes ensure the continued safe operation for at least the period until the next PSR
- The period, until the next PSR is prognosticated. (JAP E1)

Safety analysis

SAFETY FACTOR 5 - DETERMINISTIC SAFETY ANALYSIS

5.55. A review of the deterministic safety analysis should be conducted for each nuclear power plant, confirming the design basis for items important to safety and evaluating the plant behaviour for postulated initiating events. (CAN B-10)

Objective

5.56. The objective of the review of the deterministic safety analysis is to determine to what extent the existing deterministic safety analysis is complete and remains valid when the following aspects have been taken into account:

- actual plant design including all modifications of SSCs since the last update of the Safety Analysis Report or the last PSR; (CAN A-26)
- current operating modes and fuel management;
- the actual condition of SSCs and their predicted state at the end of the period covered by the PSR

- use of modern (RU-4) validated codes;
- current deterministic methods;
- current safety standards and knowledge (including research and development outcomes);
- existence and adequacy of safety margins.

Scope and tasks

5.57. The review should include the following tasks:

- Review the application of analytical methods, guidelines and computer codes used in the existing deterministic safety analyses and compare them against current standards and requirements
- Review the current state of this safety analysis (original and updated) for the completeness of the set of postulated initiating events forming the design basis taking into consideration national and international operating feedback experience from plants of a similar design.
- Evaluate whether the assumptions made in performing the deterministic safety analyses remain valid given the actual condition of the plant.
- Evaluate whether the actual operational conditions of the plant meet the deterministic safety acceptance criteria of the design basis.
- Evaluate if the assumptions used in the deterministic analysis are in accordance with current regulations and standards, (Armenia-13)
- Review the application of the defence in depth principles including emergency operating and severe accident management procedures.
- Evaluate if appropriate deterministic methods are used for development and validation of emergency operating procedures and accident management programme at the plant.
- Evaluate if calculated radiation doses and radioactive releases for normal and accident conditions meet regulatory requirements and expectations.
- Analyze functional adequacy and reliability of systems and components, safety impact of internal and external events, equipment failures, and human errors, adequacy and effectiveness of engineering and administrative measures to prevent and mitigate design-basis-and beyond-design-basis accidents. (UKR-3)

The reference IAEA requirements for the review of deterministic safety analysis safety factor are in Refs. [3] and [5], recommendations are in Refs. [11], [12], [15], [18].

Methodology

5.58. In the review of this safety factor, the feedback and the progress of new knowledge in physical phenomena, analyses and modelling should be systematically considered.

5.59. The set of postulated initiating events forming the design basis should take into consideration operating feedback experience from the plant and from national and international plants of a similar design since the previous PSR and should be updated as necessary.

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

5.61. The review should identify or confirm any major weaknesses as well as the strengths of the plant design in relation to the application of defence in depth, and it should evaluate the importance of systems and measures to prevent or control accidents, using a complete set of postulated initiating events.

5.62. It is necessary to demonstrate or to reassess the capabilities of the plant in its more recent state including, if possible, the future improvements to cope with a specified range of plant states (normal operation, anticipated operational occurrences and design basis accident conditions) within the regulatory requirements and expectations.

5.63. If it is necessary to repeat the analysis, (SP-38) current analytical methods should be considered, particularly with regard to computer codes for transient analyses. The assumptions used in these calculations (conservative or best estimate) should be justified and inherent uncertainties should be identified and their potential impact assessed. (UK-71)

5.64. When the changes were relevant, (SP-39) the supporting analyses for beyond design basis accidents should be reviewed. It should be determined whether the arrangements aimed at preventing severe core damage and arrangements to mitigate its consequences are still sufficient and whether any improvements are reasonably practicable.

SAFETY FACTOR 6 - PROBABILISTIC SAFETY ASSESSMENT ~~ANALYSIS~~ (CAN A-27)

5.65. ~~PSAis a comprehensive and structured approach~~ The review of the PSA should be conducted to identify weaknesses in the design and operation of the plant and to evaluate and compare potential options for remedying any such weaknesses.

Objective

5.66. The objectives of the review of the PSA are to determine:

- to what extent the existing PSA study remains valid as a representative model of the plant
- whether the results of the PSA show that the risks are sufficiently low and well balanced across the postulated initiating events and operating states
- whether the scope (all operating modes, internal and external hazards) (Armenia-14), methodologies and ~~extend~~ extent (Hungary-2) (level 1, 2, 3) of the PSA are in accordance with current national and to the international standards and good practices
- whether the existing scope and applications of PSA are sufficient for the period of operation until the next PSR or whether it is required to develop new applications or to broaden the scope
- the extent to which the existing PSA can be used in the performance of the global assessment

Scope and tasks

5.67. The review of this safety factor covers in particular:

~~• Existing PSA and its assumptions.~~

~~• Updates of PSA to reflect the current plant status, including updated reliability data.~~

~~• Analytical methods and computer codes used in the existing PSA and comparable methods for a modern nuclear power plant, including validation.~~

~~• Guidelines for PSA of operator action, common cause events, cross-link effects, redundancy and diversity.~~

- Consistency of the accident management programme for beyond design basis accidents with PSA results.

- The existing PSA, its assumptions, fault schedule, representation of operator actions and common cause events etc are a valid representation of the current plant configuration and safety case. (Armenia-15)
- The scope and applications of the PSA are sufficient for at least the period of operation until the next PSR.
- Analytical methods and computer codes used in the PSA are valid and comparable with current methods.
- Review/evaluate the assessment and modeling of operator action, common cause events, cross-link effects, redundancy and diversity. (GER-16, GER-17) (Hungary-3)
- Review/evaluate the consistency of the accident management programme for beyond design basis accidents with PSA models (GER-16, GER-18)
- Results of the PSA show that risks are sufficiently low and well balanced across postulated initiating events and operating states, and meet the relevant probabilistic safety criteria.
- The use of the PSA results in informing the Beyond Design Basis Accident management programme. (UK-74)

The reference IAEA requirements for the review of probabilistic safety assessment safety factor are in Refs. [3] and [5], recommendations are in Refs. [15], [19]. [20].

Methodology

5.68. The probabilistic safety assessment should be reviewed to confirm that the model reflects the current design and operational features, including the accumulation of plant specific operating experience and all modes of operation with the scope agreed with the regulatory body. (SP-40)

5.69. The current state of this safety ~~analysis~~ assessment should be reviewed for the completeness of the set of postulated initiating events and hazards. (RU-5)

5.70. The extent to which hazards are represented in the PSA should be reviewed to confirm that ~~exclusions~~ omissions (FRA 52) are based on site specific justifications and that these omissions do not weaken the overall risk assessment of the plant.

5.71. The analytical methods and computer codes used in the PSA should be reviewed to ensure that current methods and validated computer codes are being employed.

5.72. If it is necessary to repeat or make some new assessment, (SP-41) the assumptions used in the calculations should be justified with respect to the inherent uncertainties in order to gain a better insight into ~~existing safety margins of the plant~~ PSA results (FRA 53).

5.73. The extent to which the potential for unidentified cross-links and the effects of common cause events (often not adequately considered in older plant designs) are considered in the model should be reviewed.

5.74. The human reliability analysis used in the PSA should be reviewed to ensure that plant-specific and scenario-depending actions are modeled and current methods are being used. (GER-19)

5.75. The results of the PSA should be compared with the probabilistic safety criteria (e.g. for system reliability, core damage and releases of radioactive material) when such criteria have been defined for the plant or set by the regulatory body.

5.76. The history of updating the PSA to reflect the current plant status should be reviewed against the past decision making process. Ideally a living PSA should be maintained, however, where this is not practical, the PSA should be kept sufficiently up to date during the plant lifetime to make it useful for making decisions relating to the safety of the plant. The scope should be agreed with the regulatory body. (SP-42)

5.77. The review should consider whether the existing scope and application of the PSA is sufficient for use in the global assessment and for making decisions in the period of operation until the next PSR or whether it is necessary to develop the model or broaden its scope.

SAFETY FACTOR 7 - HAZARD ANALYSIS

5.78. To ensure the availability of required safety functions and operator actions, SSCs important to safety, including the control room and emergency control centre, should be adequately protected against relevant internal and external hazards.

Objective

5.79. The objective of the review of hazard analysis is to determine the adequacy of protection of the nuclear power plant against internal and external hazards taking into account the actual plant design, actual site characteristics, the actual condition of SSCs and their predicted state at the end of the period covered by the PSR, and current analytical methods, safety standards and knowledge.

Scope and tasks

~~5.68. The review should evaluate whether the nuclear power plant is adequately protected against internal and external hazards.~~

For each hazard listed the review should evaluate whether there is adequate protection against the hazard, taking into consideration the following:

- Hazard magnitude;
- Hazard frequency;
- Current safety standards;
- Current understanding of environmental effects;
- The hazard withstand capability of the plant claimed in the safety case, based on its current condition and allowance for predicted ageing and degradation; and,
- Procedures are appropriate to cover claimed operator actions to prevent or mitigate the hazard. (UK-77)

5.80. If not previously done the review should establish a list of relevant internal and external hazards that may affect plant safety, taking into account the actual plant design, the actual condition of SSCs, site characteristics and international practice [15]. Among other things, changes in plant design, climate, flood potential, earthquake potential (FRA 56) and transport and industrial activities near the plant site should be considered.

5.81. The following internal hazards which may affect plant safety, should be reviewed:

- fire (prevention, detection and suppression);
- flooding;
- pipe whip;
- missiles, dropped loads; (UKR-4; drop of heavy loads)
- steam release;
- hot gas release
- cold gas release
- deluge and spray;
- toxic gas;
- explosion;
- electromagnetic or radio frequency interference
- toxic/corrosive liquids and gases;

- vibration;
- traffic;
- subsidence;
- external missiles;
- high humidity;
- structural collapse;
- loss of external services (cooling water, electricity, etc); (UK-80)

5.82. The following external hazards which may affect plant safety, should be reviewed

- flooding (including tsunami);
- high winds including tornado;
- external fire;
- meteorological hazards (temperature, extreme weather conditions high humidity, e.g. drought, snow, ice build up);
- sun storm;
- hydrogeological and (UK-79) hydrological hazards (extreme ground water levels, seiches);
- seismic hazards;
- volcano hazard;
- aircraft crash; external missiles;
- explosion;
- biological fouling;
- lightning strike;
- electromagnetic or radio frequency interference;
- toxic/corrosive liquids and gases;
- vibration;
- traffic;
- loss of external services (cooling water, electricity, etc); (UK-80)

5.83. Where a hazards list has previously been established the review should consider the completeness of the list taking into account international practice [15], operating experience from other plants, changes in plant design, climate change, and changes in transport and industrial activities near the plant site. The analysis should be repeated or revised if there are relevant changes on hazards, the plant, in the computer codes or in the standards. (SP-43)

Methodology

5.84. For each of the relevant hazards, the review should demonstrate, by using current analytical techniques and data, whether the probability or consequences of the hazard are sufficiently low so that no specific protective measures are necessary or that the preventive and mitigating measures against the hazard are adequate.

5.85. The review should take into account the actual plant design, actual site characteristics, the actual condition of SSCs and their predicted state at the end of the period covered by the PSR.

5.86. The analytical methods, safety standards and knowledge used in the review should be up-to-date and valid.

5.87. In considering the risk of a particular hazardous (CAN O-15) consideration should be given to national and international experience of hazards both at nuclear power plants and more widely.

5.88. ~~Consideration should be given to real occurrences of hazard events especially where these have occurred on nuclear power plants and the lessons in managing the event should be utilised to improve existing procedures, if needed (e.g. external flooding, seismic and tornado events).~~Knowledge gained from real occurrences of hazard events, in particular those that have occurred on nuclear power plants, should be identified. Any experience from managing such events (e.g. external flooding, seismic and tornado events) should be used to improve existing procedures. (UK-81)

5.89. The adequacy of the procedures used to prevent a hazard and mitigate the consequences of a hazard should be reviewed including the extent to which theses are tested and rehearsed (Refs. [21], [22], [23], [24], [25],[26], [27] and [28]). The adequacy of the preventive and mitigating measures can be determined by deterministic or probabilistic assessment (PSA).

