



**ANSN THIRD ANNUAL MEETING
of the
Regional Advisory Safety Committee for Research
Reactors in Asia and the Pacific (RASCAP)
(EBP-ASIA)**

Hosted by the
Government of Indonesia
through the
Badan Tenaga Nuklir Nasional (BATAN)
Serpong, Tangerang Selatan, Indonesia
31 August-4 September 2015

Deshraju Rao
RRSS/NSNI
IAEA

Periodic Safety Review of Research Reactors



Contents

- **IAEA reference to PSR**
- **Objectives**
- **Periodicity**
- **Phases of PSR project**
- **Review of safety factors**
- **Implementation plan for safety improvements**
- **Regulatory review**
- **Documentation**
- **Post-PSR activities**



IAEA Safety Standards - PSR

- The IAEA Safety Standard No. GSR Part 4 – Safety assessment for Facilities and Activities
- The IAEA Safety Standards No. NS-R- 4, Safety of Research Reactors
- IAEA Safety Standard SSG-25 provides recommendations regarding the periodic safety review for nuclear power plants
- PSR for research reactors – **under development**



NSR-4 PSR References

“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 to by the regulatory body. These reviews will mainly be for identifying and solving problems concerning safety and performance and for improving safety if necessary”



Objectives of PSR

- **The objective of PSR is to determine by means of a comprehensive assessment:**
 - **The adequacy and effectiveness of the arrangements and the structures, systems and components that are in place to ensure the safety of the facility until the next PSR or, where appropriate, until the end of planned operation (that is, if the research reactor will cease operation before the next PSR is due);**
 - **The extent to which the facility conforms to current national and/or international safety standards and operating practices;**
 - **Safety improvements and timescales for their implementation;**
 - **The extent to which the safety documentation, including the licensing basis, remains valid.**



Periodicity of PSR

- It is reasonable to perform a PSR about every ten years after the start of facility operation. Ten years is considered to be an appropriate interval in view of the likelihood of the following:
 - Changes in safety standards, operating practices, technology, underlying scientific knowledge or analytical techniques;
 - The potential for the cumulative effects of facility modifications to adversely affect safety;
 - Identification of significant ageing effects or trends;
 - Accumulation of relevant operating experience;
 - Changes in how the facility is, or will be, utilized;
 - Changes in the site characteristics of the facility;
 - Changes in staffing levels or in the experience of staff;
 - Changes in the management structure and/or procedures of the facility's operating organization.



Phases of a PSR project

- **Preparation of the PSR project agreement of the operating organization with the regulatory body - scope, details, timing, the codes and standards, project team (PSR basis document);**
- **Conduct of the PSR: the OO conducts the review as per 'basis document'. The PSR report identifies findings- positive (strengths) or negative (deviations) - an implementation plan;**
- **Regulatory review: The regulatory body reviews the PSR report and the proposed safety improvements and identifies any issues it wishes to raise and should verify whether the licensing basis for the research reactor remains valid;**
- **Finalization of the implementation plan.**



PSR - Areas

- **Status of the facility**
- **Safety analysis**
- **Operational experience**
- **Organizational aspects**
- **Emergency planning and preparedness**

Each area is covered by number of safety factors, these safety factors may interact with each other.



Safety Factor-1 Facility design

- **Objective - to review the design of the facility to determine the adequacy of the design and its documentation against the current licensing basis and international standards and practices**
- **Scope and Tasks - Review of facility SSCs important to safety to ensure that they have appropriate design characteristics and are arranged and segregated in such a way as to meet current requirements for facility safety and performance, including the prevention and mitigation of events that could jeopardize safety**
- **clause-by-clause review of national and international requirements and standards listed in the PSR basis document to assess the impact of changes on the facility design.**
- **The review should demonstrate – updating of documentation to reflect modifications made to the facility/operation, effects of all modifications on the design, effectiveness of the change control process and configuration management of both facility and associated documentation.**



Safety factor-2 - Actual condition of structures, systems and components (SSCs) important to safety

- **Objective - to determine the actual condition of SSCs important to safety and whether their condition is adequate for them to meet their design requirements, to confirm that the condition of SSCs is adequately documented and to review the ongoing maintenance, surveillance and in-service inspection programmes, as applicable.**
- **Scope and Task – OLCs, obsolescence, implications of changes to design requirements and standards on the actual condition of the SSC, findings from tests of the functional capability of the SSC, results of inspections and/or walkdowns of the SSC, maintenance and validity of records, evaluation of the operating history of the SSC; the condition of the stored fuel and the fresh and spent fuel storage facilities; and verification of the actual state of the SSC against the design basis.**



Safety factor-2 - Actual condition of structures, systems and components (SSCs) important to safety (contd.)

