A Plant's Perspective on a Full Scope PSA Update

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Abstract: NPP Borssele has a full scope Living PSA model since 1995 covering internal events, and internal and external hazards for level 1, level 2 and level 3. After 20 years of working with and on this Living PSA an IAEA mission was conducted on this PSA. This paper elaborates on the model changes after the IPSART mission, the impact on the model of these changes and relates the changes to the use of the PSA.

Keywords: PRA, Living PSA, Periodic Safety Review, Plant update.

1. INTRODUCTION - THE BORSSELE PSA

NPP Borssele is owned by N.V. Elektriciteits-Productiemaatschappij Zuid-Nederland (EPZ). PSA work for NPP Borssele started in 1989. The first PSA was finalized in 1992. This PSA was for Power operation only and covered internal events. Work on the PSA continued going towards the 2nd Periodic Safety Review of 1994. The scope was expanded with Low Power and Shutdown as well as with hazards and full Level 2 and Level 3 analyses. Borssele has a full scope PSA model since 1995.

In the initial development of PSA 4 IPERS missions were conducted at different levels of the PSA model completion. The four missions were:

- Phase I review 1989, project outline and methodology reports
- Phase II review 1990, full power PSA about 60% completed
- Phase III review 1991, full power PSA finalized
- Review of the low power and shutdown PSA 1993.

The IPERS reviews have contributed substantially to the quality and completeness of the original PSA.

The PSA has been kept living ever since and some pieces of the PSA like the internal fire and internal flooding received major updates. The backfittings of the plant of 1997 and 2006 as a result of the Periodic Safety Reviews (PSR) were incorporated in the model

In 1998 a risk tool called Safety Monitor™ was introduced. This version of the PSA (that is used primarily for level 1 calculations) is user friendly and can be used by non PSA specialists for assessment of core damage frequency changes when taking components into and out of service, or changing operating alignments of equipment. The Safety Monitor model is derived from the event tree model to ensure mutual consistency.

The Borssele PSA is used on a daily basis for diverse purposes including component outage optimization, plant outage optimization and Periodic Safety Review support.

The PSA model is maintained as a living model using a major / minor update approach. Major updates of the PSA model can be done for two reasons.

1) When the PSA results or insights are significantly changed.
2) To accommodate a license application

Minor updates are all other changes to the model. The major difference in work load between a major and a minor change is that the results sections of the PSA documentation only receive a complete update for a major update.

To accommodate the change process a database is used to collect all deviations found in the model. The initiation of a model change for any found model deviation is set up to be as easy as possible. Everybody at the NPP can create a modelnote (description of an identified deviation) by just noting the comment on the model in a new modelnote in the database.

2. IPSART 2010 AND 2013

In 2009 the Dutch regulator requested the IAEA to organize an International PSA Review Team (IPSART) mission. The reason the regulator requested this mission was that in the Regulators view the PSA might not be State-of-the-Art anymore regarding the 15 years old level 2 modeling. Furthermore the regulator wanted the updated parts of the level 1 being reviewed.

The scope was agreed upon between IAEA, the Regulator and EPZ to be all PSA areas and level 1 through level 3, only seismic was excluded. Seismic is not part of the Borssele PSA. As the Regulator and EPZ agreed that the IPSART review (results) would be part of the Periodic Safety Review, EPZ requested the IAEA to compose a diverse team both for the topic areas as well as the team's geographical origin.

2.1. IPSART mission 2010

In September 2010 the IPSART mission was held. The Borssele PSA was review by a team of 9 experts for a period of 2 weeks. The IPSART team raised 134 issues, 29 of those issues turned out to be not applicable. Ultimately only 3 issues were classified as high, 49 issues were classified as medium and the remainder was classified as low. The conclusion of the IPSART team was that the PSA as reviewed during the mission was suited for its applications.

Despite the general positive result a number of areas for improvement were identified.

