Periodic Safety Reviews: Basis and Benefits of Improving Safety

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ABSTRACT. The systematic safety assessments of the Nuclear Research Facility (NRF) should be performed periodically against current safety standards and operating practices on the basis of graded approach with due account to potential hazard associated with a specific facility. The regulatory body should establish regular intervals of safety assessment performed by the operating organization and identify safety aspects and issues to be considered during the assessment (reassessment). The regulatory body should review the results of safety assessment (reassessment) and make decision with regard to the acceptability of the present safety of the NRF and its continued operation for the period until the next review of safety or final shutdown of the NRF. If the safety requirements are not fully met, measures must be taken by the operating organization to provide the required level of safety, including NRF modifications. The report presents the methodology of the Periodic Safety Reviews (PSRs) for a NRF that cover assessment of all aspects of NFR safety, and take into account the cumulative effect of various factors affecting safety. The PSRs make it sure that operation of a licensed NRF will continue in appropriate high safety manner until the planned termination of its activity.

Key Words: periodic safety review, safety factors, cumulative effect, comprehensive safety assessment

1. Introduction

Continuation of operation of Nuclear Research Facilities (NRFs)[1,] beyond the time frame originally anticipated for its operation or utilization has become a priority for many operating organizations. As presented in Ref. [1] many NRFs are in operation on average over 45 years. A long term operation of a NRF beyond the period established by the facility design and regulations should be justified by safety assessment, with consideration given to the life limiting processes, features of systems, structures and components (SSCs) important to safety and impact of occasional factors. The operating organization should have the requisite insight needed to prevent possible problems while the regulatory body should recognize potential threats to warrant serious attention to the facility in a long term operation.

The Periodic Safety Reviews (PSR)[2] is a way to obtain an overall view of actual facility safety in the context of the present state of technology and scientific knowledge, and to determine reasonable and practicable modifications to ensure a high level of safety during continued operation. The PSR can also be used to identify the life limiting features of the facility in order to determine if there is a need to modify, refurbish or replace certain SSCs for the purpose of extending the operating lifetime of the NRF. Finally, the PSR results provide

[1] NRF – nuclear facility including research nuclear reactors, critical nuclear assembles and subcritical nuclear assembles, and related complex of premises, structures, systems, elements, experimental facilities, and personnel that are in boundary of territory (NRF site) defined by the design for utilization of neutrons and ionizing radiation for research purposes.

[2] Periodic Safety Review as defined in Ref. [2] is a systematic reassessment of the safety of an existing facility (or activity) carried out at regular intervals to deal with the cumulative effects of ageing, modifications, operating experience, technical developments and siting aspects, and aimed at ensuring a high level of safety throughout the service life of the facility (or activity).

reassurance to the regulatory body that licensing basis keeps on being valid and operation of the facility may be prolonged for definite term.

2. PSR Purpose and Objectives

The purpose of PSR of a facility (or activity) consists in ensuring a high level of safety throughout the service life of the facility (or activity) by means of systematic safety evaluation with regular intervals to deal with cumulative effects, factors and circumstances that are subjected to the term of facility operation. A criterion of the achievement of the purpose is the decision-making by the regulatory body on continuation of the facility operation for the period until the next PSR or until the planned termination of its operation (if the facility will cease operation before the next PSR).

Based on the fundamental safety principals the primary responsibility for safety of a NRF rests with the operating organization (licensee). This responsibility is not simply the appearance of full compliance with the regulatory body's requirements. Complexity of the nuclear safety requires that all aspects, problems and trends are to be considered and the potential synergetic effects of supposedly unrelated issues not be ignored, and their risks will be reflected. In this regard, the objective of PSR is to determine by means of a comprehensive assessment the followings:

- The adequacy and effectiveness of the organizational and technical measures taken by an operating organization to ensure a high safety level at the operated facility until the next PSR or the facility final shutdown (if the facility will cease operation before the next PSR);
- The extent to which the facility conforms to current national and international safety standards and operating practices;
- The completeness and extent to which the facility safety documentation, including licensing basis, remains valid.

The PSR is not used for identifying safety issues during final shutdown or decommissioning phase, but might be important input to planning NRF decommissioning. A review of the physical security of a facility is generally not included in the PSR because of the sensitivity of the subject and the need to ensure confidentiality.

3. IAEA Documents Related to PSR of Research Reactors

It is important to emphasize that there is no specific IAEA standard or guide on PSR for research reactors. A few recommendations on PSR for research reactors are given below from Refs. [4, 5, 6].

Items 20 c), 22 a) of Ref. [4] advise that national regulations and guidance should require that operating organization shall undertake PSRs at intervals determined by the regulatory body and make proposals for upgrading and refurbishment of NRF arising from such reviews as necessary. The assessments and reviews should be well documented and subsequently updated in light of operating experience and significant new safety information.

Paragraphs 2.16, 4.16 of Ref. [5] define that systematic assessments should consider the cumulative effects of modifications, changes in procedures, ageing of components, and also use the feedback from operating experience and technical developments. It is necessary to verify that selected SSCs and software comply with the design requirements. In order to apply

principles for verification of safety, the operating organization shall carry out comprehensive periodic reviews of operational issues and safety related activities. The reviewing strategy and the safety factors to be evaluated shall be approved or agreed on by the regulatory body.