Performance and feedback of experience

SAFETY FACTOR 8 - SAFETY PERFORMANCE

5.90. Safety performance is determined from assessments of operating experience, including safety related ~~incidents~~ event (FRA 62), and records of safety system unavailability, ~~operation of organization~~ radiation doses, and the generation of radioactive waste and radioactive effluents. (RU-6) (CAN A-29)

Objective

5.91. The objective of the review of safety performance is to determine whether the plant's safety performance indicators and records of operating experience including the evaluation of root causes of plant events indicate any need for safety improvements.

Scope and tasks

5.92. The review of this safety factor should evaluate if the plant has an appropriate process 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, testing,
- replacements of SSCs important to safety due to failures or obsolescence
- modifications (temporary or permanent), to SSCs important to safety
- safety systems unavailability,
- radiation doses (to workers , including contractors, and to the public),
- off-site contamination and radiation levels (UK-82)
- discharges of radioactive effluents (UK-82)
- compliance with regulatory requirements

5.93. The review of safety performance is closely linked to the Safety Factor "Use of experience from other plants and research findings", but for this safety factor should be confined to operating experience from the plant under review.

5.94. Where safety performance indicators are used, a review should be performed of all relevant indicators of safety performance which should be subjected to a trend analysis and comparison with other plants in the same nation and (UK-83) with international trends to highlight potential safety improvements.

~~5.95. The review should also consider the effectiveness of plant methods used to evaluate and consider operating experience trends and whether more guidance is required. The findings of other safety factors should be considered in undertaking this task.~~

5.96. In addition, the review should take account of the effectiveness of the methodology used to evaluate and assess operating experience and trends, to identify whether the methodology requires revision. The findings of the reviews of other safety factors should be considered in undertaking this task. (UK-84)

5.97. The review of radiation doses etc needs to consider the types of activity being undertaken. (UK-85) This will provide an indication of the risk posed to plant personnel. Data on radioactive effluents also provide some indication of the environmental impact.

5.98. Records of radiation doses and radioactive effluents should be reviewed to determine whether these are within prescribed limits, as low as reasonably achievable and adequately managed. Although radiation risks need to be considered generically across the PSR, the review of this safety factor should consider specifically data on radiation doses and radioactive effluents and the effectiveness of radiation protection measures. Records of radiation protection doses and radioactive effluents. (FIN-19)

5.99. Data on the generation of radioactive waste should be reviewed to determine whether operation of the plant is being optimized to minimize the quantities being generated and accumulated taking into account radioactive discharge policy. (FRA63)

Methodology

5.100. Where available the review should utilize a set of safety performance indicators, developed to provide systematic coverage of all aspects of operation important to safety. These indicators should provide information on both positive and negative aspects of safety performance. The safety performance indicators developed by IAEA, by some Member States and by the World Association of Nuclear Operators (WANO) could be used for this purpose. References [29] and [30] give recommendations and guidance on the use of safety indicators for verifying compliance with the requirements for safe plant operation established in Ref. [2]. Ref. [2] requires that the operating experience at the plant to be evaluated in a systematic way and that operating experience be used as an input to the PSR.

5.101. The review should also consider any other records of operating experience from the review period relevant to safety that have not been used for the set of safety performance indicators.

5.102. The review of this safety factor should check the implementation and effectiveness of the following processes:

- identification and classification of safety related events.
- root cause analysis of incidents and feedback of results.
- applied methods for selecting and recording safety related operational data, including those for maintenance, testing and inspection.
- trend analyses of safety related operational data.
- trends in component replacements due to failures or obsolescence.
- feedback of safety related operational data to the operating regime (e. g. training).
- qualification of workers and the quality of procedures and results.
- records of radiation doses and radioactive effluents.
- off site and on site contamination and radiation levels.
- quantities of radioactive waste accumulation
- compliance with regulatory requirements
- implementation of identified corrective actions from events (UK-86)

5.103. The evaluation of trend analysis over the past plant life or since the last PSR should be reviewed to highlight potential future safety concerns (e.g. precursors to accidents) or deteriorating safety performance. The results of the previous PSR should be considered in case there are longer term trends in deteriorating safety performance.

5.104. The review should pay particular attention to the effects of any changes in operation of the facility (e.g. use of a new design of fuel) on safety performance, and should only use indicators or records that have a continuing relevance to planned future operation at the plant.

5.105. Ref. [2] establishes the requirements for a radiation protection programme, including requirements for setting prescribed limits and for the management of radioactive waste and effluents arising from the operation of a nuclear power plant, and associated Safety Guides [31] and [32] provide relevant recommendations and guidance. These documents should be considered when reviewing the records of radiation doses, radioactive waste accumulation and radioactive effluent discharges.

5.106. The PSR should include a review of the effectiveness of the operating organisation's process for the routine evaluation of operating experience. However, where a common process is applied by the operating organization at several plants, and this process has been reviewed by

a recent PSR at another plant, this element of the review can be confined to reviewing how the process is applied at the plant under review. Ref. [33] provides detailed guidance on reviewing the effectiveness of the process for the feedback of operational experience.

5.107. Performance indicators also enable comparisons to be made with other nuclear power plants and provide an opportunity for operating organizations to benefit from each other's experience (see also para. 4.39). The extent to which this is being undertaken should be considered.

5.108. In cases where there are significant findings in the effectiveness of the process, the PSR should document a full review of operating experience at the plant over the review period.

5.109. Where the review indicates a weak performance or trend, the review should seek to identify possible root causes (e.g. deficiencies in procedures, training or safety culture).

5.110. For the purpose of providing data for other safety factors and consideration in the global assessment the results of the routine evaluations should be summarized to give an overall assessment of the safety performance during each year of plant operation addressed by the review period, if it is applicable (e.g. indicators, trends). (SP-45) Trends should be reported, and where necessary further analysis undertaken, to highlight any potential safety problems.

SAFETY FACTOR 9 - USE OF EXPERIENCE FROM OTHER PLANTS AND RESEARCH FINDINGS

5.111. Experience from other nuclear power plants, and sometimes from non-nuclear power plants (SP-46), together with research findings, can reveal unknown safety weaknesses or can help in solving existing problems. Ref. [2] requires operating organizations to obtain and evaluate information on operating experience at other plants and to derive lessons for its own operations. This should include information from other plants owned by the operating organization and wider national and international experience, including relevant aspects of non-nuclear facilities.

Objective

5.112. The objective of the review of experience from other plants and research findings is to determine whether there is adequate feedback of safety experience from other nuclear power plants and of the findings of research and whether this is used to introduce safety improvements at the plant or within the operating organisation Refs. [33] and [34].

Scope and tasks

5.113. The review should identify operating experience reports from other plants owned by the operating organization and relevant national and international experience and research findings, including reports and findings from non-nuclear facilities that may be important to nuclear safety. Then, it should be verified that this information has been properly considered in the routine evaluation of operating experience and research developments and that appropriate action has been taken.

5.114. The review of this safety factor is closely related to the review of safety performance addressed above. However, unlike the review of safety performance, the review of this safety factor should seek to identify good practices and lessons learned elsewhere and to take advantage of improved knowledge derived from research.

Methodology

5.115. The review of this safety factor should:

- Ensure arrangements are in place for the feedback of experience relevant to safety from other nuclear power plants and relevant non-nuclear plants
- Review the effectiveness of such operating experience programs and their output
- Review the process for assessing and, if necessary, implementing the output of research and operating experience relevant to safety

5.116. There are established arrangements for the dissemination of operational experience at nuclear power plants by the IAEA, the OECD Nuclear Energy Agency, WANO, the Institute of Nuclear Power Operations (INPO) and various plant owners' groups. The operating organization should have a process in place for receiving, analyzing and acting upon such operational experience. The PSR should provide a summary of the findings from this process and evaluate the effectiveness of the process. Where the review of effectiveness indicates significant shortcomings in the process, the PSR should include a review of wider operational experience from the review period; the appropriate measures should be taken. Those measures can be review of wider operational experience. (SP-47)

5.117. Arrangements for the dissemination of research findings are not as well established. The operating organization should nevertheless have arrangements for receiving and assessing information received as feedback as a part of its routine activities. The PSR should include a

review of the adequacy of these arrangements and the timely implementation of assessment findings

5.118. For an operating organization with more than one nuclear power plant, it may be more advantageous to have generic assessments applicable to several plants rather than perform specific reviews of this safety factor for each plant. Thus, in these circumstances (UK-89) a full review of this safety factor should be undertaken for the reference plant in a series of linked PSRs. Subsequent reviews for follow-on plants ~~should~~ may (SP-48) be limited to the consideration of any non-generic matters and make reference to the full review as long as PSR are performed within a short time frame so that reference review is still valid.

Management

SAFETY FACTOR 10 - ORGANIZATION, MANAGEMENT SYSTEM AND SAFETY CULTURE

5.119. The operating organization should have a management system to ensure that policies and objectives are established so that they are implemented in a safe, efficient and effective manner.[38] Similarly, the organization and individuals should have a safety culture to ensure that all duties important to safety are carried out correctly, with alertness, due thought and full knowledge, sound judgment and a proper sense of accountability.

Objective

5.120. The objective of the review of organization, management system and safety culture is to determine whether the organization, the management system and safety culture are adequate and effective for ensuring (UK-91) the safe operation of the nuclear power plant.

Scope and tasks

5.121. The review of management system (Slovakia 5) should include the (FRA71) review the following elements or programmes against national and international standards: (Armenia-16)

- Utility and/or (Armenia-17) plant policy statements of the operating organization
- Documented management system
- Structure of organizations directly responsible for operating facilities and activities and providing operating, maintenance and engineering services

- Roles and responsibilities of those managing, performing and assessing work
- Processes and supporting information that explain how work is to be specified, prepared, reviewed, performed, recorded, assessed, and improved.

5.122. In addition, the review of the management systems should:

- Confirm there are adequate processes for managing organizational change
- Confirm there is human resource management process that ensures (Egy-6) adequate, qualified human resources including succession planning.
- Confirm there is adequate control of documents, products and records and that this information is readily retrievable
- Confirm there is adequate control of purchasing of equipment and services where this affects plant safety
  - Verify that suppliers have adequate management systems (SP-49, rejected) in place to ensure that equipment and services supplied are fit for purpose and provided in an effective and efficient manner.
- Confirm there are adequate communication policies
- Confirm there are adequate facilities for training and that training programmes are well structured
- Confirm there are formal arrangements for employing suitably qualified internal and external technical, maintenance or other specialized staff
- Confirm there are adequate processes for feedback of experience to the staff including experience relating to organizational and management failures
- Confirm there are suitable arrangements for maintaining configuration of the NPP
- Confirm there are programmes for continuous improvement including self assessment and independent assessment (Armenia-18) (UK-93 Confirm)

5.123. The review of Safety Culture is an assessment of commitment to safety and should include:

- Review the safety policy to confirm that it states that safety takes precedence over production and that this policy is effectively implemented

- Review procedures to ensure that nuclear and radiation safety are controlled and applied consistently and conscientiously by all staff (SP-50_Rewrite)
- Assess the extent to which a questioning attitude and conservative decision making exist
- Verify that there is a strong drive to ensure that all events which have the potential to be instructive are reported and investigated to discover the root causes and timely feedback provided to appropriate staff on findings and remedial actions
- Ensure that unsafe acts and conditions are identified and challenged in constructive manner wherever and whenever they are encountered by plant employees and contractors.
- Ensure that the organization is a learning entity by searching for improvements and new ideas, and by benchmarking and searching out best practices and new technologies
- Ensure there is an established communication process for safety issues
- Verify there is a process for prioritization of safety issues with realistic objectives and timescales that ensures these issues receive proper resources.
- Ensure there is a method for achieving and maintaining clarity about the organizational structure and accountability for what is to be done.
- Ensure there is adequate training in safety culture, particularly for management staff.

The requirements of Ref. [13] and recommendations of Ref. [35], [36], [37], ~~[36]~~ (SP-51) and statements of Refs. [38], [39], [40], [41] and [42] should be considered in reviewing the tasks identified above.

Methodology

5.124. ~~Regular and systematic reviews of management systems to ensure that the safety policies and goals and objectives of the organization are being met are required, and should therefore be evaluated to ensure that the tasks identified above are completed.~~ Regular and systematic reviews of management systems are required to ensure that the safety policies, goals and objectives of the organisation are being met as required. These reviews should include evaluation of how the tasks highlighted in 5.123 are being undertaken and completed. (UK-94) This can be achieved by reviewing independent audits on behalf of senior management, task observations (JAP-17), self assessments and supporting corrective action plans.