- The PSA documentation needed better structure and better readability.
- The initiating events analyses and documentation needed restructuring of the grouping and corresponding frequency assessment.
- The heavy load drop analysis needed to be improved and expanded.
- The effects of Level 1 phenomena (steam/feedwater lines breaks in turbine hall, sump plugging, failures to isolate turbine following reactor scram) needed to be better elaborated.
- A more systematic and detailed analysis of common cause failures was needed
- A number of HEPs associated with recovery actions that are significant to the CDF results should be re-evaluated using detailed analysis that includes a feasibility assessment.
- A more detailed analysis of spurious actuation in case of fires at the plant needed to be done.
- A detailed assessment was required of the operations involved during fuel unload, fuel storage and core load operations to determine whether the existing LPSA accurately models current refueling practices.
- Specific Level-2 and Level-3 PSA features essential for the intended applications needed to be improved.

2.2. Update project

The Dutch Regulator endorsed the IPSART mission recommendations and imposed EPZ to solve all recommendations. This is stronger than IAEA IPSART objectives that state that implementation of review findings is solely the decision and responsibility of plant managers and PSA team.

As NPP Borssele extended lifetime is foreseen until the year 2034 and therefore the prolonged use of its PSA, EPZ decided to not only solve all issues but to solve the issues and topic areas in a broad way.

Work on the high priority issues started almost immediately after the IAEA mission as a task of keeping the PSA living. The high priority issues solved first involved the common cause and data update mentioned below.

For all the other issues a project was initiated. The project goal was to solve all issues in a broad manner to make the PSA fit for another 20 years of use. The work was performed by 3 consultancy companies. To ensure the quality of work mutual reviews and EPZ review was carried out in addition to the quality standard of the consultancy companies. Besides quality the benefit of these reviews is the dissemination of knowledge of impact of each one's changes on other topic areas within the PSA.
The most important changes are described below

Common cause failures
Based on the IPSART recommendation to perform a more systematic and detailed analyses of the Common Cause failures it was decided to evaluate the whole spectrum of components for common cause failures. In the original PSA the Common Cause modeling was a compromise between model insight and model/computational limits. The common causes for the important systems were modeled, but the limitations in software, mostly solution time did not allow for all common cause failures to be modeled.

In the updated PSA all common causes were evaluated including intersystem common causes and non redundant component common causes. Groups of Common Cause failures where defined based on distinctive similarity between components. The modeling in the PSA fault trees was done using the automated Common Cause Failure Expansion tool of the WinNUPRA© software. The new model has well over 2000 Common Cause events modeled. This has led to a problem in understandable naming in events because of a 16 character naming limitation. The naming limitation was solved by using hex code on 2 of the 16 characters such that failures of all component combinations for up to a group size of 8 components can be represented.

Each failure combination associated with a common cause group (CCG) is first represented by a binary code, as shown in the following table 1.

Table 1: Common Cause Basic Event Naming Convention

Failure Combination	Specific Failed Components in CCG (denoted by x)								Binary Representation	Hex Code
	8	7	6	5	4	3	2	1		
8/8	x	x	x	x	x	x	x	x	11111111	FF
7/8	x	x	x	x	-	x	x	x	11110111	F7
7/8	x	-	x	x	x	x	x	x	10111111	BF
4/4					x	x	x	x	1111	0F
2/4					x	-	x	-	1010	0A
2/4					-	-	x	x	0011	03
2/3						-	x	x	011	03

The common cause update of the model was supported by a major data update. Common Cause data from the US NRC was used [1].

Human Error probabilities

In 2006 the Human Reliability Analyses (HRA) was updated as part of the PSR. For the 25 most important Human actions a detailed analyses was performed using the EPRI HRA Calculator®. Data for the 2006 update was obtained using the EPZ procedures, using interviews and by simulator observations. As the model was changed since the 2006 HRA update, the top 25 of most important Human Actions has changed. The IPSART mission identified some important Human Actions that did not have detailed analyses to underpin the Human Error probability. It was advised to do detailed analyses for all (changed) important Human Error Actions. EPZ decided to update all post initiator Human Error events in the model using detailed data in the EPRI HRA calculator®. This is important given the living character of the PSA. Furthermore this facilitates the applications the PSA is used for. For individual analyses Human Error's that are normally not important for the results can become the risk driver.