- **Methodology**
- **The actual condition of the SSCs important to the safety of the facility should be reviewed for obsolescence, modification history and operating history. The implications of changes to design standards, Walk downs in addition to other inspections.**
- **Where data are lacking, they should be generated or derived by performing special tests, facility walkdowns and inspections as necessary. The validity of existing records to ensure that they accurately represent the actual condition of the SSCs important to safety, including any significant findings from ongoing maintenance, tests and inspections.**
- **After determining the actual condition of the SSCs important to safety, each SSC should be assessed against the current design basis (or updated design basis: see safety factor 1) to confirm that design basis assumptions have not been significantly challenged and will remain so until the next PSR.**



Safety factor 3 - Equipment Qualification

- **Objective:** To determine whether equipment important to safety is qualified to perform its designated safety function and this qualification is being maintained until at least the next PSR.
- **Scope and tasks:** Records of equipment qualification; Procedures for: updating and maintaining qualification, ensuring that modifications and additions to SSCs important to safety do not compromise their qualification; monitoring of actual environmental conditions and identification of 'hot spots' of high activity or temperature; Protection of qualified equipment from adverse environmental conditions.
- **Methodology:** equipment classification resulting from design modifications; designed environmental conditions; the availability of equipment, the management system provisions that ensure that an effective qualification programme is in place.



Safety factor 4 - Ageing Management

- **Objective:** To determine whether ageing in a research reactor is being effectively managed so that required safety functions are maintained, and whether an effective ageing management programme is in place for future facility operation.
- **Scope and tasks:** The comprehensiveness of the programme, the effectiveness of operating and maintenance policies and/or procedures for managing the ageing of replaceable components; evaluation and documentation of the timely detection and mitigation of ageing mechanisms and/or ageing effects; potential ageing degradation that may affect the safety functions of SSCs important to safety; management of the effects of ageing on those parts of the facility that will be required for safety when the nuclear reactor has ceased operation, for example the spent fuel storage facilities; record keeping.



Safety factor 4 - Ageing Management (contd.)

- **Methodology:**
- **The review should demonstrate that:**
 - **A systematic and effective comprehensive ageing management programme is in place;**
 - **It covers SSCs important to safety, 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 programme contributes to ensuring the continued safe operation for the next PSR period, and to the end of life of the facility.**

Safety factor 5: Utilization

- **Objectives:** To determine whether the existing arrangements are adequate to ensure safety of experiments and utilization and whether the changes in the utilization are adequately addressed.
- **Scope and tasks:** Review of on-going utilization and any foreseeable changes; adequacy of arrangements; changes in the facility documentation with respect to utilization
- **Methodology:** Review of records and documentation, adequacy of procedures, training of external users and experimenters, procedures for approval of experiments.



Safety factor 6 – Initiating events and hazard analysis

- **Objective:** To determine the adequacy of the identified postulated initiating events, including internal and external hazards, with account taken of the facility design and site characteristics for the period covered by the PSR, and current analytical methods, safety standards and knowledge.
- **Scope and tasks:** List of initiating events and relevant internal and external hazards that may affect facility safety should be reviewed for completeness, validity, and relevance.
- **For each relevant initiating event and identified hazard, the review should verify, by means of current analytical techniques and data, that the preventive and mitigating measures in place are adequate; use of current analytical methods, safety standards and information , use of operating experience both national and international.**