Paragraph 2.39 of Ref. [6] recommends that the nature of the review and the interval between the reviews should reflect the risks that the research reactor presents. For this review a comparison of the existing safety analysis report (SAR) with information on operating experience should be made. This includes lessons from accidents and information on radiological aspects, modifications, experiments and other aspects of operation. If required, the operating organization should submit to the regulatory body a request for licence amendment. This request may include a revised SAR.

It was recognized that in light of the Fukushima Daiichi NPP accident a complementary safety assessment (reassessment) of operated NRFs should be carried out to define challenges needed to ensure safety of the facilities operation and reveal necessity for the regulatory body to produce new regulations or revise existing regulations. The IAEA has elaborated the safety report [7] to support methodology of this reassessment, which may be used for strengthening PSR process and improving NRF safety.

It is expected that the review process developed by the IAEA for Nuclear Power Plants and presented in Ref. [3] may be applied to NRFs by means of a graded approach. The key points of PSR are represented below.

4. Key Points of PSR

As established in Ref. [3] the complex task of PSR may be subdivided into several important aspects of safety, which are termed “safety factors”. The fourteen safety factors may be evaluated:

Safety factors relating to the plant

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

Safety factors relating to safety analysis

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

Safety factors relating to performance and feedback of experience

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

Safety factors relating to management

(10) Organization, the management system and safety culture;

(11) Procedures;
(12) Human factors;
(13) Emergency planning.

Safety factors relating to the environment

(14) Radiological impact on the environment.

This subdivision is not unique. The number of the safety factors and their grouping for the purpose of PSR may be different, and may be further developed and completed by the regulatory body. If the safety factor is not relevant for a specific NRF, the factor application may be omitted or reduced in accordance with the potential hazards associated with the NRF by means of a graded approach.

The PSR is typically performed by a number of review teams that work in parallel. Each safety factor is reviewed in accordance with its individual objectives, scope, tasks and methodology. The findings specific to each safety factor should be documented and ranked according to their safety significance. The two types of findings may be identified resulting from review of the safety factors:

- Positive findings (that is strengths): these include current practice that is in line with the current codes and standards, good practice.
- Negative findings (that is deviations): these include current practice that does not meet requirements of safety standards or does not comply with the current licensing basis and inconsistent with the facility operational documentation and operation procedures.

The PSR should include the following general phases, which may overlap or be further subdivided as appropriate:

- Preparation of the PSR project;
- Conduct of PSR;
- Regulatory review.

Short description of the each phase is given below based on Ref. [3].

Preparation of PSR Project:

Before the review work is started the operating organization should develop PSR project, PSR basis document, and quality assurance plan. The regulatory body should agree the PSR project that governs the conduct of PSR and the regulatory review of the PSR results. The basis document should identify the scope, major milestones, including cut-off dates, methodology of PSR, as well as the safety factors to be reviewed, the structure of the documentation and applicable safety standards, codes and practices. The process for categorizing, prioritizing and resolving findings should also be agreed on and set out in the basis document. To ensure the appropriate quality and format of the PSR documents, a quality assurance plan should be prepared that, among other things, should define the requirements for the preparation and verification of the PSR documentation.

Conduct of PSR:

The operating organization should conduct the review in line with the basis document. The assessment for each safety factor should be made against current safety standards and operating practice as identified in the PSR basis document. The positive or negative findings from the review should be identified and ranked according to their safety significance. A list of proposed safety improvements should be prepared for each negative finding. A safety factor report should be prepared to summarize the results of the review of each safety factor. A safety factor report should include a scope of review, criteria, applied methodologies, performance since the previous PSR, and evaluation and prioritization of the negative findings. It is expected that the findings on all safety factors may be outlined in a single report.

A level of facility safety should then be determined by a global assessment reflecting the combined effect of all safety factors. A global assessment report should be prepared to document significant outcomes, analysis of interfaces, overlaps and omissions between the safety factors as well as the category, ranking and priority of safety improvements proposed for further facility operation. Finally, the summary PSR report should be prepared. This report should include an integrated implementation plan and assessment of safety of future facility operation over period addressed in the PSR. It is recognized that some safety features, such as current seismic features, cannot be easily backfitted, and some design aspects, such as plant layout, are difficult to modify. For these cases the risk associated with the shortcomings should be assessed and justification for continued facility operation should be provided.

Regulatory Review:

The operating organization should submit the PSR reports to the regulatory body either during PSR or during a structured continuous improvement programme, as required. The regulatory body should review the PSR reports and assess the findings and proposals for safety improvements. The regulatory body should prepare the integrated project report, including evaluation of adequacy of the PSR, safety improvements, and time schedule for the integrated implementation plan.

After Completion of the Regulatory Review:

Both the operating organization and the regulatory body should maintain adequate arrangements for the PSR project management after completion of the regulatory review of the PSR results. The operating organization should modify all affected safety documentation as necessary. The integrated implementation plan should be finalized by the operating organization with due account to the regulatory body recommendations included in integrated project report. Subsequent PSRs should be performed with a periodicity required by the regulatory body.