Almost 200 different Human Actions are analyzed for the updated PSA, including a robust dependency analyses.

Low power and shutdown

One of the IPSART recommendations was to evaluate the need for a new Plant Operating State (POS) for refueling shuffling operations. Another recommendation was to update the POS frequencies and durations based on the most recent 10 years' data. During the IPSART mission the plant's PSA team had to help the reviewers with the documentation regarding the plant operation states.

In day-to-day PSA applications the PSA Plant Operating State definitions that are based on logical success criteria don't always match the way the plant is operated.

The definition of the POS's was reviewed and revised. The refueling shuffling operations turned out to be covered by the current model. New POS's however were defined to distinguish between Midloop Open and Closed operations and small changes in the POS definitions were applied to match the PSA POS's with the technical specification POS's. Furthermore a new operation state was defined for the Fuelpool operation that takes place parallel to the reactor POS's. The model is set up to differentiate between early (shutdown) and late (startup) states. In total the PSA has 9 Plant operation States for the reactor, 2 Plant operating states for the spent fuel pool and 2 plant operating states for the transfer of the fuel between the reactor and the spent fuel pool.

External Hazards

The external hazards of the Borssele PSA received several updates over the years. This has resulted in a dispersed analysis. The IPSART mission found that the external events section could use optimization.

The screening of the External hazards was revisited based on the SSG-3[2] methodology. Based on the revised screening criteria meteorites were added to the PSA.

Given the location of the NPP on the Westerschelde estuary flooding is considered as the most important external hazard. In the Netherlands the dedicated authority (Ministry of Transport, Public Works and Water Management) adopted a probabilistic approach for "dike management". EPZ asked a consultancy company to adapt this approach to calculate the exceedance frequency of certain water levels on the plant site. The probability of flooding of the plant turned out significantly lower than in previous studies. The external flooding risk is dominated by lower flood levels that impact the cooling water intake structure.

Success Criteria

The whole PSA had a sanity check. The purpose of this check was for completeness and availability of references and underpinning the success criteria analysis. The conclusion was that the deterministic underpinning was not complete for the LOCA's. Although originally not foreseen new deterministic analyses for LOCA's were performed. This has lead to less success branches for the small LOCA in the PSA. The small LOCA is now the single largest initiator contributing 10% of the core damage frequency.

Level 2

The level 2 part of the Borssele PSA had not changed much since its' initial construction in the early nineties. In the period before the IPSART mission EPZ had an assessment performed for the Level 2. From this assessment it was already clear that the underpinning analyses of the Level 2 did not meet the present standards. EPZ set out a rough outline for updating the level 2. The IPSART review emphasized this view on the Level 2 and the outline for updating of the level 2. The old MAAP analyses were abandoned for a plant specific MELCOR model. With this model 30 general severe accident calculations were carried out and 19 calculations were done for quantification of the radiological release to the environment. Part of the calculations is specific for the non-power states. The level 2 structure and documentation was completely revised to meet IAEA SSG-4 and to provide better clarity for non level 2 specialists.

Level 3

The level 1 and level 2 model results were propagated through the level 3 model to demonstrate that NPP Borssele meets the Dutch level 3 risk metrics (individual risk and societal risk). The (reactor) core inventories were updated just before the IPSART mission as part of a license change. For the fuel elements that are in the spent fuel pool an inventory had to be defined.

Dutch regulations changed since earlier level 3 calculations. Previously only the population living in the area was accounted for regarding the level 3 risk measures. The new regulations prescribe that also the population that is in the area for a limited amount of time should be taken into account. It was felt overly conservative to account for the maximum number of people in the adjacent industrial area to be accounted for during the whole year. Typically each employee is working for one fifth to one quarter of the year. To correctly account for the variations in population a dynamic population model was built taking into account 80% of the working force during office hours and 20% of the working force during non-office hours.

