CHALLENGES WITH LIVING PSA – PSA APPLICATIONS – AND PSA RESULTS PRESENTATION, INTERPRETATION AND EVALUATION

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This paper is based on a compilation and review of the results of several activities. This includes a recent result presentation seminar and results from an earlier work on result presentation challenges already in the 90'ties. Also covered are Living PSA activities in Sweden and in particular LPSA reporting with the first review of interim PSA reports from the utilities to SSM that was completed in 2015 and ideas for result presentation that are developed as part of SSM risk map work.

The paper discusses result presentation and comparison challenges, e.g. concerning treatment of uncertainty with regard to scope and varying degree of conservatism/realism. We know that different parts of a PSA are related with different uncertainty/ conservatism/ non-conservatisms, e.g. depending on the source of radioactivity, the operating modes for each source and the different types of hazards for the operating modes of each source where a full scope hazard identification includes all internal and external hazards.

One important message – still – is that uncertainties need to be considered in the analysis, be visible in results presentations and being part of any result evaluation and decision.

I. INTRODUCTION

Probabilistic Safety Assessment (PSA) has been used now for a long time to support decision making. There are several recent examples on the use of the PSA in connection to the stress tests and evaluation of the effectiveness of various compensatory measures. However, continued use of PSA insights at both utilities and the authority remains a challenge and for example requires that the PSA is fit for the specific application. This means that the PSA application needs to consider the degree to which the PSA and PSA model represent the specific plant (degree of plant specificity), and how knowledge on plant behavior and modelling approaches, i.e. R&D results (e.g. success criteria may be affected), are considered including conservatism and other uncertainties of importance.

It is also very important that results are presented and evaluated in a way that they do not bias decision making. This is also a challenge, in particular it is very important to consider the various degrees of conservatism and uncertainty in different parts of the PSA. There has been an increasing attention to what is referred to risk aggregation, i.e. to combine results from different parts of the PSA, including recent extensions to site level.

The objective with this paper is to discuss living PSA and PSA application challenges, especially regarding results presentation, interpretation and evaluation. The paper is based on a compilation and review of the results of several activities. This includes a result presentation seminar in Stockholm in spring 2015 (Ref. 1), a review of an early work on result presentation and aggregation in the 90'ties (Ref. 2), and Living PSA activities at SSM including the first review of interim PSA reports (Ref. 3) from the utilities to SSM that was completed in 2015 and development of a risk map (Ref. 4)

II. REVIEW OF SELECTED INFORMATION

II.A. Overview

Over the years, PSA has matured in different aspects. Standards have been developed; modelling techniques and tools have advanced in parallel with the general development of computers and software. Better data for component failure probabilities, human reliability estimations and common cause failures are available. This means that the baseline PSA covering basic transients can be seen as realistic meeting rather high requirements on the degree of realism, plant specificity and level of detail, not the least in the modelling of dependencies.

There has also since many years been extensions in scope adding more operating states (Low power and Shutdown PSA) and hazards of both internal and external (to the plant) origin. In addition there has been a trend in scope extension towards more sources of activity, not the least after Fukushima. One reason to these extensions is that it has been realized that even with low frequencies and the plants being designed to cope with different hazards, there is a risk for a significant contribution to the public risk. Difficulties in realistic and detailed modelling of hazards, e.g. because of the administrative burden (e.g. huge amounts of information needed for a full blown realistic fire PSA) and to take fire as a phenomena into account (spreading, suppression, heat and smoke impact on equipment failure probabilities etc.) have led to the use of mainly conservative assumptions, and in some cases also non conservative assumptions.

Differences in the underlying assumptions for the different parts of the extended scope needs to be addressed, especially in the case of an application where we want to calculate and use information on the risk drivers in decision making. Such use may be biased of such differences. There is a challenge in combining (aggregate) different contributors. This is even more evident today when also taking steps into so called site level PSAs when the concept of risk aggregation has been further realized as a challenge.

The scope extensions pose a challenge concerning risk integration / aggregation and then result interpretation and evaluation. A recent workshop organized by the Nordic PSA group (NPSAG) discussed result presentation issues (Ref. 1). This challenge has however been discussed since many years, e.g. in a research report on external events from 1997 (Ref. 2). More recent work is ongoing, e.g. as part of post Fukushima activities where site aspects and multi-source aspects in general have been given much attention. Risk aggregation challenges and methods are covered by an ongoing WGRISK (Working Group RISK at OECD NEA) activity on site PSA that include risk aggregation issues and an EPRI (Electric Power Research Institute) report on "An approach to Risk Aggregation for Risk Informed Decision making that was published in April 2015 (Ref. 5).