5.125. The review should consider whether the regular management system reviews have been conducted at sufficient intervals and have covered:

- outputs from all forms of assessments (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

5.126. The review should also consider whether weaknesses and obstacles have been identified, evaluated and remedied in a timely manner. It should also consider whether the need to make changes to, or improvements in, policies, goals, strategies, plans, objectives and processes have been properly identified in the management system reviews.

5.127. Where scopes of the regular reviews of management systems do not address any of the above tasks the PSR should undertake a detailed review of the excluded tasks.

5.128. A safety culture assessment ~~should~~ could (JAP 14) be performed by interviewing all levels of personnel at the NPP and personnel supporting an NPP. If it is the review team who is going to perform the safety culture assessment through interviews, the team should integrate behavioural scientists to be able to carry out such assessment.

SAFETY FACTOR 11 - PROCEDURES

5.129. Procedures affecting nuclear safety (UK-95) should be comprehensive, validated, formally approved and subject to rigorous change and distribution (SP-52) control. In addition, they should be unambiguous and relevant to the actual plant (with modifications taken into account), and should reflect current practice and due consideration of human factor aspects (for example, it should be considered whether the procedures are user friendly).

The Ref. [2] and [5] establishes the requirements for operating procedures and associated Safety Guides Refs. [25], [29], [31], [35] and [43] provide relevant recommendations and guidance.

Objective

5.130. The objective of the review of procedures is to determine whether the operating organization's processes for managing, implementing and following operating and working (Armenia-19) procedures and for maintaining compliance with operational limits and conditions and regulatory requirements (FRA 80), are adequate, effective and ensure plant safety.

Scope and tasks

5.131. The review of the operating organization process should consider the following types of procedures:

- Operating procedures for normal and abnormal conditions (including operational occurrences, design basis accident conditions and post-accident conditions);
- Procedures for the management of beyond design basis accidents, including severe accidents (e.g. symptom-based emergency operating procedures).
- Maintenance, test and inspection procedures;
- Work permit procedures;
- Control procedures for the modification of the plant design, procedures and hardware, including the updating of documentation;
- Control of the operating configuration; (UK-96)
- Procedures for radiation protection, including those for on-site transfers of radioactive material. (Procedures for radioactive effluents and waste management) (FRA82)

Methodology

5.132. The review of ~~the procedures~~ this (Armenia-20) safety factor should:

- Ensure there is an effective process for formal approval and documentation of all safety related procedures
- Ensure there is a formal system for development and modification of a procedure governing safety-related activities.
- Evaluate audits, self assessments, safety performance and events to determine if there is understanding and acceptance of these procedures by management and staff
- Determine if procedures are followed

- Evaluate adequacy of these procedures in comparison with good practice
- Determine if arrangements for regular review and maintenance of these procedures are in place
- Ensure that procedure are structured and written taking into account human factor consideration (for example, it should be checked whether the procedures are user friendly and can be achieved by the number of staff present during their use (UK-98)
- Evaluate process to update procedures to allow for changes in the assumptions and limits and conditions arising from the safety analysis, plant design and operating experience.
- The analysis and justification of the accident management procedures are documented.
- Ensure an auditable trace can be undertaken of procedures (UK-99)
- Categorisation of documents (UK-100)
- Evaluate distribution process of procedures controlled copied and removal of obsolete edition, and that only the last approved edition is used (SP-53)

5.133. During the review of this safety factor it should be assessed whether procedures are comprehensive, validated, formally approved and subject to rigorous change control. The review should examine the processes for ensuring that the procedures are adequate and effective in ensuring safety. The review should focus on those procedures that are of high safety significance and should not entail a technical review of all procedures. (The safety significance can be determined from a deterministic safety analysis and a PSA.)

5.134. The review should consider if there is adequate involvement in the development of procedures by the staff that use them:

SAFETY FACTOR 12 - HUMAN FACTORS

5.135. Human factors influence all aspects of the safety of a nuclear power plant. The review should examine the status of the human factors to determine whether these comply with accepted good practices and do not present an unacceptable contribution to risk. In particular, it should determine whether the operating organization actions claimed to be in support of safety are feasible and properly supported.

Objective

5.136. The objective of the review of this safety factor is to determine the status of the various human factors that may affect the safe operation of the nuclear power plant.

Scope and tasks

5.137. The review of ~~the Human Factors~~ this (Armenia-22) safety factor should:

- Confirm that there are adequate staffing levels for the operation of the nuclear power plant with due recognition of absences, shift working and overtime restrictions.
- Confirm availability of qualified staff on duty at all time.
- Confirm there are adequate programmes for initial training, refresher training and upgrading training, including the use of simulators.
- Confirm that the operator actions have been assessed to confirm that assumptions made in safety analyses (probabilistic, deterministic and hazard analyses) are valid
- Confirm human factors in maintenance are assessed to promote error free execution of work
- Confirm there are adequate competence requirements for operating, maintenance, technical and managerial staff.
- Review systematic and validated staff selection methods (e.g. testing for aptitude, knowledge and skills)
- Review fitness for duty guidelines relating to hours, types and patterns (UK-105) of work, good health and substance abuse.
- Compare the policy to maintain the know-how of the plant staff against good practices and ensure adequate succession management
- review processes for employing suitably qualified external technical, maintenance or other specialist staff
- Confirm there are adequate staff training facilities and programs
- Review the following human-machine interface:
- design of the control room and other work stations
- analysis of human information requirements and task workload
- clarity and achievability of procedures

5.138. Review the following human-machine interface:

- design of the control room and other workstations;
- analysis of human information requirements and task workload;
- clarity and achievability of procedures.

Further recommendations and guidance can be found in Refs [25], [27], and [28]. (UK-106)

Methodology

5.139. The review of this safety factor (UK-107) should include the above tasks, recognized international and national good practices should be considered.

5.140. This safety factor review (Armenia-23) should be carried out with the assistance of properly qualified specialists. Because of the difficulties associated with carrying out an objective review of what is essentially its own human performance, the operating organization may decide that specific elements of the review can only be carried out by external consultants.

5.141. The review of the human-machine interface should consider the actual condition of the plant using for example plant walk-downs by specialists. (UK-108)

5.142. If deficiencies in the procedures and processes or in the design of the human-machine interface represent a potential adverse contribution to risk, the operating organization should provide proposals for corrective action to be considered in the global assessment. These may include improvements to procedures, enhanced training or, redesign of the human-machine interfaces.

SAFETY FACTOR 13 - EMERGENCY PLANNING

5.143. The design and operation of a nuclear power plant should prevent or otherwise minimise (UK-109) releases of radioactive substances that could affect the health of workers, the public or the environment. Emergency planning for the possibility of such a release is a prudent and necessary action not only by the operating organization but also by local and national authorities.

Objective

5.144. The objective of the review of emergency planning is to determine (a) whether the operating organization has adequate plans, staff, facilities and equipment for dealing with

emergencies and (b) whether the operating organization's arrangements have been adequately coordinated with local and national systems and are regularly exercised.

Scope and tasks

5.145. A PSR should include an overall review to check that the 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.

5.146. PSR should verify that the operating organization has considered significant changes at the nuclear power plant site and in its use, organizational changes at the plant and changes in the maintenance and storage of emergency equipment, and developments around the site that could influence emergency planning.

5.147. The review of this safety factor should:

- Evaluate the adequacy of on-site equipment and facilities for emergencies.
- Evaluate the adequacy of on-site emergency centres.
- Evaluate the efficiency of communications in emergency cases, in particular the interaction with organizations outside the plant.
- Evaluate the content and efficiency of emergency training, performed exercises and check records of experience from these exercises.
- Evaluate arrangements for regular reviews of emergency plans and procedures and their regularly update.
- ~~Evaluate the security arrangement for emergencies~~. (CAN A-17) .
- ~~Consider changes in the maintenance and storage of emergency equipment, and of residential developments around the site.~~ (CAN A-18)
- ~~Consider implementing changes to the emergency planning related to beyond design basis Accidents~~ (CAN A-18)
- Consider changes in the maintenance and storage of emergency equipment, and of residential and industrial (SP-54) developments around the site.

Ref. [45] establishes the requirements, Refs. [46], [47], [48], [49] and [50] provide relevant recommendations and guidance for emergency preparedness and response for a nuclear or radiological emergency.

Methodology

5.148. Records of emergency exercises should be reviewed to evaluate the competence of its on-site and off-site staff, the required functional capability of equipment (including communications equipment) and the adequacy of emergency planning.

5.149. The operating organization's interactions with relevant off-site emergency organization (CAN O-9) such as the regulatory body, police, fire departments, hospitals, ambulance services, local authorities, public welfare authorities and information media should be evaluated.

5.150. The review of adequacy of on-site equipment and facilities for emergencies and off-site emergency centres should include walk-downs.

5.151. The content and efficiency of emergency training and performed exercises can be evaluated by reviewing the records of these exercises with respect to, e. g., frequency, results of the exercises, and actions taken in case of deficiencies. This can be compared with current national and international guidelines and good practices.

5.152. Arrangements for regular reviews of emergency plans and procedures and their periodic updates can be evaluated by reviewing the operating organization's management processes.

Environment

SAFETY FACTOR 14 -RADIOLOGICAL IMPACT ON THE ENVIRONMENT

5.153. The operating organization should have an established and effective surveillance programme that provides radiological data on the surroundings of the plant site. In some Member States such a programme is also carried out by public organizations, which can facilitate independent validation of the data provided by the operating organization.

Objective

5.154. The objective of the review of the radiological impact of the nuclear power plant on the environment is to determine whether the operating organization has an adequate and effective (UK-112) programme for surveillance of the radiological impact of the plant on the environment.

Scope and tasks

5.155. Radiological data should be compared with the values measured before the nuclear power plant was put into operation and/or the historical values examined during the last PSR.

(SP-55) In the event of significant deviations, an explanation should be given taking into account relevant factors external to the nuclear power plant.

5.156. Where radiological environmental data has not been published since the start of plant life or since the last PSR the data should be complied and published. To: The data should be offered to the Regulatory Body. (SP-56)

Methodology

5.157. In examining whether the surveillance programme is appropriate and sufficiently comprehensive it should be ensured that the radiological impact of the plant on the environment is not significant compared with that due to ~~naturally~~ sources (SP-57) of radiation.

5.158. In some Member States, a surveillance programme is also carried out by a public organisation. This can facilitate independent validation of the data provided by the operating organisation. (UK-116) Examples of such data are the concentrations of radionuclides in air, water (including river water, sea water and groundwater), soil, agricultural and marine products and wild flora and fauna. (UK-117)

5.159. As part of the review it should be verified:

- concentrations of radionuclides in air, water (including river water, sea water and groundwater), soil, agricultural and marine products and animals are being monitored by operating organization or by independent public organization and trended and the appropriate actions are taken.
- Potential new sources of radiological impact have been recognized.
- Samplings and measurement methods are consistent with current standards.
- Records of effluent releases are being monitored and trended and that appropriate actions are taken to remain within (revised) release limits and as low as reasonably achievable.
- On-site monitoring is being continued at locations and using methods that will have a high probability of promptly detecting releases of radionuclides
- Off-site monitoring for contamination levels and radiation levels is adequate and corrective actions are taken to keep the levels as low as reasonably achievable. (CAN A-19) (SP-58)
- Actions have been taken to clean up contamination where reasonably practicable

- Alarm systems to respond to unplanned releases of effluents from on-site facilities have been available and will remain available in the future.
- Appropriate data has been published on the environmental impact of the plant.
- Changes in the use of areas around the site have been taken into account in surveillance programmes.

5.160. The review should look in addition for potential new sources of radiological impact by looking at relevant plant modifications and the actual condition of the SSCs.

6. GLOBAL ASSESSMENT

6.1 The objective of the global assessment is to present a global judgment of the plant's ability and the safety culture (JAP 15) for continued operation that includes a balanced view of the significant PSR results including safety improvements and the plant strengths identified in the review of PSR safety factors. The impact on safety associated with the findings for all the safety factors should be evaluated in their totality by a global assessment. This should be performed after completion of all individual safety factor reviews.

