Experiences gained from a Living PSA workshop held on the PSA Castle Meeting in April 2013 in Stockholm.

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Abstract: The PSA Castle meeting in April 2013 was organized by the Swedish Radiation Safety Authority (SSM) together with the Nordic PSA Group (NPSAG). Participants on the meeting represented licensees, regulators, consultants, research organizations, international organizations and universities. A workshop on the subject "Living PSA (LPSA)" was held the last meeting day.

The workshop results show very clearly that the interpretation of the meaning of the "LPSA concept" and the daily practice to work with PSAs at different nuclear power plants in the Nordic countries, in Europe and in USA differs. Different strategies practiced in those countries using the properties associated with the LPSA, means that stakeholders have varying meanings and goals at maintaining and ensuring the quality of the PSAs and their applications. Established LPSA processes, instructions for maintaining the LPSA concept vary among stakeholders and the pros and cons with all these are unknown.

The aim with this paper is to open up for a wider international discussion about the interpretation and understanding of the LPSA concept, to achieve a harmonized view on methods for ensuring quality of base PSAs, quality in mandatory PSA updates and intermediate updates, quality in mandatory and voluntary applications but especially in the area of resource efficient reviewing methods and quality assurance (QA) methods of PSAs and applications.

Keywords: Living PSA, PSA quality, PSA review, PSA application, PSA management and reporting.

1. INTRODUCTION

Prior to the workshop held on the PSA Castle meeting the interpretation of the "LPSA concept" was believed to be understood, executed and practiced in different ways among regulators and licensees within countries and within a country. Also, PSAs may have different legal base and are used in different ways in the safety work, and are therefore also reviewed or quality assured in a variety of ways and according to different methods and procedures. The host of the meeting, SSM together with the NPSAG, therefore wanted to use the opportunity to discuss the various aspects of the "LPSA concept" with the meeting participants and to map the common understandings and views of the concept and the differences in opinions. The objective was also to open up for an international discussion about a common view and base on the workshop topics.

The LPSA workshop aimed to address overall PSA strategies with special emphasis on managing models and applications. The workshop objectives were also to exchange experience and learn from the workshop participants from various stakeholders regarding how they interpret the needs to have access to a PSA updated. Also, access to current PSA applications providing justified and quality assured results reflecting the actual as-built and as-operated plants to elaborate on. Different participants' definitions and understanding of the as-built and as-operated PSA was also a goal on the workshop.

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2. BACKGROUND

The LPSA concept is understood, executed and practiced in different ways among a regulator and licensees within countries and within a country. Further, existing international guidance e.g. [1] on how to practice the LPSA concept are considered as too general and allow for too wide interpretations.

The perception about the application of the LPSA concept prior to the workshop was that the role of PSA varies also between countries and involved stakeholders e.g., due to the different supervision strategies (deterministic, risk informed or both), different legal bases for PSA, confidence on PSA and also due to a variety of applied reviewing strategies of PSAs and applications. A wider knowledge about how the LPSA concept is practiced and maintained by stakeholders within the nuclear industry was therefore seen as necessary to explore at the workshop.

3. CONCLUSIONS OF THE LPSA WORKSHOP

The LPSA concept contains several different properties that are judged to be dependent onf each other and are part of the overall LPSA concept, but are not so clearly described in existing guidance for maintaining high quality in the LPSA processes. Some of these properties are;

- legal bases for PSAs,
- update intervals of required as-built and as-operated PSAs,
- PSA activities between the required update intervals,
- triggers for update of as-built and as-operated PSAs,
- use of copies of as-built and as-operated PSAs in applications, pilot studies,
- regulatory demands that strengthen the use of PSA in applications,
- review processes and their possibilities to find weaknesses in PSAs,
- Quality Assurance (QA) strategies and processes of PSAs,
- relationship between safety documentation and the required as-built and as-operated PSA and documentation and models and of the interim PSA models.

The LPSA properties illustrated in figure 1 depend on each other and a modern view or regulations on the LPSA concept need to take those aspects into account.