Safety factor 7 -Deterministic safety analysis

- **Objective:** To determine to what extent the facility deterministic safety analysis is complete and remains valid when the following aspects have been taken into account: the actual facility design, including all modifications of SSCs since the last update of the safety analysis report ; Current operating modes, facility utilization and fuel management; Applicable safety standards and knowledge ; the existence and adequacy of safety margins.
- **Scope and tasks:** Review of: the application of analytical methods, guidelines and computer codes used, the current state of the deterministic safety analysis for the completeness of the set of PIEs forming the design basis; Evaluation of: validity of assumptions, whether the actual operational conditions of the facility meet the acceptance criteria for the design basis, emergency planning and the accident response at the facility are in accordance with current regulations, national and international standards and practices based on deterministic safety analysis

Safety factor 7 -Deterministic safety analysis (contd.)

- **Methodology:**
- **The facility deterministic safety analysis should be reviewed against the current national and international requirements, standards and good practices to verify that the design basis for SSCs important to safety is valid and that facility behaviour for postulated initiating events is properly analyzed.**
- **The capabilities of the facility in its current state, and where relevant with account taken of planned safety improvements, should be demonstrated to be within regulatory requirements and expectations for both normal operation and accident conditions.**
- **If it is necessary to repeat the analysis, consideration should be given to using current analytical methods, particularly with regard to computer codes for transient analyses. If the earlier approach is still used, its continuing validity should be verified explicitly in the review, including the assumptions used, the degree of conservatism applied and inherent uncertainties in the analysis.**



Safety factor 8 - Operating experience

- **Objective:** To determine whether the facility's safety performance and records of operating experience, including the evaluation of root causes of facility events, indicate any need for safety improvements.
- **Scope and tasks:** Adequacy of processes for routine recording and evaluation of safety related operating experience, Safety related incidents, low level events, precursors and near misses; Safety related operational data; Maintenance, inspection and testing activities; Replacements of SSCs important to safety owing to ageing, failure or obsolescence; Modifications, either temporary or permanent, to SSCs important to safety; Unavailability of safety systems;



Safety factor 8 - Operating experience (contd.)

- **Methodology:** The review should examine records of operating experience from the review period and evaluate the adequacy of the facility's safety performance methodologies and processes with regard to:
- **Safety related events, including implementation of corrective actions following events; Root cause analysis of incidents and feedback of results;**
- **Methods for the selection and recording of safety related operational data, including data on maintenance, testing and inspection;**
- **Trend analyses of safety related operational data, and component replacements owing failures or obsolescence;**
- **Feedback of safety related operational data to the operating regime (for example, for training purposes);**
- **Programmes in place for ensuring continuous improvement, including self-assessment and independent assessment;**



Safety factor 9- Use of experience from other facilities and research findings

- **Objective:** To determine whether there is adequate feedback of relevant experience from other research reactors and from the findings of research and whether this is used to introduce reasonable and practicable safety improvements at the facility or in the operating organization.
- **Scope and tasks:** Identify operating experience reports and other information that may be important at the operating organization, together with relevant experience and national and international research findings from nuclear and non-nuclear facilities. It should be verified that this information is relevant and has been properly considered within the facility's routine evaluation processes and that appropriate action has been taken. The review of the use of experience from other facilities and research findings should seek to identify good practices and lessons learned elsewhere and take advantage of improved knowledge derived from research.



Safety factor 9- Use of experience from other facilities and research findings (contd.)

- **Methodology :**
- **The review of the use of experience from other facilities and the nuclear industry, in general, should:**
 - **Verify that arrangements are in place for the feedback of experience relevant to safety from other research reactors, the nuclear industry and from relevant non-nuclear facilities;**
 - **Review the effectiveness of such programmes for the timely feedback of operating experience and for their output;**
 - **Review the processes for assessing and, if necessary, implementing research findings and findings from operating experience relevant to safety;**
 - **Use of IRSRR**



Safety factor 10 - Organization, the management system and safety culture

- **Objective:** To determine, to the extent applicable, whether the organization, management system and safety culture are adequate and effective for ensuring the safe operation of the research reactor
- **Scope and tasks:** Policy statements of the operating organization; The documentation of the management system; The adequacy of arrangements for managing and retaining responsibility for activities or processes important to safety that have been outsourced, if used; Roles and responsibilities of personnel, The communication policies, processes and supporting information that explain how work is to be specified, prepared, reviewed, performed, recorded, assessed and improved.
- **In addition:** Organizational change; HR management, control of documents, products and records, control of purchasing of equipment and services, quality assurance where this affects facility safety.