6.2 The global assessment should highlight interface issues and identify overlapping issues between the safety factor reports, thus ensuring that such issues are appropriately addressed by fully considering all contributing factors.

6.3 A cross-functional analysis (see Appendix A) (JAP E2) should be carried out during the global assessment. An approach using appropriate general, high level categories consistent with the IAEA Fundamental Safety Principles (SF-1) is recommended.

6.4 The global assessment review should consider supporting information such as PSR scope and methodology documents, regulatory requirements, regulatory feedback for previously submitted PSR documents, regulatory issues and additional reference material.

6.5 The global assessment should be performed by an interdisciplinary team with appropriate plant operation, design and safety expertise who participated in the review process. It is also beneficial if the interdisciplinary team undertaking (UK-121) the global assessment includes members that are independent from the PSR project team.

6.6 A method to assess, categorize, rank and prioritize findings should be established prior to performing (US-9) the global assessment.

6.7 The safety improvements should be categorised (UK-123) (by safety significance) and prioritized. The approach for the ranking and prioritization of safety improvements can be based on deterministic analyses, probabilistic safety assessment, engineering judgement, cost benefit analysis and/or risk analysis (as further discussed in paragraph 6.8). These safety improvements, along with the safety improvements resulting from the safety factors review, should be included in the integrated implementation plan.

6.8 The risks associated with the findings should be assessed and an appropriate justification for continued operation should be provided.

Although shortcomings are individually acceptable, their combined effects should also be reviewed for acceptability. (JAP 18) This is particularly relevant in considering human and organizational factors. It is also possible that a weakness in one safety factor can be compensated for by strength in another safety factor. For example, it may be acceptable on a temporary or permanent basis to use a strength in human factors (such as operator action supported by adequate procedures) to compensate for a weakness in design or equipment (such as a lack of automatic protection against a postulated slow type of reactor fault of very low probability).

As part of global assessment, the following items should be considered:

- Time required for implementing corrective actions and/or safety improvements - the actual benefit to safety that the action will achieve and the duration of the benefit (the remaining period of plant lifetime) should be considered. Adequate interim measures could be taken alternatively depending on the safety significance and the remaining plant life. (JAP 13) If the modification is necessary on grounds of unacceptable risk, then continued operation, pending implementation, (UK-124) should not be permitted until it has been implemented (UK-125) or adequate interim measures approved by the regulatory body (SP-60) have been taken.
- Use of PSA - The use of PSAs to measure the risk posed by any of the findings can be considered. (JAP E3) (JAP 22) In any case the findings in this safety factor have to be reflected in a global evaluation - the consideration of a sole risk-based decision process is not appropriate. (GER-20) PSA results may provide ~~a~~ useful information for comparing different alternative improvements nevertheless uncertainties in data and techniques exist and due to this the reliability of the results is not high enough. (JAP E3) (JAP 22) (SP-61)
- Deterministic consideration should be given to the total effect of the findings, corrective actions and/or safety improvements and strengths identified in the PSR, to ensure that the overall level of plant safety is adequate.
- Strengths identified may include, for example, ongoing programmes relating to operational focus, human performance, management of work, training, nuclear professionalism, equipment reliability, management of risks. (UK-126) (SP-62)

6.9 The global assessment should demonstrate that the safety requirements of the defence in depth concept and the fundamental safety functions such as reactivity control, core cooling

and the confinement of radioactive material are fulfilled. (JAP 23). Defence in depth may be demonstrated by reference to the five levels defined in Ref [INSAG 10] (UK-127)

6.10 Findings identified as a result of the global assessment should be documented in a global assessment report. Where the global assessment determines that safety improvements or corrective actions are required these should be categorised (by safety significance) and prioritized. The approach for the categorisation and prioritization of safety improvements can be based on deterministic analyses, probabilistic safety assessment, engineering judgement, cost benefit analysis and/or risk analysis (see 6.8). These safety improvements should be included in the integrated implementation plan. (UK-128)

~~6.11. The plant operating organization should commit itself effectively to the integrated implementation plan of corrective actions and/or safety improvements.~~ (JAP 21_move to 9.1) (CAN O-17_move to 8)

7. ROLES AND RESPONSIBILITIES

7.1 The primary responsibility for conducting a PSR and reporting its findings lies with the operating organization (licensee) of the plant. The operating organization, if required, (JAP 4) should report all safety significant findings of the review to the regulatory body ~~by a date agreed with the regulatory body~~ (JAP E4)

7.2 Depending on the national rule (JAP 5), the regulatory body has the responsibility for:

- Specifying or approving the requirements to perform a PSR
- Reviewing the actual scope of the PSR, the conduct, the findings of the PSR and the consequential safety improvements, (JAP E5) (SP-64)
- Assessing the prospects for safe operation for the period until the next PSR, and
- Taking appropriate licensing actions
- Informing the national government and the general public about the results of the PSR consequential safety improvements, including safety improvements (SP-65)
- Approve the previous documents of operating organization (Basis document and Project Plan) (SP-63)

7.3 If the operating organisation or regulatory body does not posses sufficient resources or expertise to review the PSR, assistance might be required from external consultancies or technical support organisations. UK-131 However, the operating organization and the regulatory body should have sufficient technical expertise to manage the contracted work effectively, to assess the results achieved by the contractors, and to take responsibility as stated in 7.1 and 7.2.

The operating organization and the regulatory body should have sufficient technical expertise to manage the contracted work effectively, to assess the results achieved by the contractors, and to take responsibility as stated in 7.1 and 7.2. If there are insufficient capabilities of the operating organization or of the regulatory body, assistance in performing or reviewing the PSR may be required from external consultants or technical support organizations. (JAP 12)

7.4 In addition, certain parts of a PSR could be carried out by external consultants so as to ensure objectivity. An example of this is the ~~review~~ assessment (ENISS-34) of the safety factors of organization, management system and safety culture as well as human factors. While the primary responsibility for carrying out the PSR (ENISS-34) rests with the operating

organization, an independent review should be considered to ensure suitable (UK-132) objectivity.

~~In addition, certain parts of a PSR could be carried out by external consultants so as to ensure objectivity. An example of this is the review of the safety factors of organization, management system and safety culture as well as human factors.~~ While the primary responsibility for carrying out the review rests with the operating organization, an independent review should be conducted to provide the necessary objectivity. Certain parts of the PSR, which concern to the operating organization itself such as management system, safety culture and human factors, could be conducted by external consultants/organization for ensuring objectivity. (JAP 16)

8. REVIEW PROCESS

INTRODUCTION

8.1 The basic process for implementing the strategy described in Section 4, which is applicable to the safety factors as per the Basis Document, is shown in Fig. 1. It consists of parallel activities by the operating organization and the regulatory body which are illustrated in Figs 2 through 5.

8.2 The activities of the operating organization can be divided into three steps:

- The first is the preparation for the PSR project,
- The second is the conduct of the PSR reviews, (JAP E12)
- The third is the analysis of the findings (including the Global Assessment), and preparation of a programme of safety improvements. (JAP E12)

8.3 The regulatory body's activities are carried out throughout the PSR project. The following paragraphs provide guidance on how these activities could be carried out by the operating organisation and its regulator. (UK-134) The review process described in this section is intended to be sufficiently flexible to allow a Member State ~~to review each safety factor and~~ to modify it ~~in detail to~~ for complying with national requirements and to facilitate the use of findings of relevant studies and routine or special safety reviews. (JAP E13)

8.4 The starting point of a PSR is is the information by operating organization (RU-7) the agreement between the operating organization and the regulatory body on the general scope, requirements for the PSR, and its expected outcome, as described and agreed in the Basis Document. As part of the agreement, the operating organization and the regulatory body should determine an appropriate time to freeze the set of documents to be reviewed ~~included~~ and freeze the status of the safety performance of the plant to be taken as a basis for the PSR in order to ensure the consistency across all parts of the PSR ~~and to achieve the agreed time schedule~~. (JAP E6) (JAP E14)

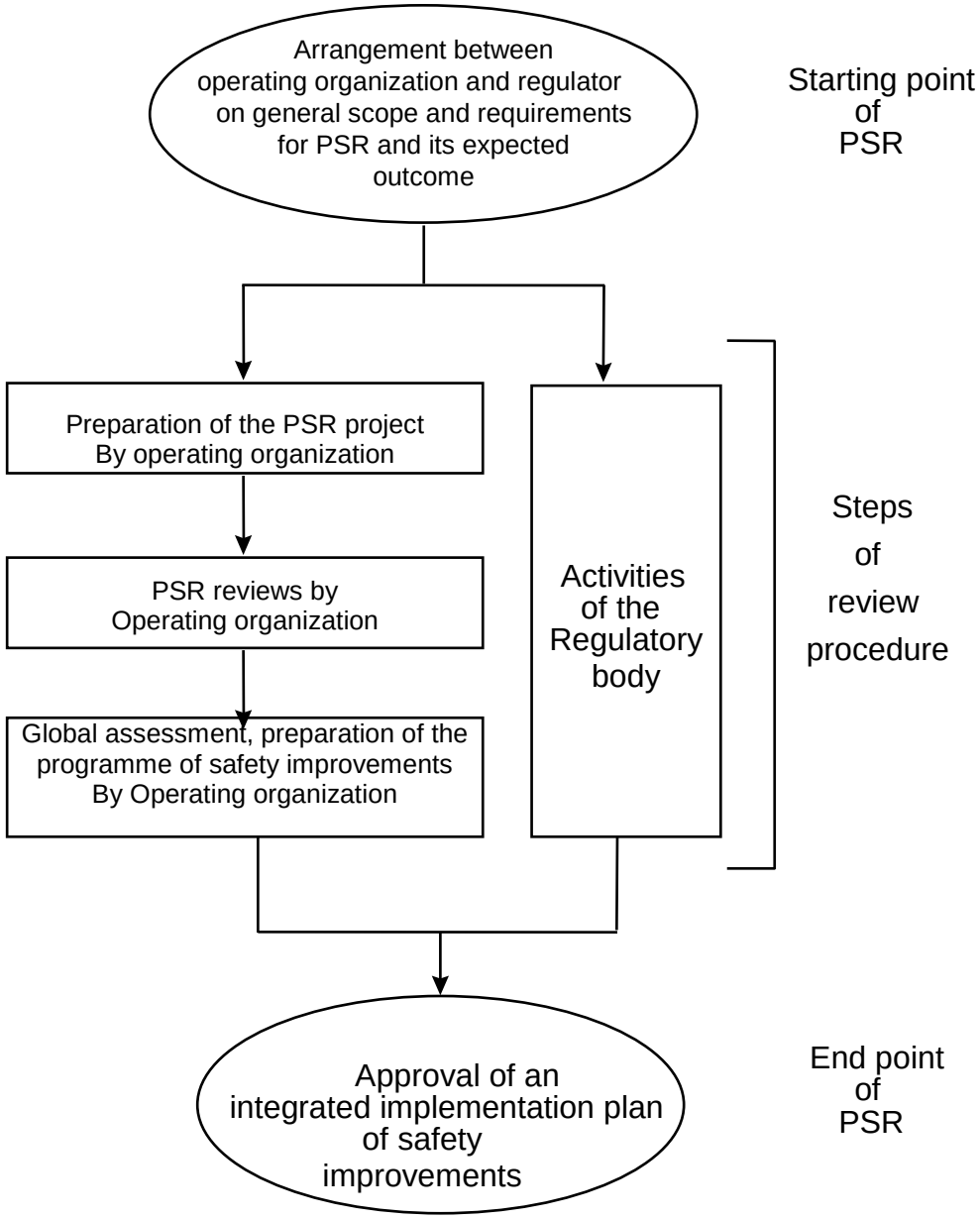

FIG. 1. Procedure for periodic safety review of a nuclear power plant: flowchart of an overall process. (JAP 19) (JAP E7) (JAP E9) (JAP E10) (JAP E11) (CAN B-13)