The Living PSA puzzle

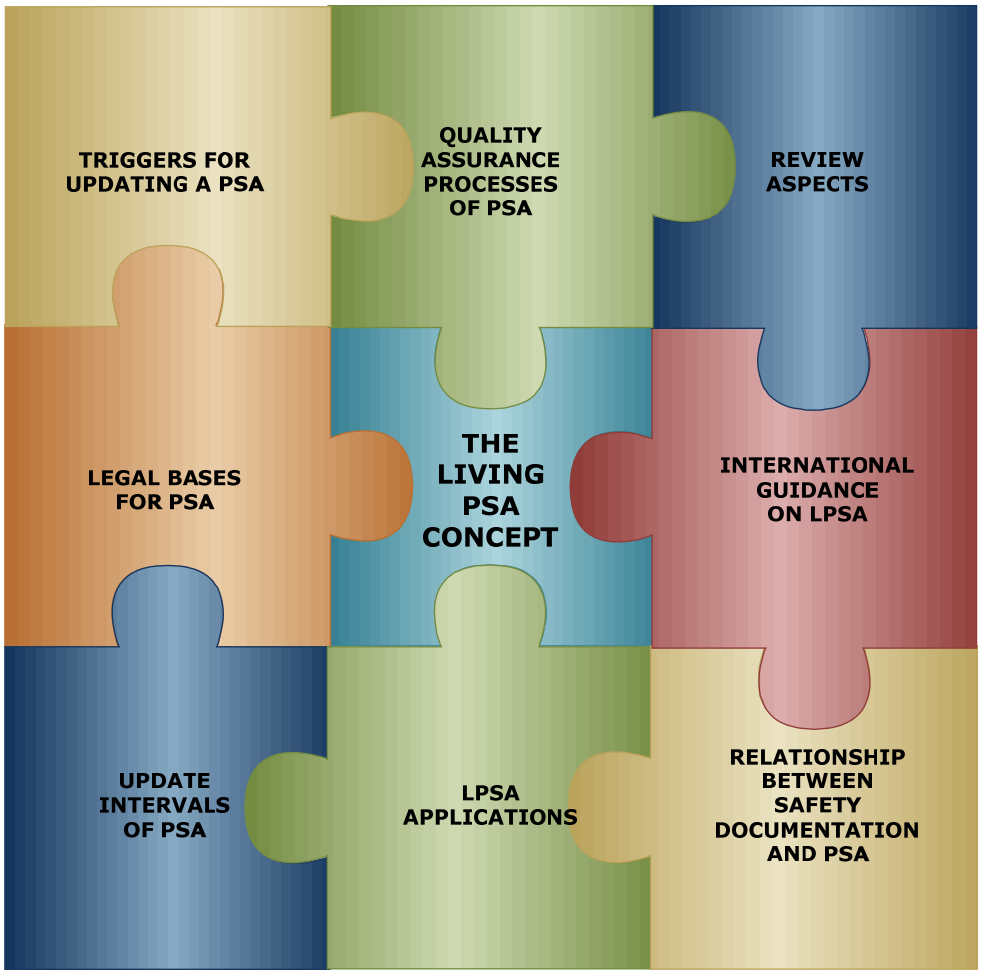

Figure 1. The Living PSA puzzle pieces.

There is a consensus among most of the workshop attendees that the different properties discussed and expressed about the understanding of the LPSA concept, is judged to be the absence of clear process descriptions. E.g. the absence of process descriptions describing how to maintain the different LPSA properties and the dependency between them. Also, that there are not at present any modern common international views on the LPSA concept to refer to at development of legal base for PSA, processes and instructions for e.g., reviewing of base PSAs and applications.

3.1 Differences in methods and aims with the LPSA

Regulators in different countries act according to predetermined supervision strategies, have expressed different scope and level of details in their regulations and in the general recommendations, opinions and applied methods for regulating LPSA-status at licensees. A full understanding of similarities and differences in the way that different regulations are written and in which way they reflect the different areas in the LPSA concept map (figure 1) could not be reached by the LPSA workshop.

The aims with PSAs differ between countries and the main stakeholders act in different ways. In some countries PSAs are only updated at the time for a Periodic Safety Review (PSR) every 8-10th year. In other countries PSAs are not mandatory to report to regulators.

It is an observation from the workshop that licensees and regulators therefore have developed processes for maintaining and updating the PSAs and applications and reviewing or QA practices in different ways and that these strategies are not well known in the safety assessment community.

3.2 Legal base for PSA

The legal base for PSA varies between countries and are exerted in different ways in the safety work. PSAs and applications are therefore updated, reported, reviewed and approved (QA specificities) in a variety of ways and according to different procedures at regulators and licensees.

Few regulators provide detailed and specific requirements on the legal basis for LPSA, e.g.;

- quality issues to be fulfilled,
- triggers and update intervals for official updates as well as of voluntary interim PSA updates,
- principles for agreed updates,
- review and approval aspects,
- guidance the regulator rely on,
- demanded or voluntary PSA applications to be performed and reported.

