Interaction between Industry and Regulator to Improve Quality of the PSA

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Abstract:
The paper considers organization, scope, issues and benefits related to interaction between industry and regulatory body in the PSA area using Russian national experience. Actually there are two main interaction points:

- Regulatory reviews of safety substantiation which involves PSA or its applications;
- Development of regulatory documents.

Regulatory PSA review procedures are described. Interaction with industry experts in course of review process is discussed. Key issues raised during reviews and their impact on the PSA are summarized. Main PSA issues are included in the validity conditions of operational licence to be fixed within a prescribed period of time.

A corpus of Russian regulatory guides in the field of PSA is described. The regulation trend in the area of PSA is discussed. PSA aspects to be additionally covered by new regulatory documents are outlined. Regulations on PSA for hazard-induced initiating events and risk informed decision making are the most recent ones.

Impact and participation of the industry in development of regulatory guidelines are considered. Examples of PSA–induced proposals for changing regulatory documents (e.g., overhaul period extensions for NPPs) and associated discussion are presented.

Although Fukushima like consequences are usually analysed based on deterministic stress tests initiated by the Regulatory Authority a probabilistic approach is also used for mapping this accident to Russian plants within a joint regulator-industry activity.

Keywords: PSA Quality, Regulatory Body, Nuclear Power Plants.

1. INTRODUCTION

Russian national nuclear development program is rather ambitious. In total 33 power units of different design and age are operated at 10 nuclear plants of Russia. Of these, there are 17 different VVER type reactors, 15 various channel boiling reactors, and one fast breeder reactor. Plant ages differ from pilot operation period to 40-year life time. Several units are now under construction or siting phases. Several different advanced plants are in design for some new sites in Russia. Plants are located at sites having various geological and environmental conditions. Variety among plants in terms of design, age and site conditions raises an issue of plant specific safety evaluation including probabilistic safety assessment (PSA) for any unit.

The Federal Environmental, Industrial and Nuclear Supervision Service (Rostechnadzor) is the Russian regulatory authority which is responsible, in particular, for nuclear safety regulation. The Rostechnadzor has issued the administrative regulations to manage the licensing processes [1]. PSA must be provided to apply licence for unit construction or operation. The required PSA scope and quality are established in several regulatory guides [2-5]. Last but not least, by the end of 2011 the Rostechnadzor issued a circular on the policy in the area of PSA [6] taken into account post-Fukushima reality and past experience. The role of PSA is declared to be of utmost importance.

The only utility, Rosenergoatom Concern, is responsible for nuclear and radiological safety at all stages of nuclear power plant (NPP) life cycle according to the Federal Law "On the Use of Atomic Energy" [7]. Many Russian design and research companies which are independent of the utility are involved in safety

evaluation. The Rosenergoatom Concern has developed a program of works for 2011-2015 to incorporate PSA methods in plant operation and coordinate efforts of different companies.

Practical activity in the area of the nuclear regulatory review and development of nuclear regulatory documents is carried out by the Scientific and Engineering Centre for Nuclear and Radiation Safety of the Rostechnadzor (SEC NRS). The number and variety of plants result in about 200 reviews a year performed by the SEC NRS. A good portion of them is related to PSA itself and its applications. Industry representatives are efficiently involved in the review process through discussion of preliminary results of the review with the regulatory body and SEC NRS staff. The development of PSA regulatory documents is managed by the Rostechnadzor. However the industry actively participates in this process both at the level of experts involved in working groups and by declaring official positions of companies which are taken into account in regulatory decision making. Moreover, industry sometimes claims the regulatory authority to issue new documents or modify existing ones. This is a permanent dialog of two sides having different responsibilities.

The paper considers organization, scope, issues and benefits related to interaction between industry and regulatory body in the PSA area using Russian national experience.

2. REGULATORY REVIEW PRACTICE

In accordance with Circular [6] the Rostechnadzor believes that PSA results may be used and are used by the Regulatory Authority and by operating or design organizations both for the assessment of a safety level of NPP units and during the development of measures for NPP safety improvement. At the same time, the Rostechnadzor believes that PSA results can be used only with confirmation of their quality and reliability by a review of a high quality, which is carried out independently of PSA developers. The purpose of an independent PSA review is the determination of the PSA completeness and quality important to confirm the adequacy of PSA results and conclusions presented for the review. In addition, reliability analyses of safety related systems to be included in the safety analysis report are also reviewed. It is usual practice to invite well-known independent experts from industry to improve the quality of the regulatory review. On the other side, PSA teams are intensively involved in oral and written discussions to find the best way of resolving emerging issues. The systematic discussions between the utility and regulatory body are intended to improve safety of plants in spite of a natural conflict of interest.