Safety factor 10 - Organization, the management system and safety culture (contd.)

- **Safety culture:**
- **A review of the safety policy to verify that it states that safety takes precedence over the facility's operational commitments and to confirm that this policy is effectively implemented;**
- **A review of procedures to ensure that nuclear and radiation safety are properly controlled and that appropriate measures are applied consistently and conscientiously by all staff;**
- **An assessment of the extent to which a questioning attitude exists and conservative decision making is undertaken in the organization; events investigation and that timely feedback is provided to appropriate staff on findings and remedial actions;**
- **Verification that unsafe acts and conditions are identified and challenged in a constructive manner, that the organization has a learning culture, adequate training in safety culture, particularly for managers**



Safety factor 10 - Organization, the management system and safety culture (contd.)

- **Methodology:**
- **The reviews should include evaluation of how the tasks are being undertaken and completed.**
- **The review should examine whether weaknesses and obstacles can be identified, evaluated and remedied in a timely manner via the management system. It should also examine whether the need to make changes to, or improvements in, policies, goals, strategies, plans, objectives and processes can be properly identified by the management system.**
- **Where the scope of the regular management system reviews has not addressed any of the aspects, the PSR should undertake a detailed review of the omitted tasks.**
- **An assessment of safety culture could include interviews of personnel at all levels of the operating organization and personnel providing support services.**



Safety factor 11– Procedure management

- **Objective:** To determine whether the operating organization's processes for managing, implementing and adhering to operating and working procedures and for maintaining compliance with OLCs and regulatory requirements are adequate and effective and ensure facility safety.
- **Scope and tasks:** The review should verify that the procedure management establishes an effective process for formal approval and documentation of all safety related procedures and that there is a formal system in place for development and modification of any procedure governing activities affecting safety, including adequate arrangements for tracking changes.



Safety factor 11– Procedure management

- **Methodology**
- — **Verify: effective process in place for formal approval and documentation of all safety related procedures; a formal system in place for development, validity and modification of any procedure governing activities affecting safety, including adequate arrangements for tracking changes; categorization of procedures according to safety significance;**
- — **Evaluate audits, self-assessments, safety performance and events to determine whether there is adequate understanding and acceptance of these procedures by managers and staff; updating of procedures due to changes; removal of obsolete procedures**
- — **Determine whether arrangements for regular review and maintenance of the procedures are in place and are adequate;.**
- — **Examine whether there is adequate involvement in the development of procedures by the staff which will use them;.**



Safety factor 12 - Facility Staffing

- **Objective:** To evaluate the facility staffing and how the staffing may affect the safe operation of the research reactor and to seek to identify improvements that are reasonable and practicable.
- **Scope and tasks:** adequate staffing levels exist for operating the facility, with due recognition given to absences, shift working and restrictions on overtime; Qualified staff are available on duty at all time required by the facility procedures; initial training, refresher training and upgrading training; Operator actions needed for safe operation have been assessed; Staffing for maintenance activities are assessed to promote error-free execution of work; Staff selection methods (for example, testing for aptitudes, knowledge and skills) are systematic and validated; fitness for duty guidelines including substance abuse.



Safety factor 12 - Facility Staffing

- **Methodology:**
- **The review of facility staffing should take account of recognized national and international good practices.**
- **The review may need to use the assistance of properly qualified specialists. Because of the difficulties associated with carrying out an objective review of what is essentially the performance of the facility's own staff, the operating organization may decide that specific elements of the review should be carried out by external consultants.**



Safety factor 13 - Emergency planning and preparedness

- **Objective:** To determine; (a) whether the operating organization has in place adequate plans, staff, facilities and equipment for dealing with emergencies; and (b) whether the operating organization's arrangements have been adequately coordinated with the arrangements of local and national authorities and are regularly exercised.
- **Scope and tasks:** Evaluate: the adequacy of on-site equipment (including maintenance and storage) and facilities for emergencies; the adequacy of on-site technical and operational support centers; the efficiency of communications in the event of an emergency, in particular the interaction with organizations outside the facility; the content and efficiency of emergency training and exercises and check records of experience from such exercises; arrangements for the regular review and updating of emergency plans and procedures; the effects of any recent residential and industrial developments around the site.