The differences in the legal bases on PSAs make it difficult for licensees to find and create harmonized views, and to create effective procedures to review and approve PSAs and applications.

The belief of SSM and NPSAG is that clear regulatory positions on how to maintain and keep a PSA quality assured, updated and used in risk informing NPP safety is important for all licensees as well as for regulators.

3.3 Differences in review and Quality Assurance

PSA studies and results are used in varying ways in decision making e.g.

- to be a complement to and support to deterministic evaluations and positions of plant modifications,
- to be a complement to and support to deterministic evaluations and positions of severe accident scenarios and in emergency preparedness,
- evaluation of risk impact and importance of occurred safety related events including their importance for different defence in depth levels,
- evaluation of overall plant weaknesses and strengths and to specific hazard types (internal and external origin),
- evaluation of different design concepts,
- evaluation of SSC as input to risk informed classification and
- evaluation of SSC as input to risk informed definitions of allowed outage times and test intervals.

There is a common position from the workshop that the suitability of PSAs has to be evaluated, before the use in different applications. Some guidance is available, e.g. the NRC Regulatory Guide 1.200 and in its ASME base. There is still however a need for further development and practice, on how to certify a PSA for a specific application.

For example, there are various degrees of conservatisms that need to be considered. Conservative data and assumptions are mainly chosen (to save resources) when bounding analysis can show that the risk contribution from a separate subset of analysis (e.g. a hazard) in the PSA is small. It is important that the safety review or quality assurance process at the licensee evaluates the PSA results and then take into account the degree of conservatisms in data, assumptions and modelling. This is especially important in the review of different kinds of licensee own voluntary or in mandatory PSA applications.

3.3.1 Licensee Review

Licensees strive to have as realistic PSA studies as needed in order to support the existing demands and objectives on as-built and as-operated PSAs. To meet the demands for a living PSA, most PSAs are updated regularly. The update frequency is dependent on the needs for meeting the own and

regulatory requirements, on updated PSA level-1 and level-2 studies and further on the needs for specific applications.

Updating of PSAs include also review activities. The differences in reviewing methods do also create differences in the resources and time for performing a PSA-update at licensees.

It is not an easy task to review a complete PSA in detail. A comprehensive review of a PSA is a huge work that requires large resources and a multidisciplinary team. The scope of the review, the independence of the review team in relation to the PSA team, the level of detail, and methods vary between different utilities/countries. There exist review guidance, but most are directed towards a full PSA review. Specific guidance on best review approaches in the case of PSA updates due to new applications, different triggers are limited, e.g.

- what shall the focus be on?
- only on the plant changes?
- only on new data introduced?
- only on results?
- on other parts of the PSA?
- shall existing and remaining conservatisms and assumptions be reviewed and in which way?

3.3.2 Regulatory Review

There are differences in regulatory approaches on PSA reviews, from no review at all to very detailed reviews. There are examples where a regulator develops a PSA in parallel, and that this PSA is used in the review of a licensee PSA and applications. The review practices also differ as a result of differences in PSA deliveries with different importance and impact on the licensed safety case.

For the continuous updating of mandatory PSA, most regulators rely on a well-functioning reviewing process at the licensees. Some regulators have reviewing guidance documents [6, 7].

Ensuring the suitability of PSAs for different applications:
PSAs are reviewed and quality assured after PSA updates. However, the reviewing and quality assurance processes have difficulties to secure which quality aspects are needed or most important for the applicability of the PSA for specific applications, especially taking into account variations in the degree of conservatism in model and data, between different sub-scope of the PSA. Existing guidance from IAEA [1, 2, 3, 4] and ASME [5] can be further developed to enhance trust in advices from risk informed applications.

3.3.3 Review follow-up actions

Studies on pros and cons with different reviewing procedures and methods for ensuring high quality of PSAs and applications and effectiveness of these are missing or unknown. Summing up the workshop, it is noted that experiences from reviews and QA of PSAs and applications practiced in different countries, could be of valuable help at optimization of review and QA processes at all licensees as well as at regulators.

3.4 PSA usages and applications

Some of the basic PSA uses are common among most or all utilities, whereas the other more advanced applications are less spread.

There exist different strategies on how to maintain the quality of PSA and PSA applications (frequency and types of review activities) and how often the studies have to be updated (due to different update triggers) and reported internally at a licensee and to the regulator. An observed common PSA update interval is 4-6 years, according to the workshop attendees. In many countries PSAs are only updated when a Periodic Safety Review (PSR) report have to be completed (usually

every 8-10 year. The latter indicates on weak use of PSAs at licensees and regulators, also that PSAs may not be a part of the safety documentation in some countries.