Another challenge is living PSA, i.e. to make sure that the PSA continuous to be plant specific and realistic as time goes by, and that uncertainties are controlled along the way. Plant changes needs to be addressed in the PSA updating process so that the existing PSA (model) is fit for purpose (and continuous to be so) and that it is useful for its expected applications. When do we need to update the PSA to make sure that results not are biased in certain applications and how do we control this process? What is the effective process to have a smooth continuous transition from one PSA model to another that follows plant and methods development?

II.B. Result Presentation Seminar

A recent NPSAG activity is a seminar on result presentation and interpretation that took place in April 2015. The objective with the workshop was to present and exchange experiences on the presentation of PSA level 1 results at the different participating organizations – Forsmark, Oskarshamn and Ringhals. SSM presented the view of the authority and expectations on the results to be presented. The further aim was to discuss potential improvements and potential harmonization in support of result comparability and also investigate the interest and needs of the stakeholders to move on with a joint development project. The background to the seminar is that NPSAG listed PSA results as a priority area in the NPSAG roadmap for 2014 (Ref. 6). SSM had also done some work on formulating a NPSAG project proposal on development of result presentation in the PSAs.

A survey covering result presentation in six selected countries was developed in support of the seminar and is part of the report (Ref. 1). The conclusions from this survey are:

- The presentation of results is different from country to country. Some countries (like for example Switzerland) are prescriptive regarding requirements on which results should be presented, but most countries are not prescriptive.
- Generally, probabilistic safety analyst should provide sensitivity analyses to prove result robustness.
- Quantitative results seem to be very important in some countries (for example China and the US). In Sweden the numerical results are relevant, but the qualitative description of the results is equally important.
- The As Low As Reasonably Practicable (ALARP) principle is used in the United Kingdom (UK) to facilitate the discussion of results and decision making. If the results are above some threshold, then the licensee shall demonstrate that they have done what is reasonable to improve safety and provide its justification.

The survey also identified that EPRI has further information on result communication to explore, e.g. with regard to aggregation of results (EPRI report was available in April 2015 (Ref. 5)). It is not necessarily optimal to sum up different initiators to one total core damage frequency (CDF), since the conservatisms in different parts of the analysis may skew the results interpretation. This should preferably be accounted for (or at least discussed) if quantitative criteria are applied.

The main conclusions from the seminar are:

- Results are in principle presented in similar fashion for all three utilities involved (in the nine PSA studies). The PSAs are judged to have a rather high standard, however there are improvement areas.
- Result evaluation can be further developed, e.g. there is a need to reflect and consider more clearly the degree of conservatism and uncertainty in the different parts of the analysis scope, especially when the contributions to total results are presented (cfr. risk aggregation).
- Use of sensitivity analyses need extension and with a focus to support result validity and trustworthiness.
- PSA-studies usually focus on weaknesses but this should be complemented more with also descriptions of strengths.
- Uncertainty analyses should be used but it is unclear how uncertainty results can be made useful for the end users. Uncertainty results should be part of strengthening robustness together with sensitivity analyses results.
- Harmonization in result presentation is a way forward that is seen as useful, however not for comparison of results between different PSAs. Comparisons should focus on methods, strengths and weaknesses. E.g. ASME (American Society of Mechanical Engineers) PRA Standard can support comparisons.
- Harmonization concerning certain definitions is appropriate and in support of comparability of results. Examples are the initiating event groups (internal events, area events and external events) where specific initiating events are placed, and other central conditions, e.g. the time period that is used in PSA level 1 and level 2 respectively.

The discussions concluded that there is currently not enough support for a joint project, most attendants having the view that many of the issues are plant specific and not suited for a joint project. However, SSM has the intention to increase the attention to result presentation aspects in future PSA review activities. This will support identification of e.g. plant specific deviations in the grouping of initiating events. Such observations can be the basis for more work later. SSM review is also expected to lead to more harmonization over time.

The seminar has identified areas for continued work on result presentation and evaluation but the responsibility will for the time being stay with the individual stakeholders (utilities and SSM). The seminar also noted result presentation and evaluation challenges that were discussed in a research report already in 1997 (Ref. 2).

Recent SSM PSA reviews has identified that assumptions and uncertainties not are fully described and justified in the result presentations. The reviews have also identified a need for further development of result evaluation and conclusion sections in the PSAs. These review findings are in line with the recommendations from the result presentation seminar.