5. PSRs Practice in the Russian Federation

In practice the Rostechnadzor[3] issues a licence for period of 5-10 years. When the licence expired, the operating organization should obtain a new one and submit a full set of the NRF safety documents to the Rostechnadzor for reviewing during a new licensing process.

[3]The Federal Environmental, Industrial and Nuclear Supervision Service (Rostechnadzor) - the state regulatory authority in the field of the use of atomic energy

Therefore, in fact, the safety reassessments of the NRFs in Russian Federation are being performed every 5-10 years.

The IAEA Integrated Regulatory Review Service mission in the Russian Federation (November 2009) recommended to develop the national legal provisions for PSRs of nuclear facilities as set out in Ref. [8]. In this regard, the national standard [9] has been developed to specify the requirements to PSR for NRFs licensed for operational period more than 10 years apart from the facilities that are in a final shutdown mode or in decommissioning state. The standard covers the following:

- Program of PSR;
- Baseline data and references for safety assessment of the NRF;
- Provisions on comprehensive review of the NRF safety;
- Measures for safety improvement based on the results of the comprehensive review of the NRF safety;
- Global assessment of the NRF safety;
- Requirements to the PSR report.

Thus, one integrated report on findings on all safety factors and global assessment of the NRF safety should be prepared.

The operating organization should submit to the regulatory body for regulatory review the following set of safety documents in compliance with Administrative Regulations [10]:

- Program of PSR;
- PSR report;
- Safety analysis report (SAR) modified in result of PSR;
- NRF technical specifications;
- Programme of research and experiments at the NRF;
- List of nuclear and radiation hazardous work at the NRF and technical and organizational measures for safety ensuring.

The PSRs and the need to make safety improvements often call for revision of the facility design and its operational and licensing documentation in order the actual configuration of the facility will be reflected. In case the licensing documentation has to be modified, the operating organization should apply to the Rostechnadzor to amend licence conditions and authorize continuation of the facility operation. The PSR report and the required set of the safety documents are to be enclosed in the application. The Administrative Regulation sets detailed administrative procedures for processing the applications for a licence or amendment licence conditions by the Rostechnadzor. The following steps are envisaged for making decision on modification of licence conditions from PSR results:

- Preliminary check and examination of the application and set of the safety documents;
- Decision-making based on preliminary review to accept the application and the results of PSR for processing or not to accept in case the set of the safety documents is not completed;

- Examination of the safety documents submitted with the application for modification of the licence conditions; confirmation of these documents validity and reliability;
- Decision-making to modify the licence conditions based on PSR results or to deny application for changing the licence conditions;
- Grant a licence for continuation of facility operation for the period until the next PSR or planned termination of the facility operation with the modified licence conditions attached.

The Federal Law on the Use of Atomic Energy [11] does not define limit for duration of licence for facility operation. With this regard, the Federal Law has been amended by requirements on performing and use PSR of nuclear installations and storage facilities that oblige the operating organizations to carry out the PSR in case the licence has been issued for a period over 10 years. Further, the operating organization should conduct periodic safety assessments of nuclear installations and storage facilities every 10 years in accordance with the programme developed and approved by the operating organization for this purpose. Each PSR results should be reviewed by the Rostechnadzor. The arrangements for the NRF safety enhancement should be reflected in the SAR.

The Rostechnadzor can insert the PSRs as an obligatory requirement in the licence conditions of the NRF if appropriate.

6. Benefits of Improving Safety from PSRs

The PSRs process is a key to enabling the operating organization to manage facilities and activities safely for a long time and to accumulate knowledge and experience gained in previous reviews. It is also a vital input in reporting to demonstrate to stakeholders the compliance of state of a NRF with regulatory requirements.

The PSRs provide the following benefits for improving the NRF safety:

- Strengthen monitoring of possible negative phenomena, effects, trends and threats due to systematic safety assessment;
- Timely evaluation of the cumulative impact of safety factors, subsequent, reasonable and practical decisions on modification, refurbishment or replacement of SSCs based on outcomes of its comprehensive safety assessment;
- Quality of safety documentation, compliance with national and international safety standards and operating practices;
- Flexibility and safety in performing of new experiments and research programmes;
- Open and transparent interaction between all stakeholders involved to enhance the understanding of all safety aspects of a NRF operation.

It should be stressed that certain aspects of PSR can be carried out more effectively by external consultants. For example, the review of the safety factors relating to organization, management system and safety culture, and the safety factor relating to human aspects could benefit from reviews carried out by specialists completely independent from the organization of the operating the facility.

7. Closing Remarks

- PSRs provide a systematic, consistent and reliable process to find the problems in facility operation before the problems have caught the facility or/and the operating organization.
- PSRs provide a proactive approach in improving safety and enhancing quality of safety documents.
- Reasonable periodicity of PSR is about ten years.
- PSRs may provide continuation of a NRF operation at a required high safety level until the planned termination of the NRF operation.

8. References

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