Documentation

The PSA documentation structure reflected the history of PSA. On many places the newer parts of the model referred to older parts of the model. To understand non-power externals the documentation referred back to power externals. And in the power externals one was referred to power internals. Next to difficult readability, it made updating of the documentation a very complicated task. The documentation was only usable for PSA practitioners with in-depth knowledge of the Borssele PSA. For the update project is was decided to completely restructure the documentation to allow for easier reading and review of the PSA and to facilitate communication of the PSA basics and results with plant personal. Multiple internal referencing was removed as far as possible. Table 2 shows how the TECDOC-1511 attributes are addressed in the PSA documentation.

Table 2: PSA Chapters and TECDOC 1511 Attributes

Chapter	Title	TECDOC 1511 Attributes
PSA-1	Introduction and objectives	
PSA-2	Introduction and Objectives Level 1 Analysis	
PSA-3	Plant operational states	
PSA-4	Initiating events	1. Initiating events analysis (IE)
PSA-5	Success criteria	3. Success Criteria Formulation and Supporting Analysis (SC)
PSA-6	Accident sequence delineation	2. Accident Sequence Analysis (AS)
PSA-7	System notebooks	4. Systems Analysis
PSA-8	Human Interactions	5. Human Reliability Analysis (HR)
PSA-9	Data analysis	6. Data Analysis (DA) 7. Dependent Failures Analysis (DF)

Chapter	Title	TECDOC 1511 Attributes
PSA-10	Level 1 results	8. Model Integration and Core Damage Frequency Quantification (MQ) 9. Results Analysis and Interpretation (RI)
PSA-11	Safety Monitor Model	
PSA-12	Level 2 analysis	
PSA-13	Level 3	
PSA-14	Overall conclusions	
PSA-15	Summary	
PSA-16	Samenvatting (Dutch Summary)	

Complementary Safety Margin Assessment
After the Fukushima accident EPZ did a Complementary Safety Margin Assessment (CSA) to better understand the margins of the plant to beyond design incidents. Following the CSA several robustness measures are initiated among which the introduction of shutdown Emergency Operating Procedures (EOP's). The implementation of these shutdown EOP's with dedicated testing on the simulator coincided with the shutdown modeling phase of the IPSART update project. Good interaction between these 2 projects resulted in changes in both the EOP's and in the PSA.

2.3 IPSART follow-up: 2013 and beyond

The update project was not completely finalized before the follow-up mission. For all areas however the model was adjusted with reports underpinning the work. The PSA documentation itself was not completely updated. The Safety Monitor model was also not updated.

Follow-up mission
In April 2013 an IPSART follow-up mission was held. The objective of the follow-up IPSART mission was to review the updated PSA model and documentation and to check how the IPSART 2010 mission comments have been addressed in the full scope PSA for the Borssele NPP. For the follow-up mission 7 experts reviewed the work for a period of 6 working days. All 7 experts participated in the original mission.

The outcome of the mission was positive. All experts agreed that most of IPSART recommendations are implemented into the LPSA and that the LPSA model has the potential to serve the intended applications. All high issues are resolved. With some new issues that were found the total number of issues during this follow-up mission was 32 of which only 7 in the medium to medium/low category, the remainder were in the low category. Already during the follow-up mission on many of the new/remaining issues an agreement on the resolution was reached or the actual changes to model and documentation were implemented.

Finalization of update work
With the upcoming PSR in mind the scope of the PSA-update project was prolonged and expanded. The solutions of the issues form the follow-up mission as discussed with the experts were implemented in the model. Extra effort was put in getting the Safety Monitor model synchronized with the other PSA updates, as soon as possible. Given the large changes in the non-power event trees as compared to the power trees it was decided to rebuild the Safety monitor top logic fault trees for LPSD completely using an automated approach. In the previous versions of the Safety Monitor model this was done manually and only the minimal sequences of the event trees were converted to top logic fault tree for the Safety Monitor model. . The power model top logic was updated by hand.

