POLICY STATEMENT
APLLICATION OF PROBABILISTIC SAFETY ANALYSIS AND RISK INFORMED METHODS FOR NUCLEAR PLANTS

1. Preamble

In 1999, Gosatomnadzor of Russia published the Policy Statement "Application of Probabilistic Safety Analysis of Operating Units of Nuclear Plants", which for the first time noted the need for using probabilistic safety analysis (PSA) to assess the safety level and to regulate the safety of the units of the nuclear plants (NPs) in the Russian Federation.

The need and importance of mandatory application of the PSA methods in design, operation and reconstruction of the power facilities were indicated at the session of the Council of General and Principal Designers in the Field of High-Technology Sectors of Economy under the Chairman of the Government of the Russian Federation (Clauses 6 and 7, minutes No. 4 of December 7, 2009).

Taking account of the experience of PSA application gained for the past period both in the Russian Federation and abroad, Rostechnadzor as a body for state safety regulation in atomic energy use considers it necessary to announce the need for in-depth and broad employment of PSA and risk informed methods (the ones based on joint consideration of results of probabilistic and deterministic research) as comprehensive tools for safety assessment of NP units.

2. PSA as Method of NP Safety Assessment

Since the publication of the U.S. Nuclear Regulatory Commission's report "The Reactor Safety Study" in 1975, PSA has been significantly improved and found wide use in the international practices of NP design, operation and regulation. After the publication of the 1999 PSA Policy Statement of Gosatomnadzor of Russia, PSA has seen significant development in Russia as well and found application in the practices of design, operation and safety regulation of the NP units.

Many of the advanced countries with nuclear energy programmes have employed risk informed methods to assess decisions made at an NP unit as a means of safety assessment of the NP units. In 2011, the International Nuclear Safety Advisory Group under the IAEA DG released INSAG-25 "A framework for an Integrated Risk Informed Decision Making Process" dedicated to application of risk informed methods.

PSA is aimed at detailed analysis of the real state of an NP unit, including analysis of the safety important systems and components, analysis of results of their audits and tests, analysis of operating regulations and arrangements, analysis of reliability of NP unit personnel's actions, and allows detection of the factors which have the greatest effect on safety. These factors can be conditioned by particularities of NP siting, specific features of design solutions of an NP unit and its operating conditions.

PSA and risk informed methods are tools allowing:

- assessing the current safety level of an NP unit and determination of ways to enhance it as appropriate;
- detecting the most safety significant initiating events, accident sequences, NP unit components, the personnel's actions;
- developing recommendations on the actions aimed at enhancing the safety level, and determining priorities for their implementation;
- assessing how upgrading actions affect the safety level of an NP unit;
- assessing the reliability level of the safety important systems (components)

considering aging effects, their proofness to common cause failures and erroneous action of the NP unit personnel;

- assessing the safe operation conditions of an NP unit;
- justifying changes to the design and operation documentation;
- planning inspections and assessing their results;
- assessing significance of operating events;
- assessing the lists of design basis and beyond design basis accidents;
- justifying the beyond design basis management guidance.

Most of the above areas employing PSA and risk informed methods are valid not only for the NPs but also for the other atomic energy facilities (research reactors, vessel reactors and their related facilities, nuclear fuel cycle facilities, storage facilities, means of spent fuel transportation).

Regarding the study of types of initiating event consequences, PSA is traditionally divided into three levels:

- Level 1 (PSA-1) is for determination of overall probability of severe beyond design basis accidents in a time interval equal to one year; PSA-1 includes assessment of strong and weak points in the safety of an NP unit focused on analysis of accident sequences which lead to severe beyond design basis accidents, and assess the current and planned actions to prevent severe accidents;
- Level 2 (PSA-2) is for determination of probability of radioactive substance emission in a time interval equal to one year; PSA-2 is performed in addition to the analysis performed within PSA-1; PSA-2 studies phenomenology of severe accidents (for example, those of the containment), transport of radioactive substance from damaged fuel assemblies to the environment, and assesses the effectiveness of the current and planned actions to mitigate severe accidents;
- Level 3 (PSA-3) is for determination of damage risks; PSA-3 is performed in addition to the analysis performed within PSA-2; PSA-3 studies propagation of radioactive substance in case of an accident in the NP area, determines probabilities of irradiating the people, risks of fatalities and health damage, risks of radioactive contamination of the area.

NP unit PSA is performed for internal initiating events (conditioned by failures of the NP unit components, NP unit personnel's errors), for on-site fires, flooding and other effects, and for initiating events conditioned by external natural (earthquakes, floods, extreme weather conditions, etc) and man-induced (accident explosions, accidents at the hydraulic engineering structures, spills of dangerous substances, aircraft crushes, etc) impacts considering all possible modes of NP operation, including operation at the rated and lower power level, start-ups and shutdowns, outages and refueling.

By now, the first stage of work on PSA development has been completed. Rostechnadzor has received, as part of the sets of documents demonstrating safety of the NP units, PSA-1 for internal initiating events during power operation for all NPs currently constructed and operated. PSA-1 of shutdown modes have been developed and submitted for a number of NP units. Rostechnadzor expects that the operating organization within its activities on periodic safety assessment will develop and submit to Rostechnadzor PSA-1 for other types of initiating events conditioned by on-site fires and flooding, external natural and man-induced impacts, as well as PSA-2. Rostechnadzor notes that the Fukushima Daiichi accident shows that proofness of the NP units from external natural and man-made effects is an extremely important safety aspect for an NP unit.