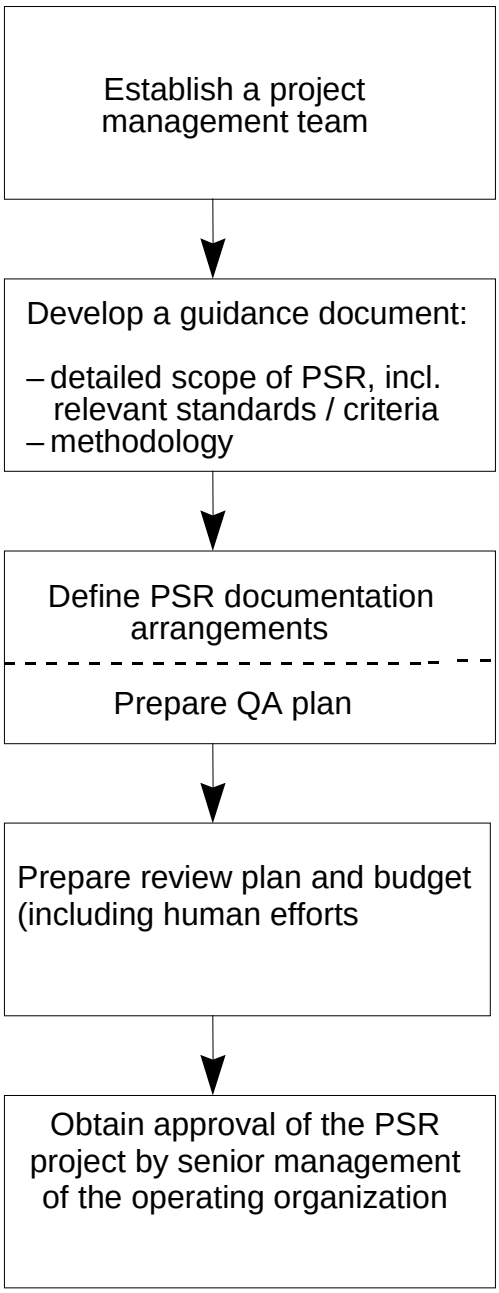

FIG. 2. PSR review Plan (HUN 4)

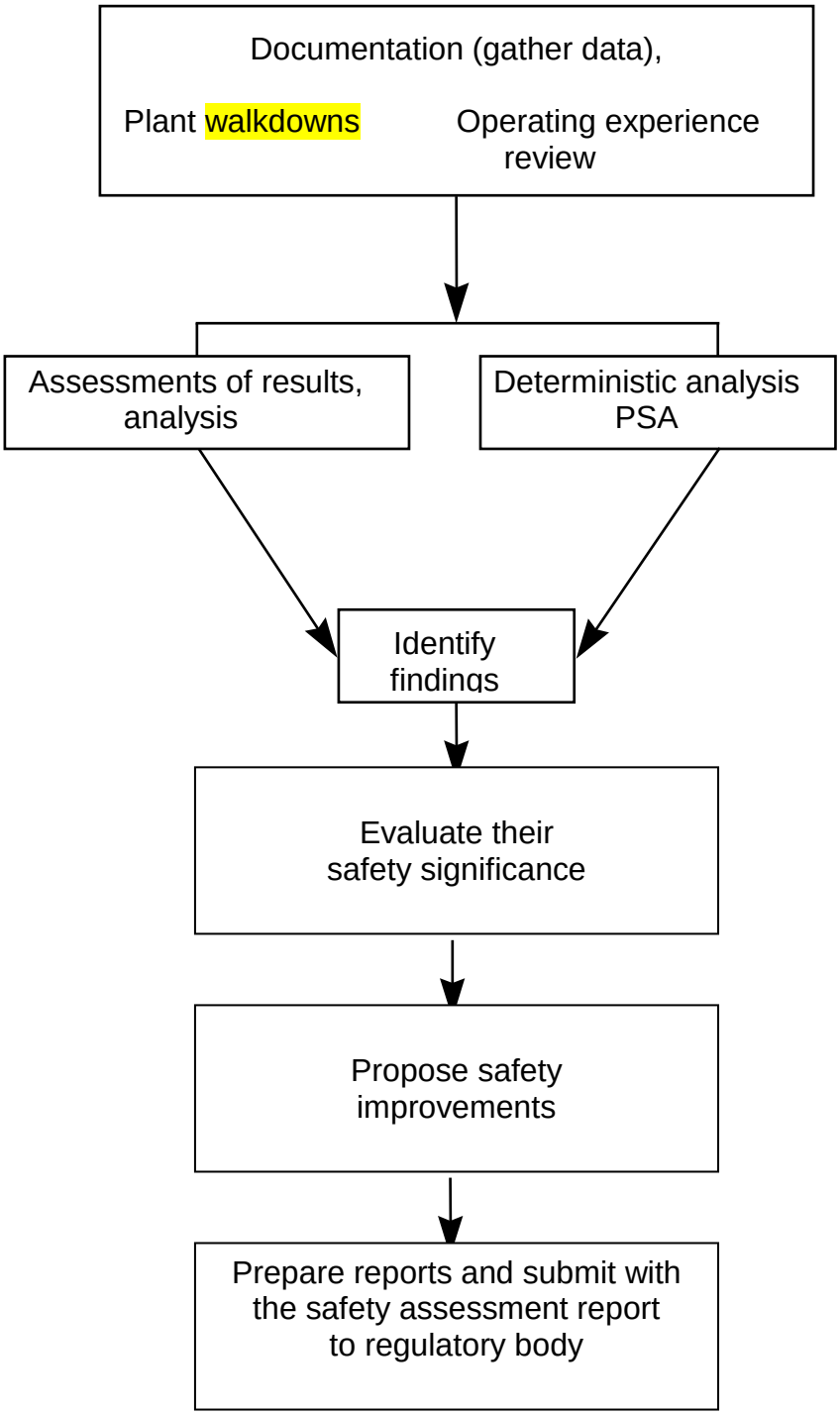

FIG. 3. PSR reviews. (UK-136)

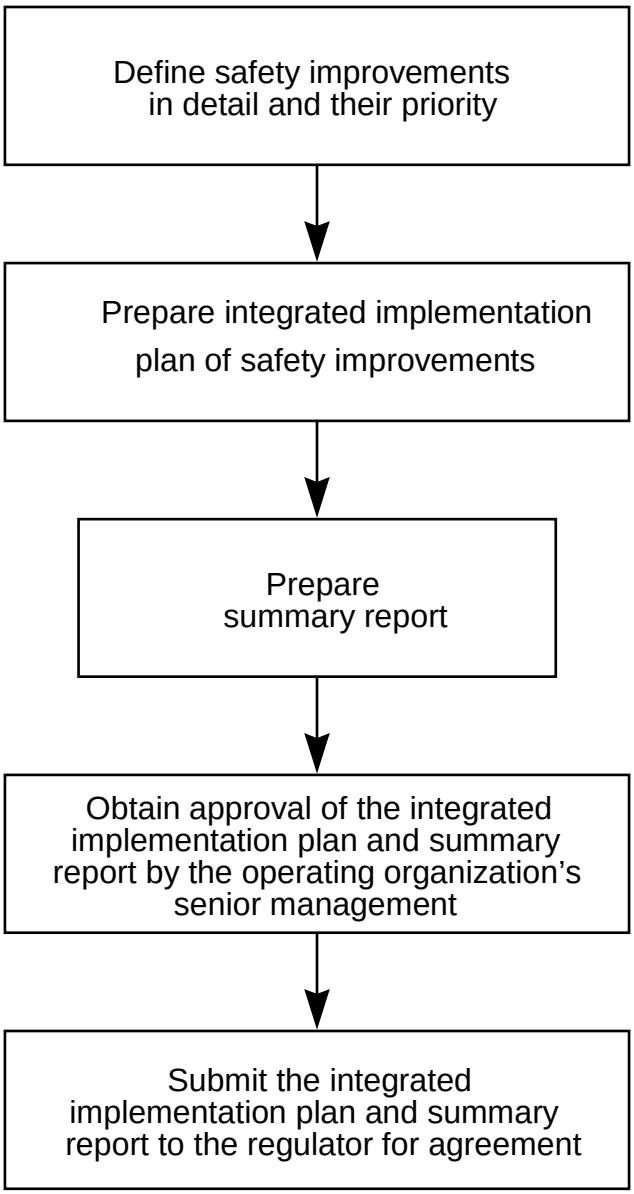

*FIG. 4. Preparation of the programme of safety improvements (*JAP E8)

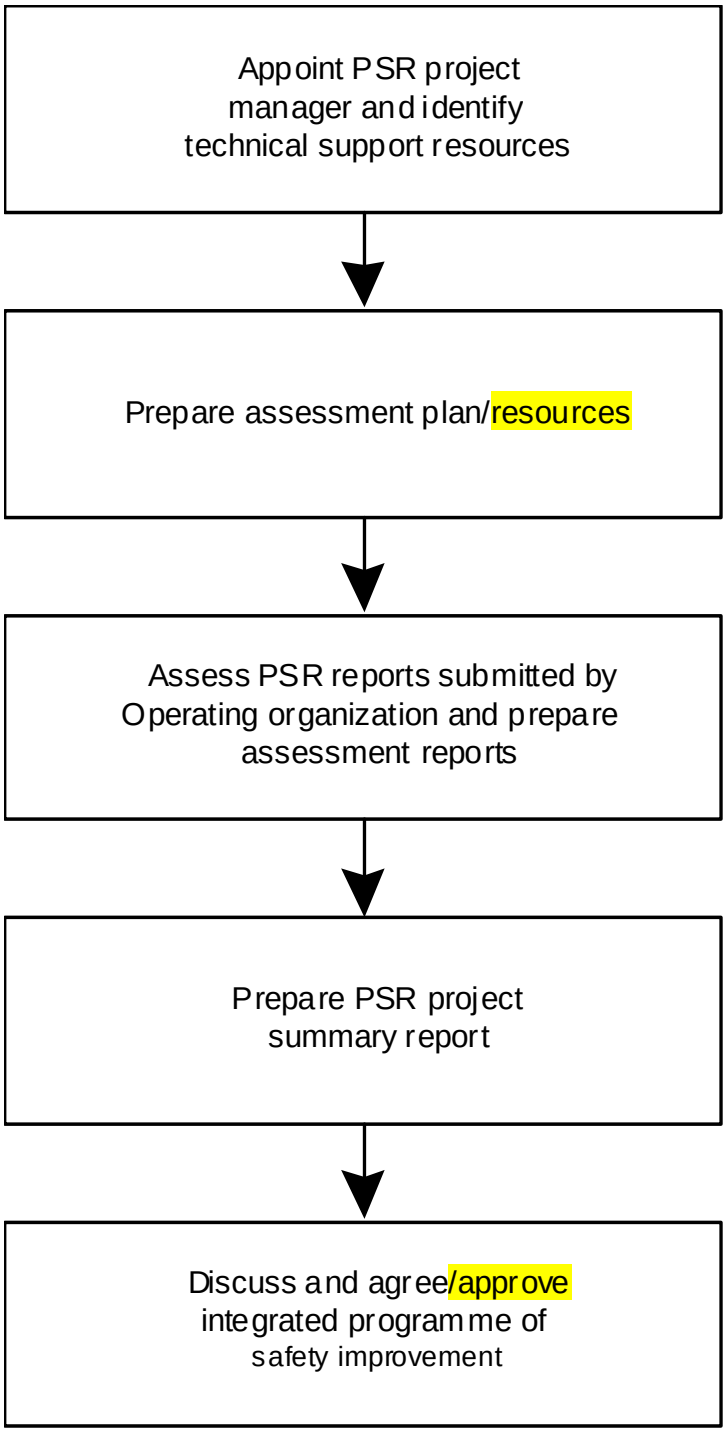

FIG. 5. Activities of the regulatory body. (JAP 10) (SP-66) (HUN-5)

ACTIVITIES OF THE PLANT OPERATING ORGANIZATION

Preparation of the PSR project

8.5. ~~Since the PSR is a major task,~~ (JAP E15) An appropriate project management team should be established and a reasonable schedule developed at the outset of the project. This is necessary in order to complete the PSR within the agreed time-scale and budget.