3. MODELING REQUIREMENTS AND ISSUES

3.1 General guided requirements of PSA

The general requirements for the PSA were derived from strategic EPZ goals using a structured approach. The first step was to look at the applications for which the PSA is used. These applications determine the scope of the PSA and the PSA update. The applications relevant for KCB are defined in an EPZ internal PSA strategy report. This report describes the strategy for maintenance and applications of the living PSA and justifies how the requirements of the licenser and the demands of the EPZ policy are fulfilled within this strategy. The EPZ strategy report distinguishes four types of PSA applications.

- Support operational decision making during regular operation
- Support operational decision making in exceptional situations
- PSA analysis of proposed modifications
- PSA analyses to support periodic safety review

The applications of the PSA as defined for KCB are directly related to the PSA application as defined by the IAEA. The basic application of the PSA is the assessment of the overall plant safety. The requirements for the use of the PSA for this application are defined in the IAEA safety guides SSG-3 [2] and SSG-4 [3].

The other applications relevant for the PSA of KCB are as follows:

1. Periodic safety review.
2. Configuration planning (e.g. support for plant maintenance and test activities).
3. Dynamic risk-informed TS.
4. NPP upgrades, back-fitting activities and plant modifications (hardware and also plant procedure changes).
5. Determination and evaluation of changes to allowed outage time and changes to required TS actions.
6. Risk-informed optimization of TS.
7. Determination and evaluation of changes to surveillance test intervals.
8. Risk informed in-service testing.
9. Short term risk-based performance indicators.
10. Evaluation and rating of operational events.
11. Risk evaluation of corrective measures.
12. Risk evaluation to identify and rank safety issues.

The IAEA developed a guideline that defines which PSA metrics and PSA attributes are required to use the PSA for specific applications, IAEA TECDOC 1511 [4]. For each Borssele PSA application the required PSA results were matched. Some risk metrics as defined in the IAEA TECDOC differ from the risk metrics for the Dutch situation. The Level-3 metrics for the Dutch situation are Individual Risk (IR) and Group Risk (GR). These metrics replace Large Early Release Frequency (LERF) and its derivatives (i.e., CLERP, ICLERP, LERF(t) and LERFAVE), and QHO. Level-3 risk importance measures are based on IR. An example of how the Borssele PSA applications are related to the IAEA risk metrics is depicted in Figure 1.

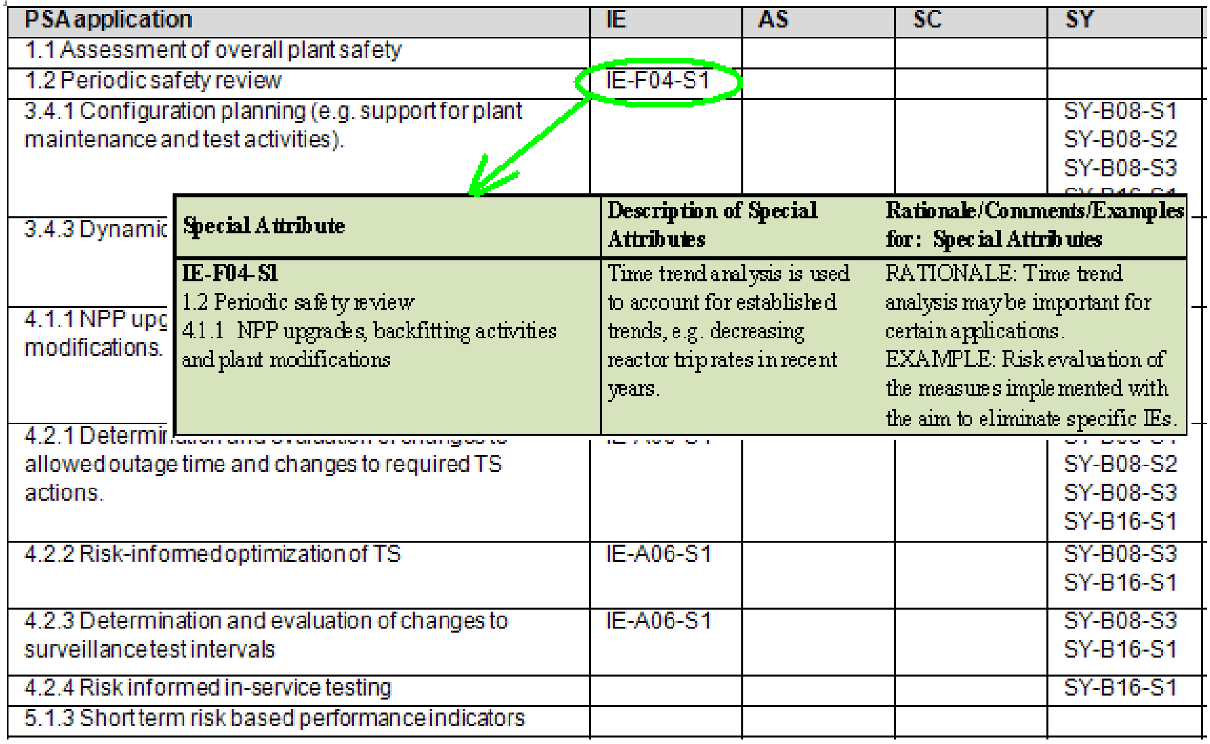
Figure 1: Depiction of Required PSA Results (columns) for the Selected PSA Applications