Practice of the PSA reviews in Russia shows that a PSA of a high quality should have the following attributes [6]:

- Methodology and software used for the PSA is in line with the modern international practice, i.e. state-of-the-art. Conformity of models developed within the PSA to adopted methods and admissions should be assured;
- PSA of an operating plant is performed with the involvement of the appropriate plant personnel (e.g., staff responsible for operation, maintenance, engineering, safety analysis, and outage planning). Usually the plant personnel are interviewed to determine if any potential plant operational state, plant transition mode, initiating event has been overlooked. Discussions with the plant operating and training personnel are carried out to confirm that the interpretation of the procedures and the expected responses to an initiating event are consistent with the training and plant operational practices. The plant staff are always actively involved in walk downs for internal/external hazard PSAs;
- PSA is based on the plant-specific initiating event and reliability data, site-specific fragility parameters and plant-specific information, including the results of detailed walkdowns to determine as-installed and as-current conditions. Collection and evaluation of the data should be performed in a consistent and systematic way. In case of the PSA for the plant in design information from a referent plant should be used;
- PSA completely reflects the actual design and operational features of the plant. PSA logic models should be adequate to the real state of the NPP unit of its design development;

- Models of accident sequences accepted in the PSA are supported by deterministic calculations using applicable and proven computer codes;
- Dedicated PSA quality assurance programme is established to assure that the chosen methods and data are used, applied, and documented in an adequate and controlled manner.

Key issues raised during reviews and their impact on the PSA are related to the following:

- Scope of many PSAs is still limited. First of all, PSAs for external hazards should be considerably extended to get the cumulative plant risk profiles;
- Some plant transition modes are out of scope of the shutdown PSA that could lead to underestimation of the total plant risk;
- Potentially important accident sequences are sometimes missing with similar consequences as mentioned above;
- Incorrect modelling of dependencies is found in some cases. This is of utmost importance because dependencies are the main driving mechanism of plant behaviour;
- Uncertainty of a frequency estimation of the catastrophic steam generator header rupture is an extremely important issue for VVER-type plants since the frequency of the initiating event have a direct impact on the large release frequency;
- National common cause failures data collection is not established. As a result, only U.S. and IAEA generic data are used. However common cause failures are important contributor to risk and Russian and foreign plants as a rule are rather different. Therefore reviews push the industry to start the common cause failure data collection. Some positive changes in industry practice initiated by review comments can be observed [8];
- Mapping of the full power PSA performed first to shutdown plant operational states is a complicated task. However it is sometimes performed in a simplified way not taken into account plant specific conditions;
- Although Russia has probably the youngest nuclear reactors in the world, with an average age of 19 years, some plants are beyond the initial life time of 30 years. Reviews pay special attention to fracture mechanics models used for the rupture frequency estimation and justification of plant life time extension. It is evident that behaviour of non-replaceable equipment like the reactor pressure vessel is a key issue in regulatory decision making.

Main PSA issues are always included in the validity conditions of an operational licence to be fixed within a prescribed period of time.

3. DEVELOPMENT OF PSA REGULATORY GUIDES

The main Russian regulatory document issued in 1997 [9] establishes safety goals requires the PSA performance for NPPs in design. Two main safety goals are as follows:

- In order to avoid evacuation of the population it is necessary to aim that an estimated probability value of the large release, established by the requirements for the site, would not exceed 10^{-7} per reactor year. It should be noted that this requirement is stronger than one presented in INSAG-12 [10].
- It is necessary to aim that a value of the total probability of the beyond design-basis accidents, assessed by a probabilistic safety assessment, would not exceed 10^{-5} per reactor year.

It should be underlined that General Rules [9] are now updated in close co-operation between regulator and industry. Requirements to PSA are expected to be more specific. According to other regulatory documents [11,12] of a lower level PSA for operating NPPs has also to be carried out.

The licensing process directed by [1] involves PSA to obtain both a licence for plant construction and an operational licence.