Safety factor 13 - Emergency planning and preparedness (contd.)

- **Methodology:**
- **Records of emergency exercises should be reviewed to evaluate the effectiveness and competence of the staff of the operating organization and of off-site (emergency) organizations, the required functional capability of equipment, location and storage (including communications equipment) and the adequacy of emergency planning.**
- **Interaction with relevant off-site organizations such as the police, fire departments, hospitals, ambulance services, regulatory bodies, local authorities, government, public welfare authorities and the news media should be evaluated.**
- **Adequacy of on-site equipment and facilities for emergencies and off-site emergency facilities or locations should include walkdowns of relevant areas on and off the facility site.**



Safety factor 14 - Radiation protection

- **Objectives:** To determine whether the operating organization has in place adequate plans, staff, facilities and equipment for radiation protection including environmental discharges and waste management
- **Scope and tasks:** Radiation doses (to workers, users, and contractors); Off-site contamination and radiation levels; Discharges of radioactive effluents; Generation of radioactive waste.
- **Methodology:** Records of radiation doses and radioactive effluents; Off-site and on-site contamination and radiation levels; Accumulation of radioactive waste; trends in the above.



Global assessment

- A judgment of the research reactor's suitability for continued operation on the basis of a balanced view of the findings from the reviews of the separate safety factors.
- The global assessment should consider all the findings (positive and negative) from the separate safety factor reviews and should consider what safety improvements are reasonable and practicable. The global assessment should also consider overlaps and omissions between the separate safety factors and so determine whether additional or grouped safety improvements arising from more than one safety factor review are also reasonable and practicable. Identified safety improvements judged not to be reasonable and practicable should not be pursued any further.
- The risks associated with negative findings should be assessed and an appropriate justification for continued operation should be provided.



Implementation plan for safety improvements

- The safety improvements and the implementation plan proposed may be updated after the PSR report has been discussed and agreed with the regulatory body to address the outcomes of discussions regarding the scope and adequacy of the proposals for safety improvements and applicable changes to their ranking, prioritization and timing.
- The implementation plan should consider interactions between individual safety improvements, with consideration given to appropriate configuration management. The plan should also specify the schedules for implementation of safety improvements and the necessary resources.
- The implementation plan should be subject to approval by senior managers from the operating organization, who should commit the necessary human and financial resources.



Documentation

**Consistent documentation of the facility with focus on information (on SSCs, etc.) relevant to safety
(Available from the operator already at the end of preparation phase)**

Introduction to the PSR, scope, objectives, structure, applied regulations		
Comparison of the facility status vs. license requirements and applicable regulation		
Deterministic safety analysis (DSA)		PSA (if necessary)
Operational experience	Organization, management, feedback of internal and external experience, staffing	Emergency procedures
Global assessment (results and findings)		
Implementation plan for measures		

Regulatory review of PSR

- The regulatory body reviews the PSR basis document and agrees an PSR report(s) and assesses the PSR findings and proposals for safety improvements submitted by the operating organization. To do this, the regulatory body may use its own analysis methods and verification and validation calculations, for example, using alternative computer codes if available and appropriate.
- During the course of PSR, if any finding poses an immediate and significant risk to the safety, regulatory body should require OO to address the same and not wait till completion of PSR.



Post-PSR activities

- **Implementation of identified reasonable and practicable safety improvements in a timely manner**
- **The outcomes of the PSR and the resulting safety improvements will often necessitate changes to facility documentation. Such changes may arise from the PSR or from the implementation of safety improvements arising from the PSR and will often result in the revision of design, operation safety and licensing documentation to reflect the actual configuration of the facility.**



**Thank you for your
kind attention!**



This activity is conducted by the IAEA, with funding by Japan, among others. The views expressed in this presentation do not necessarily reflect the views of Japan.