	CDF_{AVE}	CCDP	$CDF_{(t)}$	CLERP	ICCDP	ICLERP	Key assumptions impacting results	$LERF_{(t)}$	$LERF_{AVE}$	Primary contributors to risk
1.1 Assessment of overall plant safety	X								X	X
1.2 Periodic safety review	X								X	X
3.4.1 Configuration planning (e.g. support for plant maintenance and test activities).			X		X	X		X		
3.4.3 Dynamic risk-informed TS					X	X				
4.1.1 NPP upgrades, back-fitting activities and plant modifications.										
4.2.1 Determination and evaluation of changes to allowed outage time and changes to required TS actions.					X	X				
4.2.2 Risk-informed optimization of TS					X	X				
4.2.3 Determination and evaluation of changes to surveillance test intervals										
4.2.4 Risk informed in-service testing										
5.1.3 Short term risk based performance indicators	X		X					X	X	X
5.2.2 Evaluation and rating of operational events	X	X		X					X	
6.1.1 Risk evaluation of corrective measures										
6.1.2 Risk evaluation to identify and rank safety issues.	X						X		X	X

The next step was to define the required PSA attributes for the selected PSA applications using IAEA TECDOC 1511 [4]. Attributes were defined for all specific PSA applications. These are referred to as the Special Attributes (SAs). The SAs are divided into “essential SAs” and “supplemental SAs”. The essential SAs are considered to be those requirements needed to generate the results that reliably support the PSA application and the supplemental attributes are those that are not necessarily important for a specific application but could further enhance the usefulness of the PSA by providing a greater level of detail, or improving confidence in the results. For Borssele PSA guidance only the essential special attributes were considered. This resulted in a table with all Borssele PSA applications and the required attributes.

The last step in the approach was to match the required attributes with model in plain English. These requirements are incorporated in the PSA objectives and are basis for all future work on the PSA.
An example of the resulting table with a small part of the required attributes in plain English is depicted in figure 2.

Figure 2: Depiction of Special PSA Attributes per PSA Application



PSA application	IE	AS	SC	SY
1.1 Assessment of overall plant safety				
1.2 Periodic safety review	IE-F04-S1			
3.4.1 Configuration planning (e.g. support for plant maintenance and test activities).				SY-B08-S1 SY-B08-S2 SY-B08-S3
3.4.3 Dynamic				
4.1.1 NPP upg modifications.				
4.2.1 Determi allowed outage time and changes to required TS actions.				SY-B08-S2 SY-B08-S3 SY-B16-S1
4.2.2 Risk-informed optimization of TS	IE-A06-S1			SY-B08-S3 SY-B16-S1
4.2.3 Determination and evaluation of changes to surveillance test intervals	IE-A06-S1			SY-B08-S3 SY-B16-S1
4.2.4 Risk informed in-service testing				SY-B16-S1
5.1.3 Short term risk based performance indicators				

Special Attribute	Description of Special Attributes	Rationale/Comments/Examples for: Special Attributes
IE-F04-S1 1.2 Periodic safety review 4.1.1 NPP upgrades, backfitting activities and plant modifications	Time trend analysis is used to account for established trends, e.g. decreasing reactor trip rates in recent years.	RATIONALE: Time trend analysis may be important for certain applications. EXAMPLE: Risk evaluation of the measures implemented with the aim to eliminate specific IEs.