8.6. The schedule should take into account the time for iterative process in the safety factor review and time for interfacing between various safety factor reviews. (JAP E16)

8.7. On the basis of the scope, the organization and the schedule, an overall budget for the PSR should then be prepared. ~~If resource intensive activities are required for the safety factor reviews, such as the development of a PSA, the revision of a PSA or configuration management restoration, their scope and depth and their implications on the overall schedule and budget should be considered in the planning stage.~~ Review activities that require intensive resources should be identified and their scope and its' depth should be taken into account in the over all budget, when planning the PSR. (JAP E17)

8.8. The PSR is typically performed by a number of review teams that work in parallel. A document should therefore be prepared to provide guidance on how to review the different safety factors so as to ensure a comprehensive, consistent and systematic approach, ~~particularly if there is no existing internal process to perform the reviews.~~ (JAP 24) This guidance document should elaborate on the agreed general scope of the PSR. It should also identify applicable safety standards, methods and practices which, in most cases, will be based on current national standards and practices and will reflect current knowledge. This ~~may~~ should (SP-67) also be included in the PSR Basis Document.

8.9 To ensure the appropriate quality and format of the PSR documents, a QA plan should be prepared which, among other things, defines the requirements for the preparation and verification of PSR documentation. The QA plan should also ensure that all reviewers use the same input data to maintain consistency across all areas of the review.

8.10 The results of the reviews and the PSR reports should be recorded in a systematic and auditable manner.

8.11. Before the start of the reviews, the senior management of the plant operating organization should approve the action plan and budget.

8.12. The PSR process is a complex undertaking involving non-routine work by many of the staff of the operating organization and external technical support organizations; therefore, appropriate training and briefing of the reviewers should be performed to facilitate effective and efficient completion of the PSR.

PSR reviews

8.13 As in the paragraph 4.21 stated, a common set of databases (JAP 25) ~~should~~ may (SP-68) be developed to ensure consistency across all areas of the review. These databases should include operational data, complemented with the relevant design basis information and, if available, with information from the FSAR. It should contain not only the historical data but also predictions of future operating systems and service lifetime. It is not always possible to include all the results of the PSR in a data base. (SP-69)

8.14 The review of each of the safety factors should be carried out (see Section 5) for all plant conditions (including normal operation and accident conditions), and an assessment made against current safety standards and practices (operating experience, plant walkdowns…).

8.15 Areas where licensing basis and current standards and practices are not achieved should be identified. The safety significance of the findings should be evaluated using deterministic and probabilistic methods as appropriate (see Section 5). A list of safety improvements (or justification for not implementing safety improvements) should be prepared for each finding.

8.16 As in the paragraph 4.24 stated, (Armenia-24) if the operating organization identifies a finding that poses an immediate significant risk to health and safety to workers or the public, implementation should not await the completion of the PSR but prompt corrective actions should be taken.

8.17 Areas where current safety standards and practices are exceeded (i.e. plant strengths) should be identified and stated in the report.

8.18 A safety factor report should be prepared to summarize the results of the review of each safety factor (FRA114) (see Appendix B.2.).

8.19 A global assessment should be performed and the report should be prepared (See Section 6 and Appendix B.3.).

8.20 A PSR final report should be prepared to include the following, among others:

- A summary of the safety factors report including a list of findings showing areas where current standards and practices are not achieved, and a list of areas where current safety standards and practices are exceeded (i.e. plant strengths),
- A summary of the global assessment report, and
- Proposed safety improvements and integrated implementation plan, including their safety category (UK-139) and prioritization.

(See Appendix B.4.)

Finalization of the integrated implementation plan

8.21 The safety improvements and implementation plan proposed in the PSR final report should be updated after discussion on the report with the regulatory body. The revised final report should include the outcome of the discussions~~s~~ regarding the scope and adequacy of the proposals and applicable changes to the ranking and prioritization of the safety improvements. (JAP 26)

8.22 The integrated implementation plan should consider interactions between individual safety improvements with their appropriate configuration management. It should also specify the schedules and resources needed. It is recognized that the implementation of safety improvements will have different execution times; however, the expectation is that the majority of the safety improvements be completed far before the next PSR.

8.23 For PSRs performed for multiple standardized units, the integrated implementation plan could be executed in stages. However, this should be justified by the operating organization and, if required, (JAP 6) approved by the regulatory body.

8.24 The integrated implementation plan should be subject to approval by the senior management of the plant operating organization, who should commit the necessary human and financial resources to implement the planned safety improvements according to a reasonable schedule. These approved documents should then be submitted to the regulatory body for review and, if required, for (JAP 7) approval in accordance with national requirements and nuclear regulations.

8.25 A summary report ~~should~~ will be prepared to present the highlights of the PSR review process thereafter. This summary report could be shared with members of the public depending on the national regulations. (CAN O-18)

ACTIVITIES OF THE REGULATORY BODY

8.26 Requirements for a PSR should be established by the regulatory body.

8.27 Milestones and time frames provided by the operating organization should be approved, if required, (JAP 8) by the regulatory body.

8.28 The regulatory body should appoint a project manager for the PSR review. The responsibility of the regulatory body's project manager should include:

- Co-ordination of all PSR review activities within the regulatory body (and any external sources of assistance); and,
- Acting as a focal point for communication with the operating organisation. (UK-141)

8.29 The regulatory body should review the PSR Basis Document, as provided by the operating organisation; and should agree the format and content of the subsequent PSR with the operating organisation. (UK-142) (SP-71)

8.30 An assessment plan should be prepared by the regulatory body for performing the review of the PSR reports, to state the assessment criteria to be used, and identify the source and availability of the technical experts that will carry out the regulatory assessments.

8.31 Appropriate training and briefing of the reviewers to unify criteria (SP-72) should be performed to facilitate effective and efficient completion of the PSR assessment.

8.32 The regulatory body should review the PSR reports and assess the PSR (JAP E18) findings submitted by the operating organization.

8.33 During the assessment process, the regulatory body and/or its technical support staff should communicate with the operating organization to clarify issues, including any additional issues identified by the assessor, and to acquire any necessary additional information. The results of these interactions should be documented for future reference.

8.34 Upon completion of the regulatory assessment, reviewers should prepare assessment reports that clearly identify all significant issues which need to be resolved. The assessment reports could ~~should~~ (JAP E19) also give an initial indication of the acceptability of the safety improvements proposed by the operating organization.

8.35 In the event that the PSR identifies a finding which poses an immediate significant risk to health and safety for workers or the public, the regulatory body should ensure that the operating organization takes prompt actions and does not wait until the end of the PSR process to

implement safety improvements. ~~This may involve proposing or imposing operating restrictions or temporarily shutting down a reactor pending the resolution of the issue.~~ (JAP 27)

In assessment of the periodic safety review report, the regulatory body or its technical support organization ~~should~~ may use its own analysis and verification (validation) calculations with the use of alternative codes. (UKR-1)

8.36 Using the individual assessment reports, the regulatory body, usually the PSR project manager should prepare an integrated project report. This project report should present, in a concise way, the following:

- The regulatory body's view of the adequacy of the operating organization's PSR as documented in the submitted reports, including the safety improvements identified by the operating organization,
- Safety improvements not previously ~~addressed~~ resolved (JAP 28) in the PSR reports, and
- Evaluation of the integrated implementation plan time-scale proposed by the operating organization

8.37 The regulatory body's project report should be formally discussed with the operating organization. This may involve several meetings which should lead to an agreement from both parties resulting in the updated integrated implementation plan. Consistent with its review conclusion, the regulatory body should take appropriate licensing action. (Figure 1 and Figure 5) (JAP 20)

9. POST-REVIEW ACTIVITIES

9.1 Implementation of the integrated plan for safety improvement. Safety is enhanced by implementing the safety improvements. Therefore, it is essential that both the operating organization and the regulatory body should maintain adequate arrangements for project management after the completion of the PSR to ensure the timely completion of the Integrated Implantation Plan for safety improvement. The regulatory body should be notified when safety improvement are implemented, or of any significant delays in completing any of the improvement as per agreed timeline (or time-scale for consistency). The plant operating organization should commit itself effectively to the integrated implementation plan of corrective actions and/or safety improvements. (JAP 21_move from 6.11) (CAN O-17_move from 6.11)

9.2 Documentation from the PSR. The complete set of documents should be stored in a suitable system with sufficient detail to allow easy retrieval and interrogation, by both the operating organization and the regulatory body. The documentation should contain the ~~last accepted~~ latest version of the PSR documents ~~documentation~~ and information on lessons learned from the PSR. (JAP E20)

9.3 Updating of plant documentation. The PSR and associated safety improvements will invariably necessitate changes to plant documentation. Therefore, the plant operating organization should update all plant documentation including, for example, the safety analysis report, operating and maintenance procedures and training materials to reflect the outcomes of the PSR.

9.4 Reporting PSR results. The operating organization and/or the regulatory body should report the outcomes to the government, if required (JAP 9) in accordance with national legal requirements, custom and practice. ~~The reporting arrangements required under international conventions will also apply.~~ (JAP 29) In certain States, communicating the results of the PSR to the general public is considered to be a good practice.

9.5. The execution of the Periodic Safety Review and the implementation of safety improvements should result in the revision of design, operation and license (RU-8) documentation to reflect the current configuration of the NPP. Likewise the operating organization should modify other affected documentation (e.g Organization manual, Emergency plan, training plans) (SP-75)

9.6. In the case where a Final Safety Analysis Report is part of the documentation, this report should be updated after completion of the Periodic Safety Review to reflect the integration of the result of reviews of reference documents and requirements and to address new operational experience. The Final Safety Report (or equivalent safety documents) should be updated to incorporate all design changes and safety analyses work completed in support of the safety improvements.

Appendix A

A. Interfaces between Safety Factors

The teams reviewing different Safety Factors should communicate during the review process starting from the preparation phase of PSR. The team communication should be well organised because findings (or outputs) identified during the review of a specific safety factor could be an important input to the review of other safety factors. All the findings which are related to other safety factors should be provided immediately to the other reviewers. The likely (UK-145) correlation between the different safety factors is described in Table A1.

Table A1: Safety Factors Interface Matrix

The safety factors in the upper horizontal axis provide input to the safety factors in the vertical axis on the left.

		Safety Factors providing input													
		SF1	**SF2**	**SF3**	**SF4**	**SF5**	**SF6**	**SF7**	**SF8**	**SF9**	**SF10**	**SF11**	**SF12**	**SF13**	**SF14**
Safety Factors receiving input	**SF 1**		X	X	X	X	X	X	X	X			X	X	X
	SF 2	X		X	X	X			X	X	X				
	SF 3	X	X		X	X	X	X	X	X	X			X	
	SF 4		X	X			X	X	X	X	X	X			
	SF 5	X	X	X	X		X		X	X		X	X	X	
	SF 6	X	X	X	X	X		X	X	X		X	X	X	
	SF 7	X	X	X		X	X		X	X		X	X	X	X
	SF 8	X	X			X	X	X		X	X	X	X		X
	SF 9	X									X	X			X
	SF 10		X			X			X	X		X	X		X
	SF 11	X	X	X	X	X	X	X	X	X	X		X	X	X
	SF 12	X	X	X		X	X	X	X	X	X	X			
	SF 13	X				X	X	X	X	X		X			
	SF 14	X	X						X	X		X			

(**SF** 1) Plant design
(**SF** 2) Actual condition of SSCs
(**SF** 3) Equipment qualification
(**SF** 4) Ageing
(**SF** 5) Deterministic safety analysis
(**SF** 6) Probabilistic safety assessment
(**SF** 7) Hazard analysis
(**SF** 8) Safety performance
(**SF** 9) Use of experience from other plants and research findings
(**SF** 10) Organization, safety management systems and safety culture
(**SF** 11) Procedures
(**SF** 12) The human factor
(**SF** 13) Emergency planning
(**SF** 14) Radiological impact on the environment.

Appendix B
PSR Documents

The following documents should be produced during the conduct of the PSR to provide the required set of information on PSR process and the results from the PSR including safety improvements:

1. PSR Basis Document

2. Safety Factor Report

3. Global Assessment Report

4. PSR Final Report, including the integrated implementation plan

B. 1 Recommended contents of a PSR Basis Document

The PSR Basis Document should include three main parts:

General

- the scope of the PSR and proposed operating period to be considered by the review;
- cut-off date for the applicability of standards and codes and the plant status;
- plant licensing basis at the time of initiating the PSR;
- list of safety factors which are to be (UK-152) reviewed within the PSR;
- description of the systematic review approach to be used to ensure a complete and comprehensive review;
- processes for identifying and addressing deviations between current and desired plant functional and performance characteristics;
- interfaces between different safety factors;
- Global assessment (methodology and content of the Global assessment report);
- Guidance for preparation an integrated implementation plan;
- The systematic method for recording PSR outputs, including content of
    - the safety factor reports;

- global assessment report and
- the PSR final report (including the integrated implementation plan).