II.C. Result Presentation and Interpretation Issues in the 90'ties

The report SKI 97:25 (Ref. 2) discussed already in the 90'ties the challenge of risk aggregation in decision making. At that time there was an ongoing development of existing studies being extended and depth of modelling being increased, in particular with internal hazards as fire and flooding. This took place as part of the Swedish so called ASAR-90 (ASAR- As Operated Safety Analysis Report) program. The idea of ASAR-90 and the previous ASAR-80 programs were to increase the development of PSA by setting higher and higher goals, e.g. ASAR-90 required PSA level 2. PSA applications in Sweden were limited but new developments were in progress.

The extensions that were ongoing at that time concerned mainly the area events internal fire and internal flooding. The internal hazards as fire and flooding as well as external hazards are different from the basic transients originating from events usually in the Balance of Plant (BoP). The internal hazards analyses are usually performed using a set of assumptions that differ from the assumptions when analyzing the basic transients. Often simplifying assumptions that can be both conservative and non-conservative are applied. An example conservative assumption is that a fire is completely failing all equipment in the fire area, and a non-conservative example is that fire area boundaries are effective, e.g. fire doors are closed and fire dampers are working. Such differences in assumptions have an impact on the results for the analysis for the group of transients compared to the hazard group (s). These differences in conservatisms and other uncertainties are challenging in both result presentation and interpretation. Results that show area events to be large risk contributors may be misleading. Anyway, the results from the different parts of the analyses that make up the full scope are not directly comparable. One part of the 1997 project was therefore to provide some guidance that supports result interpretation and the use of these results, especially concerning internal fire and flooding.

Three main objectives were defined:

1. Clarify needs concerning design of area event result presentation.
2. Clarify how interpretation of results is affected by the different assumptions, uncertainties, completeness etcetera in the different analyses (sub-scope or groups).
3. Evaluate the status of Swedish area events PSA work and where possible identify areas where improvements in existing studies are needed or may be useful.

II.C.1. Minimum Result Presentation Requirements

The report presented a proposal for minimum requirements on result presentation, based on the most important uses of the PSA, see table I:

TABLE I. Minimum requirements on result presentation

Quantitative	**Qualitative**
1. Absolute risk level, e.g. CDF. 2. Most important risk contributors. 3. Lists with minimal cut sets per group of initiating events, specific initiating events, end states, sequences etc. 4. Importance measures for basic events, components, systems (for identification of effective risk contributors and potential risk contributors). 5. Uncertainties.	1. Important conclusions. 2. Description and evaluation of important analysis assumptions/conditions. 3. Presentation of weaknesses (or important findings) w.r.t. system, components, human interactions etc. 4. Identification and evaluation of weaknesses, knowledge gaps, and uncertainties with large result impact. 5. Evaluation of factors having an impact on decision making, e.g prioritization of actions (e.g. using sensitivity analyses).

Specific requirements are of course very much dependent on the objectives with the PSA, a base line PSA, specific application or applications, result users and their needs, the difference can be quite large comparing an experienced PSA team with other users of PSA results.

II.C.2. Comparability

Interpretation of results usually means some kind of comparison, e.g. comparing internal events PSA results with fire PSA results. Differences in the underlying basis (mix of conservative and non-conservative simplifications) make such comparison difficult. It was noted that similar problems exist also for comparison of loss of coolant initiators with non-loss of coolant initiators. SKI 97:25 (Ref. 2) also stated that lack of control of uncertainties and lack of comparability between different parts of the scope of the overall analysis has a limiting impact and may even make an efficient interpretation and use of PSA results impossible for some applications areas of interest. One important goal with the project was to define a method to support efficient interpretation and result comparisons.

The report stated two important basic uses of PSA results:

- Is the risk acceptable – requires comparison with some type of safety goal (target value)
- Efficient use of safety improvement actions – requires that different risk contributors arecompared and ranked.

It is very important that the analyses have been designed with result comparison in mind. This means that analysis conditions are chosen carefully and evaluated and differences between different parts are elaborated in detail. Differences can be chosen or forced. Minimizing chosen differences is one method to increase comparability (e.g. by avoiding incompatible data and methods when analyzing human interaction in the different parts of the analysis). Forced differences (usually due to the initiating events direct or indirect impact) can be manageable or non-manageable. A manageable difference means that it can be expressed numerically. Non-manageable differences are often related to uncertainties in model and completeness. Such cases need complementary analyses or sensitivity analyses.