In view of the above, Rostechnadzor noted the need for the operating organization to develop a programme for PSA activities for the coming years to have in

place full-scale PSA-1 and PSA-2 (for all types of initiating events and operating states) of the NPs being constructed and operated

3. PSA in Regulatory Control

Rostechnadzor has consistently moulded the regulatory requirements to employment of NP unit PSA since 1988.

Basing on the need for comprehensive safety study of the NP units, "General Safety Provisions for of Nuclear Plants" (OPB-88/97) include requirements establishing the need for performing NP unit PSA and state target reference points of probabilistic safety indicators of an NP unit. The requirement for submission of PSA-1 within the set of documents demonstrating nuclear and radiation safety of an NP unit is contained in "Administrative Regulation on Execution of the State Function of Licensing in the Field of Atomic Energy Uses by Federal Environmental, Industrial and Nuclear Supervision Service".

For the last decade, Rostechnadzor enacted a number of safety guides containing recommendations for PSA development as follows.

1. Assessment of core damage frequency (for external natural and man-induced initiating events). RB-021-02. (Valid from January 1, 2002).
2. Basic recommendations for performance of probabilistic safety analysis of nuclear plant safety. RB-032-04. (Valid from June 1, 2004).
3. Basic recommendations for Level 2 probabilistic safety analysis for nuclear plants with VVER reactors. RB-044-09. (Valid from September 1, 2009).
4. Provision on basic recommendations for development of Level 1 PSA for internal IEs and all operating modes of NP unit. RB-024-11. (Valid from September 9, 2011).
5. Provision on basic recommendations for development of Level 2 PSA for NPs with RBMK. (Valid from December 22, 2011).

The safety guides under development:

1. Provision on basic recommendations for development of Level 1 PSA for on-site fires and flooding.
2. Provision on application of risk informed methods when demonstrating changes in safe operation of an NP unit.

Rostechnadzor shall continue to develop the PSA-related regulatory and methodological framework and apply risk informed methods for NP safety regulation.

4. PSA Acceptable to Regulatory Body

The practice of reviewing the documents justifying safety of an NP unit shows that a high quality PSA has attributes as follows:

- methodological base and software used when performing PSA meet the current international practice;
- PSA is performed with involvement of the NP unit personnel;
- PSA uses data on reliability of the NP unit systems and components which as much as possible comply with the analyzed NP unit;
- PSA fully considers the actual state of an NP unit;
- the models of evolution of accident sequences adopted in PSA are confirmed with deterministic justification;
- PSA is performed using quality assurance procedures.

Rostechnadzor will use these attributes in assessing NP unit PSAs to be submitted to the regulatory body.

In accordance with international practice, Rostechnadzor will acknowledge results of the PSAs of the NP units being developed and constructed only after a

comprehensive independent review confirming the quality of analysis and consistency of the received data with the announced objectives.

5. Practical Use of PSA

Rostechnadzor will continue to use results of PSA Level 1 and Level 2 in its supervisory activities.

Rostechnadzor is planning to apply risk informed methods in its supervisory activities, in particular in assessing the current safety level of NP units, in regulatory decision making in terms of upgrading of the safety important systems and components, modifying the design and operating documentation, and changing the safe operating conditions of an NP unit, in planning and assessing inspection results, as well as in assessing the analysis performed when investigating operational occurrences of an NP unit.

Rostechnadzor will in every possible way support the effort of the operating organization aimed at developing PSA-1 and PSA-2 of the NP units, and also the initiative for a wide use of PSA results in the activities related to safety of an NP unit (assessment of the current safety level, planning of actions on upgrading, analysis of significance of deviations from requirements of the codes and standards, optimization of maintenance and repairs, management of equipment life, etc).

Special attentions should be attached to development of PSA of the NP units to be operated beyond the assigned lifetime. The use of PSA and risk informed methods is a necessary condition when justifying the possibility of lifetime extension for such units.

At the same time, the lack of initiative from the operating organization in terms of using PSA for assessment and enhancement of safety of the NP units, as well as employment of a poor quality PSA in the activities related to safety justification of the NP units being constructed and operated will be considered by Rostechnadzor as the operating organization's improper fulfillment of the requirements of the Federal Law "On the Use of Atomic Energy" in terms of implementation of full responsibility for ensuring safety of the NP units and as neglect of the safety culture principles.

6. Conclusion

Rostechnadzor considers that risk informed methods based on joint use of deterministic and probabilistic methods of safety assessment should be used to provide comprehensive assessment of nuclear and radiation safety of the NP units, and also to improve the effectiveness of safety regulation.

Rostechnadzor is planning to develop federal codes and standards in the field of atomic energy uses which will set requirements to probabilistic safety analysis.

Rostechnadzor expects that the operating organization will continue to perform full-scale PSAs-1 and PSAs-2, and apply risk informed methods in making decisions related to safety of the NP units.

Rostechnadzor considers it appropriate to use PSA and risk informed methods not only for the NPs but also for the other atomic energy facilities.