Safety Factors

In this part of the Basis document the following information should be given for each safety factor:

- Safety Factors' objectives and scope;
- applicable national and international current (ENISS-38) standards, codes, methods and practices that reflect current knowledge;
- relevant applicable industry standards and practices;
- list of input documents and processes to review;
- specific methodology for the review and identification of deviations between current and desired plant functional and performance characteristics;
- expected outputs.

Project plan for the PSR

- Project organisation;
- Time schedule;
- Quality management processes;
- Training;
- Internal communications;
- Communications plan with the regulatory body.

B. 2. Recommended contents of a safety factor report

The safety factor report should include the results of the each safety factor review using the methods detailed in the PSR Basis Document. Within this report, the findings specific to the safety factor are documented and ranked according to their safety significance. For some Member States, the safety factors are grouped within a single report; however, multiple reports can be developed. If multiple reports will be developed, a general template or structure should be provided to maintain consistency and ensure that all the items required to be reviewed are covered by the different teams performing the PSR.

The following is a suggested example of the high level format of a typical safety factor report:

- Title of safety factor;
- Introduction;
- Scope of review ;
- Review criteria (reference standards, safety assessment criteria etc.);
- Review methodology;
- Review performance since previous PSR;
- ~~A comparison of the current standards with those prevalent at the time of the previous PSR to identify and assess the significance of any changes;~~ (ENISS-39) A discussion on the results of each of the tasks.
- The compliance with requirements along with a proposed justification of resolution for each finding.
- Evaluation of the safety relevance of the findings and their ranking;
- Extrapolation for the next ten years period of time;
- Conclusions;
- References;
- Appendices.

B. 3. Recommended contents of the global assessment

The PSR results of all safety-factor reviews are assessed via a global assessment and should be documented:

- a detail of significant PSR results, including plant strengths and deviations;
- an analysis of interface between safety factors and between individual deviations;
- an assessment of the overall risk including assessment of interfaces between the deviations which still require dispositioning (CAN A-38) .

B. 4. Recommended contents of the PSR final report

The PSR final report should give conclusions for each safety factor that has been reviewed and should address the following topics:

- summary of the safety factors report;
- summary of the global assessment
    - identification of the deviations between the present state of the plant and the current safety standards and practices;
    - evaluation of the safety significance of these deviations;
    - an overall risk judgment on the acceptability of continued plant operation;
- proposal for resolving these deviations by safety improvements or corrective actions; (UK-154)
- an assessment of plant operation over the next review period.

ANNEX

Inputs, outputs and references to review the Safety Factors

Details on potential (UK-146) inputs and outputs as well as relevant references for each safety factor are listed in the following.

PLANT DESIGN

Inputs	Outputs
Standards and requirements: • Current national and international requirements, codes and standards on design and site evaluation • Current national and international good practices on design and site evaluation Plant specific documents: • FSAR related chapters (1-12, 14, 16) • A site evaluation (from FSAR or similar safety document) • A list of SSCs important to safety and their safety classification (from FSAR or similar safety document) • The documented design basis (original or reconstituted and updated) including the list of PIE's • A detailed description of the plant design, supported by drawings of the layout, systems and equipment (from FSAR or similar safety document) • Technical specifications (FSAR Chapter 16) • Results of tests in the commissioning phase • Review compliance with plant design specifications (ENISS-40) Operating Experience: • National and international operating experience from similar plants • Actual plant physical condition The review of this safety factor may require input from the following safety factors: • (SF2) Actual condition of SSCs (e.g. new review results of tests, inspections and maintenance) • (SF3) Equipment qualification (deviations of equipment qualification)	The assessment of Plant Design may indicate strengths or findings in some of the following areas: • Compliance with current safety and design standards • Defence in depth in the prevention and mitigation of events (faults and hazards) that could jeopardize safety, • Dependability (supporting systems) requirements • Records of the design basis, modifications to the plant, test results • FSAR • Recommended plant modifications • New operational margins Based on the results of the review, re-assessment of safety margins against current standards and requirements may be required Outputs from the review of this safety factor may input to the following safety factors: • (SF2) Actual condition of SSCs (e.g. new margins) • (SF3) Equipment qualification (e.g. new margins) • (SF4) Ageing (e.g. new margins) • (SF5) Deterministic safety analysis (e.g. plant design modifications) • (SF6) Probabilistic safety assessment (e.g. plant design

• (SF4) Ageing (ageing margins) • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazards analysis (e.g. design resolution of hazards) • (SF8) Safety performance (resolution of root cause analysis tasks) • (SF9) Use of experience from other plants and research findings (new PIEs, new technical solutions) • (SF10) Organization, safety management systems and safety culture • (SF12) The Human factor • (SF13) Emergency planning • (SF14) Radiological impact on the environment	modifications) • (SF7) Hazard analysis (e.g. plant design modifications) • (SF8) Safety performance (e.g. new margins) • (SF9) Use of experience from other plants and research findings • (SF11) Procedures (e.g. new margins) • (SF12) The Human factor • (SF13) Emergency planning • (SF14) Radiological impact on the environment

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ACTUAL CONDITION OF SYSTEMS, STRUCTURES AND COMPONENTS

Inputs	Outputs
Standards and requirements: • Current national and international requirements, codes and standards on design • Appropriate assessment standards • National and international operating experience from plants containing similar SSCs Plant specific documents: • A list of SSCs important to safety and their classification. • Information about the integrity and functional capability of SSCs important to safety, including material case histories. • Description of the present condition of SSCs important to safety • The assessment methods applied by the operator • Technical specification of the SSCs • Equipment qualification results. • Description of the support facilities available to the plant both on and off the site, including maintenance and repair shops. • Walk down reports • Maintenance records • Inspection results • Findings of tests that demonstrate functional capability • Operational data history and trends • Outstanding maintenance and modifications • Maintenance data – repeated, corrective, reports of obsolescence • Modification records (UK-150). The review of this safety factor may require input from the following safety factors: • (SF1) Plant design • (SF3) Equipment qualification (results of deviations) • (SF4) Ageing (e.g. ageing forecasts, effectiveness of the ageing management processes) • (SF5) Deterministic safety analysis (e.g. new PIEs) • (SF6) Hazard analysis (e.g. new internal and external hazards) • (SF8) Safety performance (operating history)	The results of this safety factor review are inputs for the following safety factors: • (SF1) Plant design • (SF3) Equipment qualification • (SF4) Ageing • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures • (SF12) The Human factor • (SF14) Radiological impact on the environment Examples of findings from the review of the actual condition of the plants structures, systems and components are the following: • Confirmation that the design basis assumptions have not been significantly challenged taking into account the actual condition of the plant and will remain unchallenged until the next PSR. • The actual condition of the SSCs of the nuclear power plant is such that the design basis assumptions are not significantly challenged or will not be challenged before the next PSR. • Additional surveillances measures are required to ensure the timely detection of ageing effects • Maintenance and testing needs to be improved • Processes do not maintain

• (SF9) Use of experience from other plants and research findings • (SF10) Organization, safety management systems and safety culture (e.g. configuration management)	adequate knowledge of the actual state of the plant, ageing processes and component obsolescence • Validity of existing records is sufficient or has to be improved.

EQUIPMENT QUALIFICATION

Inputs	Outputs
Standards and requirements: • Current national and international requirements and standards on design and site evaluation • Current national and international good practices on design and site evaluation Plant specific documents: • A site evaluation (from the FSAR or similar safety document) • A list of SSCs important to safety and their safety classification • The documented design basis (original and updated) including the list of PIE's and specific environmental parameters • List of equipment covered by the equipment qualification programme and a list control procedure • Qualification report and other supporting documents (e.g. equipment qualification specifications and qualification plan) • Records of all qualification measures taken during the installed service life of the equipment Operating Experience: • National and international operating experience from similar plants The review of this safety factor requires input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC • (SF4) Ageing • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance (operating history) • (SF9) Use of experience from other plants and research findings • (SF10) Organization, safety management systems and safety culture • (SF13)Emergency planning	The assessment of equipment qualification may indicate findings in some of the following areas: • Equipment qualification programme, its procedures (incl for BDBA) and records • FSAR • Environmental conditions • Maintenance and ageing management programmes A finding in the environmental qualification safety factor may result in one of the following: • Qualification is adequate or justification is required • Additional qualification or protection is needed for particular components • Replacement is required • Improvements to the maintenance programme, • Improvements to the ageing management programme, The results of this safety factor review are inputs for the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC • (SF4) Ageing • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF11) Procedures • (SF12) The Human factor

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AGEING

Inputs	Outputs
Standards and requirements: • Current national and international ageing management standards • Relevant guidance on the management of plant ageing and record keeping Plant specific documents: • The operating organizations ageing management manuals • A documented method and criteria for identifying SSCs covered by the ageing management programme • A list of SSCs 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, operating and maintenance history The review of this safety factor requires input from the following safety factors: • (SF2) Actual condition of SSCs • (SF3) Equipment qualification • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance (operating history) • (SF9) Use of experience from other plants and research findings • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures	The assessment of Ageing may indicate findings in some of the following areas: • (SF1) Plant design (e.g. more rapid ageing process, review design process) • (SF2) Actual condition of SSCs • (SF3) Equipment qualification • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF11) Procedures • (SF12) The Human factor

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DETERMINISTIC SAFETY ANALYSIS

Inputs	Outputs
Standards and requirements: • Current national and international guidelines for deterministic safety analyses, including guidelines for single failure criterion, redundancy, diversity and separation. Plant specific documents: • FSAR, if available • Compilation of the existing deterministic safety analyses and their assumptions. • Limits and permitted operational states. • Anticipated operational occurrences. (A list of PIEs established to cover all events that could affect the safety of the plant.) • Analytical methods and computer codes used in the deterministic safety analyses and comparable current methods (e. g. applied to a modern nuclear power plant) including validation. • Radiation doses and limits on radioactive releases for accident conditions. The review of this safety factor may require input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC • (SF3) Equipment qualification • (SF4) Ageing • (SF6) Probabilistic safety assessment • (SF8) Safety performance (operating history) • (SF9) Use of experience from other plants and research findings • (SF11) Procedures • (SF12) The Human factor • (SF13) Emergency planning	The outputs of this safety factor review are inputs for the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC (check if results of the deterministic review may lead to modifications in design) • (SF3) Equipment qualification (check if results of the deterministic review may lead to modifications in design) • (SF6) Probabilistic safety assessment • (SF7) Hazard assessment • (SF8) Safety performance • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures • (SF12) The Human factor • (SF13) Emergency planning Examples of outputs are: • Assumptions in the analyses • Assessment of the design in fulfilling the defence in depth principles or deviations ~~If the deterministic review identifies any deviations, the current safety analysis has to be updated as necessary to ensure that it is based on the actual plant design, reflects the current state and predicted state at the end of the review period of SSCs, and that it considers all postulated initiating events that are appropriate for the plant design and plant location.~~ (US-10)

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PROBABILISTIC SAFETY ASSESSMENT

Inputs	Outputs
Standards and requirements • Current national and international guidelines and codes for PSA, in particular addressing operator action, common cause events, cross-link effects, redundancy and diversity. Plant specific documents: • existing PSA documentation and models, including those used in risk-informed applications; • Postulated initiating events (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 review); • accident management programme for beyond design basis accidents with PSA results. The review of this safety factor requires input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC • (SF3) Equipment qualification • (SF4) Ageing • (SF5) Deterministic safety analysis • (SF7) Hazard analysis • (SF8) Safety performance (e.g. operating history) • (SF9) Use of experience from other plants and research findings • (SF11) Procedures • (SF12) The Human factor • (SF13) Emergency planning	The assessment of PSA may indicate finings in some of the following areas: • (SF1) Plant design • (SF3) Equipment qualification • (SF4) Ageing • (SF5) Deterministic safety analysis • (SF7) Hazard analysis • (SF8) Safety performance • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures • (SF12) The Human factor • (SF13) Emergency planning

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HAZARD ANALYSIS

Inputs	Outputs
Inputs to the review of hazard analysis should include the following: Standards: • Current national and international design codes, safety assessment standards and safety guides • National requirements • The operating organizations control procedures, safety assessment standards and safety guides Plant specific documents (including site): • Previous hazards analysis • Flood risk assessments • Climate change assessments • Seismology assessments and records • Fire protection plans • PSA assumptions (where used) • Emergency plans • Aircraft movement local patterns or trends and records of over-flying incidents • Planning applications (any change in industrial or transport activity near to the plant) • Wind speed and direction records • Volcanism/volcanic hazard records • Ambient and sea and river temperature records • River and sea level records • Meteorological hazards records • Hydrological hazards records Operating Experience • National and international operating experience from plants containing similar SSCs • Records of hazard incidents affecting the plant The review of this safety factor requires input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC • (SF3) Equipment qualification • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF8) Safety performance • (SF9) Use of experience from other plants and research findings • (SF11) Procedures • (SF12) The Human factor • (SF13) Emergency planning	The results of this safety factor review are outputs for the following safety factors: • (SF1) Plant design • (SF3) Equipment qualification • (SF4) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF8) Safety performance • (SF11) Procedures • (SF12) The Human factor • (SF13) Emergency planning Findings from the review of hazards could include the following: • Confirmation that the design basis assumptions will not be significantly challenged by internal or external hazards until at least the next PSR. • Procedures for mitigating the effects of hazards need to be improved. • Equipment qualification needs to be reassessed • Modifications are required to detect hazards or improve mitigation of the consequences of hazards e.g. flood barriers need raising • Additional monitoring and improved record keeping is required • FSAR updates are required • Plant modification processes or maintenance procedures do not adequately recognize hazards qualification requirements This safety factor could lead to a reassessment of the margins against the study cases i.e. seismic margins.