SKI 97:25 (Ref. 2) stated that most PSAs so far had separate and somewhat different objectives for different parts of the PSA scope, e.g. internal and external events or level 1 compared to level 2. The conclusion was that this fact makes it difficult or even impossible to compare results and limits the uses. In addition, the different sub-analyses are often put in separate projects, without enough co-ordination of common parts. There was also a conclusion that almost every PSA (in Sweden) has spent too limited resources on interpretation and presentation of results. The following are some of the project conclusions:

- It is imperative to decide early in a PSA project on the uses of the results (objectives – application). This will support the planning, choice of models, modelling detail, data needs and the definition of results – risk metrics to support the application and how they are to be presented.
- Previously, uncertainties were often dealt with by deliberately introducing conservatisms (to be on the safe side from a risk point of view). However, comparability requires realism, which in turn means that uncertainties need to be expressed quantitatively in the model. Thus, uncertainty analyses are needed.
- Comparability is possible, i.e. analyses and the results can be shaped to allow numerical comparison of different sub-scope results (contributions).
- Differences that hinder comparisons are chosen by the analyst and can thus be removed by better adjusting the analysis assumptions.
- Comparability presupposes that all important preconditions are identified, presented and evaluated. Preconditions needs to be chosen to prevent the existence of unnecessary differences in the different parts of the analysis scope.

The conclusions and recommendations from SKI 97:25 are still valid and important to take notice of.

II.D. SSM Living PSA Approach

II.D.1. Living PSA

The definition of Living PRA (Probabilistic Risk Assessment, term is exchangeable with PSA) is (Ref. 7):
"*The term living PRA designates a PRA that is updated as necessary to reflect any changes in the plant (e.g., design, operating procedures, data) to continue to represent the as-built as-operated plant. Therefore, the living PRA can be used in risk-informed decision-making processes, such as plant-specific changes to the licensing basis discussed in NRC Regulatory Guide 1.174). PRA configuration control is part of the process used to support a living PRA*".

Thus, the continuous use of PSA results (in addition to an instant risk picture) requires a living PSA approach. SSM also requires PSAs to be updated (SSMFS 2008:1). The continued use of PSA in different applications needs support of a PSA reflecting actual plant design and operation and knowledge. The period between PSA reporting to SSM was rather long, one reason being the time and resource consuming QA process. SSM therefore discussed and agreed with the utilities during 2013-2014 on an approach to support more frequent PSA reporting to SSM. It has to be noted that the utilities have used other update processes and controls when using their PSAs.

The agreed approach is based on a full PSA reporting to SSM every three year and the years in between interim reporting. The purpose is to provide a better base for risk informed activities, especially at SSM and provide a means for a yearly Quality Assurance (QA) stamp on the PSAs. The schedule is shown in figure 1.

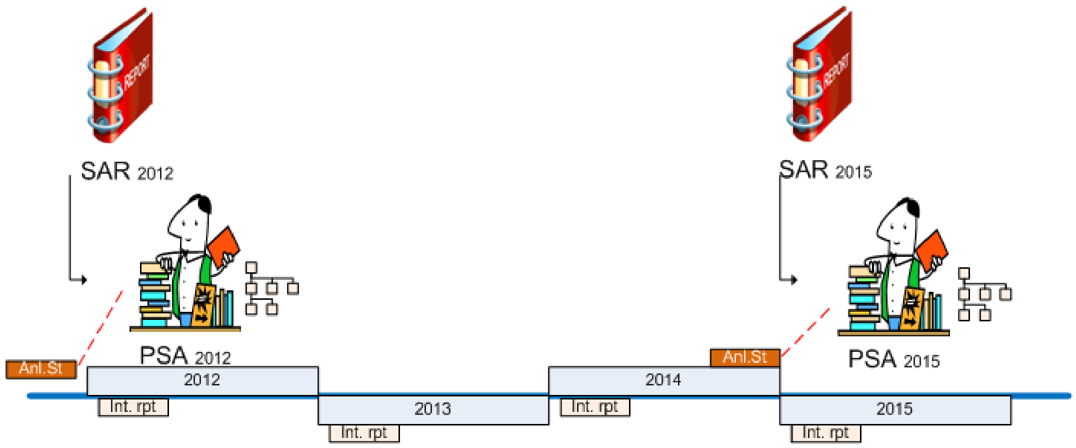

Fig. 1. SSM Living PSA reporting overview.