Most workshop attendants had a quite common position that an official appropriate update interval should be in the range of 2-4 years, for maintaining a LPSA approach and to keep the safety documentation updated. Years in between official updates of PSAs, depending on the use of PSA at both licensees and regulator, regulators should be informed about and follow the status of the development of interim PSA models and pilot studies at licensees. In some countries this kind of approach is already practiced and working well.

3.5 International guidance on conducting PSA and ensuring LPSA

Licensees do often refer to the same set of international guidance documents for both performing PSA and for review and validation of specific applications. These guides include the IAEA specific safety guides for PSA level 1 [2] and PSA level 2 [3], the IAEA TECDOC on "Determining the quality of probabilistic safety assessment (PSA) for applications in nuclear power plants [4], and the ASME PRA standard [5].

3.6 Triggers for update of PSA

PSAs are due to different legal base for PSA, and different uses at the licensees, updated in a variety of ways and intervals.
PSA updates that are reported to the regulator are often due to some of the following triggers;

- required update by regulator,
- regular update and notification of changes in the safety documentation with PSA results,
- major plant modifications impacting the safety documentation, safety cases,
- occurred safety relevant event and
- PSA is part of the Periodic Safety Review (PSR) reporting.

A Licensee PSA update is often due to some of the following triggers;

- plant changes affecting the PSA models,
- new component, initiating event, CCF or HRA data frequencies,
- need to verify the risk in new applications or pilot studies and
- new hazards e.g., due to R&D results.

3.7 The workshop recommendations

The views from the workshop and the interpretation made by SSM is that the results should be communicated and be a driver for starting up of different LPSA harmonization activities related to guidance on how the various areas in the LPSA concept could be better understood and how maintaining the LPSA concept pieces (Figure 1) could be based on wide international experiences.

Development of an updated or a new LPSA guidance should take into account the following;

- workshop observations expressed in section 3.1 to 3.6,
- requirements on properties defining "PSA quality" for base PSAs, different applications and methods on how to fulfil these properties. Different guidance documents on PSA quality for applications exist, but it is believed that there is still a need for demonstrations including practical examples.
- review processes for regular PSA updates. Depending on the status of PSA (e.g., new application, update required by regulator, part of safety documentation) the reviewing strategy can differ in scope and depth. The licensee self-assessment and reviews of PSAs do vary or should vary when reviewing PSA updates and depending on the update reason. The scope and depth of the following review areas for different types of updates need elaboration:
    - implementation of plant changes including changed procedures,
    - conservatisms and assumptions,
    - implementation of changes in reliability data and other data, as CCF and human error frequencies,

- specific checks in case of a new application and
- QA of annual model updates (interim PSAs) compared to updates when safety documentation is affected.

It is also important that pros and cons with different reviewing approaches are discussed and how to define an effective QA processes for PSA, how to perform a certain PSA quality control of applications, aiming to meet specified capability categories according to e.g. the ASME/ANS PRA standard in [5] should also be discussed.

4. CONCLUSION

A Workshop on Living PSA was performed at the Nordic PSA Castle meeting in April 2013. The workshop discussed several areas that are part of a living PSA concept. Based on the workshop findings, and their interpretation, recommendations are made in several areas. It is expected that some activities continues in order to further development project.

Major workshop results are

- the interpretation of the "LPSA concept" and the work with PSAs at different nuclear power plants in the Nordic countries, Europe and USA differs.
- the review processes related to PSA updates are performed in different ways and that the effectiveness of the different reviewing processes are unclear;
- PSAs are reviewed and QA in several ways - by PSA-team, by the operators, by external experts, by peer review team, in benchmarks by comparison with similar plants, by regulators

The differences in the reviewing methods do also create differences in the resources and time for performing a PSA-update at licensees.

A common view is that the PSA quality shall be reviewed in connection with an application. But on the other hand there exists no specific guidance on how to perform such a quality check in connection with an application.

A workshop opinion is also that the widely used and referred IAEA report [1] is considered too old and general, and should, if possible be updated.

Regulators should encourage licensees to intensify the use of PSA and risk analysis in different applications and purposes, e.g. as supporting documentation to notifications about the safety impact of plant changes, in changes affecting the licensing documentation. More PSA usage increases the quality of the PSA models.

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