The Circular [6] establishes main purposes and perspectives for performance and application of the PSA for operating NPPs and plants in design in Russia. The Rostechnadzor expects that the utility will make efforts to conduct the full scope PSA Level 1 and Level 2 for all the operating NPPs in order to get systematic and comprehensive information on all safety aspects of the units it operates.

Some guidances [2-5] provide for specific requirements to PSA contents and quality. These guidances are mainly used to review a PSA. At the moment, there are some open areas which are not addressed by existing guidances. These PSA aspects will be covered by new regulatory documents. Regulations on PSA for internal hazard-induced initiating events (internal fires and floods) and risk informed decision making to be issued in 2012 are the most recent ones. On the other hand, a guidance on the internal event PSA was issued ten years ago. The review experience showed that it should be updated, and a new version of the document [3] is published by the Regulatory Authority.

The regulator and industry intensively communicate while developing regulatory documents. The main activity is performed within working groups where experienced PSA experts delegated by design, research and operating companies discuss key issues related to the document of interest with regulatory experts. A draft document is periodically distributed among regulator and utility organisations and the working group considers official responses. Decision is usually made by consensus. However the Regulatory Authority has a deciding vote.

Russian experts are involved in IAEA PSA activity like IPSART, technical and consulting meetings, development of IAEA guidelines, etc. In addition, there are many contacts within WENRA, EUR and bilateral international projects. The accumulated international experience is used in developing Russian regulatory documents.

4. INTERACTION BETWEEN INDUSTRY AND REGULATOR ON TREATMENT RISK-BASED SUBSTANTIATIONS

Some regulatory documents are started to be developed or revised as a result of a nuclear industry initiative. For example, the utility started a program of overhaul period extensions from a year to a year and half for operating NPPs. Justification is supported by PSA and fracture mechanics studies which were reviewed and approved by the Regulatory Authority. However the current regulatory document [13] prescribes to perform tests of pressurizer safety valves once a year. This activity is possible only during unit shutdown. PSA–induced proposals for changing regulatory document [13] result in the process of revising it (new regulatory draft is published in 2011 in [15] and open for public comments).

Another example of PSA-based substantiation usage in our national practice is establishment of operational conditions, in particular, establishment of testing intervals and allowed outage periods for safety related equipment. Nowadays the Regulatory Authority often receives such substantiations from operators.

5. POST-FUKUSHIMA REALITY

The Fukushima accident has turned public opinion largely against nuclear power. At the moment, the Fukushima accident has not stopped Russian nuclear programme. However nuclear community has come under public pressure to make additional analyses on NPP safety. As a first response, the Russian regulatory authority has initiated reviews to see what lessons can be learned from the accident and has set up program, so-called “"stress tests”, to see how Russian plants would perform in the face of external hazards that result in reactor shutdown and a long-term loss of the external grid and ultimate heat sink. Also severe accident management was an issue under “stress-tests” scope.

Although Fukushima like consequences are mainly analysed based on deterministic stress tests a probabilistic approach is also used for mapping this accident to Russian plants within a joint regulator-industry activity. Follow-up actions from a stress test assessment are implementation of plant modification like autonomous mobile diesel generators and pumps, extension of battery capacity, tracing of new cable

lines, involvement of fire facilities in safe shutdown process, etc. The PSA is used to support the cost-benefit evaluation of severe accident management options and support the ranking, justification, and licensing of plant upgrades based on the level of risk reduction associated with each alternative. Any post-Fukushima measure is reviewed by the Regulatory Authority in detail.

Following the Fukushima accident special attention has been paid to the development of a seismic PSA. A full scope seismic PSA for Balakovo Unit 1 had been finished by the end of 2011. Many important findings, especially found during plant walkdowns, are now under regulatory review. Other lessons 1earnt from the Fukushima accident are to direct additional efforts to the following points within the PSA development: investigation of multi-unit accidents, spent fuel pool analysis, analysis of correlated internal and external events [14].

CONCLUSION

It appears that regulator and industry have different goals, roles and responsibilities. This conclusion is simultaneously valid and deceptive. The unity and struggle of opposites is one of the dialectical laws through which this situation can be understood. The progressive transition to a higher form is possible only through the complete resolution of the contradictions. The Fukushima accident shows that both are in the same boat called safety. The paper addresses interfacing points of the regulator-industry cooperation in Russia. Past experience confirms that this cooperation is mutually beneficial.

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