Interim reporting is expected to include a PSA model and an interim report with information on:

- Model status, i.e. the freeze date for the model. Plant changes until this date are taken into account,
- Changes in methods, scope and data compared to previous version,
- Important differences in results and evaluation compared to previous version,
- A clear statement on the validity of the PSA (LPSA), and
- A clear statement on the PSA validity for different applications.

II.D.2. First Review of Interim Reports

The first round of interim reports for 2014 was available during 2015 when SSM made the first review of these (Ref. 3). SSM noted the following need for clarifications on interim PSA reports:

Quality assured interim report: SSM sees this as a report that has passed QA at the PSA department concerning methods, facts etc. However, there is no need for the complete QA process as defined in SSM requirements that includes several QA steps and that is rather time and resource intense. Each PSA (model version) should have its own dedicated interim report to make it clear what year in the three year loop the specific model version relates to. It is further important to keep the time interval from end of refueling period until completed interim report as short as possible. SSM expect that interim report is made available at least 6 months after end of the refueling outage. The report shall be self-sufficient.

Quality assured interim model: SSM sees this as a PSA model that has passed enough QA at the PSA department to support its valid use in the PSA applications used for the plant. SSM expects that the model sent to SSM is the one that is used in the utilities PSA applications.

SSM expect further that important differences in results and evaluation, compared to the previous reporting, are described. It shall be clearly stated if previous evaluations and conclusions in SAR (Safety Analysis Report) are still valid or a description of changes. A high level result presentation should always be included, and also include result comparison with previous version.

Finally, SSM expect the interim reports to include a statement with justification on the validity of the PSA for use in different applications. The licensee should develop criteria to support validity statements. SSM sees that such criteria can be based on documents from e.g. IAEA[1] (International Atomic Energy Authority), ASME[2] and the Swiss Nuclear authority ENSI[3]. It is the position of SSM that it is important to describe any missing parts or other limitations that are important for specific applications, and the consequences for these applications.

[1] IAEA TECDOC-1511, Determining the quality of probabilistic safety assessment (PSA) for applications in nuclear power plants, IAEA 2006

[2] ASME/ANS RA-S-2008 with RA-SA-2009 addenda, Standard for level 1 / Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, 2009

[3] ENSI-A05/e, “Probabilistic Safety Analysis (PSA): Quality and Scope”, March 2009 and ENSI-A06/e, “Probabilistic Safety Analysis (PSA): Applications”, March 2009

II.D.3. Risk Map

The idea is that the PSA reporting shall be used as input to a "risk map" that SSM can use for risk informing its SSM supervision activities, e.g. supporting decisions whether a notification or event shall be reviewed by SSM and the review depth to be applied.

SSM has been working with this risk map since 2014 when the first version was ready. The risk map is essentially a compilation of results from the Swedish PSAs. Both quantitative and qualitative results are presented. The risk map shall be updated regularly and reflect current PSAs.

The risk map shall provide information about each NPP risk profile, including dominating contributors to core damage and to radioactive releases and information on strengths and weaknesses. The first version focused on core damage, i.e. PSA level 1 results related to the fuel in the reactor pressure vessel. The idea is that eventually all radioactive sources and hazards for each operating mode shall be covered. The first version includes information as listed in table II.

TABLE II. SSM Risk Map Information

- **Initiating Events**: Contribution from individual initiating events**.**
- **Sequences:** List of the ten dominating sequences together with a qualitative description of these.
- **Rooms:** The rooms (plant locations) with the largest contribution to core damage frequency together with information on dominating sequences and important equipment in the affected rooms.
- **Important failure events:** Basic events (representing equipment failures and erroneous manual actions) and common cause failure (CCF) events with the largest risk decrease (RDF) and risk increase (RIF) factors.
- **Manual actions:** Separate list with manual actions RDF and RIF.

Some risk measures can be taken directly from the PSA while other information will need certain analyses work at SSM.

Further work is planned to include risk information for functions, system and event groups. It is also planned to include sensitivity and uncertainty information in future versions. Such information is crucial when using this information in risk informed activities. As mentioned above, the risk map provides an important basis for risk informed supervision and to support a graded approach by providing the PSA view on components and conditions with the largest contribution to risk (safety) and thus greater attention can be given to these compared to less important risk contributors. Maintaining a risk level also requires attention to events with large RIF.

A large RIF indicate that the event is important with regard to the analyzed top event (e.g. CDF) within the analysis scope. A large RDF indicates that the event is important with regard to lowering of the CDF. Events with low RDF has a small impact on the total risk, thus risk reduction activities should focus on events with high RDF.