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SAFETY PERFORMANCE

Inputs	Outputs

Standards and requirements:
• Current national and international standards, requirements and good practices
• Operating Experience:
  • Best international practice in the use of safety performance indicators developed by IAEA and the World Association of Nuclear Operators (WANO).
 	
Plant Specific Inputs:
• Records of operating experience relevant to safety, including those of:
  ○ frequency of unplanned trips while a reactor is critical;
  ○ frequency of unplanned operator actions in the interests of safety and their success rate;
  ○ selected safety system actuations and/or demands;
  ○ safety system failures;
  ○ safety system unavailability;
  ○ trends in causes failure (operator errors, plant problems);
  ○ the backlog of outstanding maintenance, 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 stored;
  ○ Quantities of radioactive effluents.
  ○ Reports from the plant's routine analysis of safety performance indicators.
  ○ Procedures, documentation and outputs from the plant's routine process for the review of operational experience.
 	
The review of this safety factor may use input from the following safety factors:
• (SF1) Plant design
• (SF2) Actual condition of SSC
• (SF5) Deterministic safety analysis
	The assessment of safety performance may indicate findings in some of the following areas:
	• the training process relating to safety performance.
	• plant processes and procedures.
	• safety culture
	• FSAR
	• Strengths and weaknesses demonstrated by performance indicators
	
	The results of this safety factor review are outputs for the following safety factors:
	• (SF1) Plant design
	• (SF2) Actual condition of SSC
	• (SF3) Equipment qualification
	• (SF4) Ageing
	• (SF5) Deterministic safety analysis,
	• (SF6) Probabilistic safety assessment
	• (SF7) Hazard analysis.
	• (SF10) Organization, safety management systems and safety culture
	• (SF11) Procedures
	• (SF12) The Human factor
	• (SF13) Emergency planning
	• (SF14) Radiological impact on the environment

• (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF9) Use of experience from other plants and research findings • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures • (SF12) The Human factor • (SF14) Radiological impact on the environment	

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USE OF EXPERIENCE FROM OTHER PLANTS AND RESEARCH FINDINGS

Inputs	Outputs
Standards and requirements: • Current national and international standards and safety documents • Relevant standards from the OECD Nuclear Energy Agency, WANO, and the Institute of Nuclear Power Operations (INPO) Operating Experience: • International Operating experience databases such as IAEA IRS database, WANO/INPO, owner group databases • IAEA IRS Highlights reports and topical studies, WANO Significant Event Reports and Significant Operating Experience Reports • National and international operating experience from similar plants Plant specific inputs: 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 plant's routine assessment of operating experience at other plants; • Procedures and documentation governing the plant's routine process for the review of operational experience at other plants; • Assessments from the plant's and/or its operating organizations routine review of emerging research findings; • Procedures and documentation governing the plants or its operating organizations routine process for the assessment of research findings. • Independent internal or external audits and self-assessments regarding operating experience and research findings The review of this safety factor may use input from the following safety factors: • (SF1) Plant design • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures • (SF14) Radiological impact on the environment	The results of this safety factor review are outputs for the following safety factors: (SF1) Plant design (SF2) Actual condition of SSC (SF3) Equipment qualification (SF4) Ageing (SF5) Deterministic safety analysis, (SF6) Probabilistic safety assessment (SF7) Hazard analysis (SF8) Safety performance (SF10) Organization safety management systems and safety culture (SF11) Procedures (SF12) The Human factor (SF13) Emergency planning (SF14) Radiological impact on the environment

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ORGANIZATION, MANAGEMENT SYSTEM AND SAFETY CULTURE

Inputs	Outputs
Standards and requirements: • Current national and international standards and regulations • Current national and international good practices Plant Specific documents: • The organisation's safety policy and related documentation; • management system procedures and documentation (quality assurance, configuration management, ageing management); • outputs from application of the organization's management system procedures, including e.g. quality plans. • records (e.g. training, commissioning, maintenance, testing, etc) • Documentation describing the organizational structure and safety-related roles and responsibilities of individuals and groups • Organization's management procedures • Corrective action programme and reporting processes • Roles and responsibility documents • Organization charts • Safety culture surveys Operational Experience • National and international operating experience with respect to organization and administration • Internal audit and surveillance reports • External audits (e.g. OSART) • Self assessments • Safety performance assessments • Previous safety culture assessments The review of this safety factor may require input from the following safety factors: • (SF2) Actual condition of SSCs • (SF5) Deterministic safety assessment • (SF6) Probabilistic safety assessment • (SF8) Safety performance • (SF9) Use of operating experience and research findings • (SF11) Procedures	The assessment of this safety factor may indicate findings in some of the following areas: • Clarity of policy statement • Adequacy of management system documentation • Structure of organization • Work processes (how work is specified, prepared, reviewed, performed, recorded, assessed, and improved) • Control of documents, products, and records • Purchasing process • Communication process • Organizational change management • Commitment to safety • Procedural compliance • Questioning attitude • Learning organization • Prioritization of safety issues • Clear organizational roles and responsibilities • Safety culture training • Regular safety culture assessments The results of this safety factor review are outputs for the following safety factors: • (SF2) Actual condition of SSCs • (SF3) Equipment qualification • (SF4) Ageing • (SF8) Safety performance • (SF9) Use of operating experience and research findings • (SF11) Procedures • (SF12) The Human factor

• (SF12) The Human factor • (SF14) Radiological impact on the environment	

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PROCEDURES

Inputs	Outputs
Standards and requirements: • Current national and international requirements for procedures • Current national and international good practices for procedures Plant Specific documents: • Procedures governing the process for the development, elaboration, validation, acceptance, modification, withdrawal and following of procedures • Station procedures • Audits and self assessments that indicate whether procedures are being followed • Symptom based emergency operating procedures for restoring critical safety functions Operating Experience: • Current national and international operating experience involving procedural issues • Safety significant events involving procedural issues The review of this safety factor may use input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSC • (SF3) Equipment qualification • (SF4) Ageing • (SF5) Deterministic safety analysis, • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance • (SF9) Use of operating experience and research findings • (SF10) Organization, safety management systems and safety culture • (SF12) The Human factor • (**SF**13) Emergency planning • (**SF**14) Radiological impact on the environment	The assessment of procedures may indicate strengths or findings in some of the following areas: • Process for development, elaboration, validation, acceptance, modification, and withdrawal of procedures • Clarity of procedures • Procedural compliance • Effectiveness and adequacy of procedures The results of this safety factor review may be inputs for any of the other safety factors: • (SF4) Ageing • (SF5) Deterministic safety analysis, • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance • (SF9) Use of operating experience and research findings • (SF10) Organization, safety management systems and safety culture • (SF12) The Human factor • (SF13) Emergency planning • (SF14) Radiological impact on the environment

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THE HUMAN FACTOR

Inputs	Outputs
Standards and requirements: • Current national and international requirements • Current national and international good practices for ensuring human factors do not affect the safe operation of the nuclear power plant Plant Specific documents: • Policy to maintain the know-how of the plant staff. • Training records, also for training in safety culture, particularly for management staff • 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 of their causes and corrective actions and/or safety improvements • Audits and self assessments of hours of work and time records Operating Experience: • Current national and international operating experience involving human factors issues • Safety significant events involving human factors issues The review of this safety factor may use input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of SSCs • (SF3) Equipment qualification • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance • (SF9) Use of operating experience and research findings • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures	The assessment of human factors may indicate strengths or findings in some of the following areas: • Staffing levels • Training programs • Operating, maintenance and engineering practices • Competency management • Staff selection and recruitment and succession management • Knowledge management • Use of external technical resources • Human-machine interface • Communications Outputs from the review of this safety factor may provide input to the review of other safety factors: • (SF1) Plant design • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF8) Safety performance • (SF10) Organization, safety management system and safety culture • (SF11) Procedures

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EMERGENCY PLANNING

Inputs	Outputs
Standards and requirements: • Current national and international standards on emergency planning Plant specific documents: • The operating organizations emergency planning manual • Strategy, procedures and organization for emergencies • Studies of the mitigation of accident consequences • Procedures for the management of beyond design basis accidents and management guidelines Operating Experience: • Records of experience of performed emergency exercises and lessons learned. • Lessons learned from national and international exercises The review of this safety factor may use input from the following safety factors: • (SF1) Plant design • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis (in particular regarding industrial, commercial and residential developments around the site) • (SF8) Safety performance • (SF9) Use of experience from other plants and research findings (e. g. new mitigation strategies or technical solutions) • (SF11) Procedures The review of this safety factor may use input from the safety factor PSA when an appropriate analyses are available (PSA level 3 or at least Level 2).	The assessment of emergency planning may indicate strengths or findings in some of the following areas: • Status of the emergency preparedness of the plant • Confirmation that an effective emergency planning process is in place. • Technical and/or administrative improvements in the communication to external bodies are necessary. • Emergency training with organizations outside the plant needs to be improved. • Updating of emergency plans in accordance with the results of current safety analyses, accident mitigation studies and good practices. Outputs from the review of this safety factor may be input to the review of the safety factors: • (SF1) Plant design • (SF3) Equipment qualification • (SF5) Deterministic safety analysis • (SF6) Probabilistic safety assessment • (SF7) Hazard analysis • (SF11) Procedures

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RADIOLOGICAL IMPACT ON THE ENVIRONMENT

Inputs	Outputs
Inputs to the review of the radiological impact of the nuclear power plant on the environment should include the following: Standards • IAEA safety requirements and guides including NS-R-1, NS-G-1.13 and NS-G-3.2. • Relevant standards from the OECD Nuclear Energy Agency, WANO, and the Institute of Nuclear Power Operations (INPO). • Relevant National standards Plant Specific Documents: • Plant specific inputs to the review of radiological impact of the nuclear power plant on the environment are derived from the design and safety performance safety factors • 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. • Changes in the use of areas around the site). • Records of effluent releases. • Records from off -site monitoring. • Published environmental data. The review of this safety factor may use input from the following safety factors: • (SF1) Plant design • (SF2) Actual condition of the SSC (e.g. findings that suggest there is an increased risk of leakage or inadvertent release) • (SF8) Safety performance • (SF9) Use of experience from other plants and research findings • (SF11) Procedures	Outputs from the review of this safety factor could, potentially, input to the reviews of all the other safety factors The results of this safety factor review are outputs for the following safety factors: • (SF1) Plant design • (SF7) Hazard analysis • (SF8) Safety performance • (SF9) Use of operating experience and research findings • (SF10) Organization, safety management systems and safety culture • (SF11) Procedures

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