One major challenge for the risk map is the same as mentioned above, and concern risk aggregation.

SSM is currently working with further development of the risk map and how to use it in risk informing the supervision activities. This work includes some new ideas on result presentation that can be useful. There is also work to support automation of the risk map updating process when SSM receives new interim reports or complete PSA updates. Two of the new ideas for result presentation are:

- Plotting initiating event (IE) frequency versus barrier
- Plotting number of MCS (Minimal Cut Sets) versus mean MCS size

The traditional presentation of results usually uses a bar diagram to show the total barrier against CDF and how it is split on IE frequency and conditional core damage probability given the initiating event. Another idea is to plot the frequency versus the barrier. This method can support visual identification of outliers, e.g. for a high frequency event with extremely low plant barrier or in case of a low frequency event there is a high barrier.

The other idea is to use statistical information from the individual analysis cases. The information to be used is the total number of MCS in a specific analysis case and the mean MCS size in the analysis case, the latter has to be calculated. This plot can also show outliers, e.g. cases with deviating large or small mean MCS sizes.

There are also some other ideas on potentially interesting ways of presenting results for use in risk informed activities. One example is the manual actions where it can be of interest to identify occurrences of multiple manual actions in the same MCS, occurrences of initiating event and only manual actions, and similar for CCF, occurrences of multiple CCF in the same MCS and occurrences of initiating event and only one CCF.

III. CONCLUSIONS

Regarding result presentation and comparison there are still challenges, e.g. concerning treatment and consideration of uncertainty with regard to scope and varying degree of conservatism/realism. We know that different parts of a PSA are related with different uncertainty/ conservatism/ non-conservatisms, e.g. depending on the source of radioactivity, the operating modes for each source and the different types of hazards for the operating modes of each source where a full scope hazard identification includes all internal and external hazards.

Presentation and communication of PSA results has always been a challenge. This challenge has increased with the increase in scope and level of detail and with the wider use of PSA in risk informing different activities at both utilities and authorities. A report on external events in the 90'ties (Ref.2), identified the issue of risk aggregation considering different types of hazards and possible solutions were outlined. To use risk information that is complex and spans over many risk sources, operating states and a full scope set of hazards requires an in-depth knowledge about the underlying assumptions and differences in the different parts of the analyses. This has become maybe even more evident when the need to consider site aspects has been revealed. There is recent work in this subject, e.g. the EPRI report on "An approach to Risk Aggregation for Risk Informed Decision making that was published in April 2015 (Ref. 5). There is also an ongoing WGRISK activity on site level PSA that include risk aggregation issues.

Maybe one of the most important messages is that is that uncertainties needs to be considered in the analysis, be visible in results presentations and being part of any result evaluation and decision.

Living PSA is an additional challenge with regard to the aggregation aspects. Keeping a PSA up to date and to have control of assumptions and uncertainties as the PSA evolves with plant changes, and methods and data development, needs a very structured approach. For an authority it is important that the necessary information about PSA evolution is described and communicated to allow also the authority to consider the impact on PSA results. One way to do this is the type of yearly reporting that now takes place in Sweden as part of the Living PSA program.

SSM work on a risk map is identifying some new aspects of result presentation that are promising for supporting risk informed activities at SSM.

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REFERENCES

1. O. Bäckström, A. Olsson, *Slutrapport: Resultatpresentationsseminarium* (in Swedish, English translation: Final report from result presentation seminar), NPSAG Report 39-001:01 (September 2015).
2. A. Angner, *Projekt Yttre Händelser – Slutrapport* (in Swedish, English translation: Project External Events – Final Report), SKI (now SSM) Report 97:25 (November 1997).
3. C- Karlsson, *Granskningsrapport – PSA interimsrapporter 2014* (in Swedish, English translation: Review Report – PSA interim reports 2014), SSM2014-5968-5 (October 2015).
4. F. Olsson, *Riskkarta – Resultatsammanställning över svenska PSA* (in Swedish, English translation: Risk Map – Result Compilation from Swedish PSA), SSM2014-3915-1 (March 2015).
5 J.P. Sursock, S. Lewis, *An Approach to Risk Aggregation for Risk-Informed Decision Making*, EPRI 3002003116 (April 2015).
6 *The Nordic PSA Group (NPSAG) strategy: goals and purposes with NPSAG network program and Roadmap for 2014-2016*, NPSAG report 00-001:1.
7 *Glossary of Risk-Related Terms in Support of Risk-Informed Decision Making*, NUREG-2122 (May 2013).