Although this IAEA Tecdoc 1511 is for power operations, most attributes can be applied for non-power operations as well. Another limitation of the IAEA guidelines and basically all other guidelines is that they focus more on the construction of a PSA rather than on maintaining a PSA. The update that was performed on the Borssele PSA was very extensive. Most of the guidance could be applied as complete topics were basically redone. If topics need work but are not redone it is hard to find guidance on how to perform such work.

3.2 Soft requirements and modeling issues.

Besides the “hard” unambiguous requirements as described above, additional requirements are necessary to direct the PSA to be suitable for day to day analyses. The most important requirement that needs to be applied during major PSA updates is that the PSA scenario’s that lead to either Success or Core Damage must be understandable for everybody working on and with the PSA. To understand the scenario’s important for the new PSA, several team sessions with all consultants and EPZ PSA staff were held to review the results. Based on cutsets contributing to core damage the event trees were reviewed and changes to the model were defined and implemented. This approach works for the dominating cutsets but given the size of the model only a small part of the total results can be discussed this way. Obviously it is not possible to capture problems in the modeling that lead to cutsets that are too low in the results or completely missing in the results. This problem was reduced by comparing the updated Safety Monitor model results with the PSA model using a cutset comparison tool in MS-Excel. The focus of this task was on the level 1.

Another requirement that has a direct relation with the need for understandable scenarios is that the outcome of the PSA needs to be explainable to non-PSA specialists. Non-PSA specialists tend to overly value absolute numbers of the PSA rather than to look at relative changes of PSA results. The strength of the PSA is that the results tell something about intra- and inter-dependencies of systems and their contribution to the overall risk or risk change. This requirement demands for best estimate modeling. At the same time a PSA tends to be more conservative each time a subject receives a major update. This is felt throughout several areas of the PSA. Examples are the fire modeling methodology using NUREG\CR-6850[5], the way success criteria analyses are performed and applied to the PSA, and the HRA methodology. A good example for the shift to more conservative modeling is the updated HRA analyses. Previously in the PSA some credit was given to the repair of failed equipment. The new approach does not allow credit for repairs. During review of the PSA updates this has led to one instance in the model where repair was reintroduced in the model.

The scenario where repair was credited is a common cause failure of rectifiers feeding the reactor protection system followed by battery depletion. As this is modeled as a support system initiator the common cause failure for a 24 hours mission time is multiplied by 365 to make it a frequency applicable for a whole year. Although this multiplication methodology is best practice in PSA modeling this is already difficult to explain to non-PSA plant people. On battery depletion random activations of reactor protection signals can occur for a brief period of time. The PSA postulates a conservative combination of reactor protection signals and loss of all automated mitigating reactor protection signals. To justify the credit for repair specific data was collected. The availability of spare part was assured and maintenance personal was interviewed. All data collected was documented using the HRA calculator similar to normal other human errors.

Normal operation and outage operation schedules are evaluated by operation people using the Safety Monitor. Operations people that work with the Safety Monitor receive a two day in house training on PSA basics and Safety Monitor Software operation. For these people, that have generally very good plant knowledge but limited PSA knowledge, the changes in Core Damage results are indisputable. The changes in percentages are checked against plant limits and actions are defined following the outcome of the calculations. Only very big or very small changes that fall completely short of the expectations of operation people are fed back to the PSA staff of EPZ. This stresses the importance of a balanced PSA, otherwise incorrect decisions can be taken. Conservatisms can both mask PSA results and overemphasize results.

On completion of the update project the model was used to update PSR work where the previous PSA was used to identify improvements of the plant. This is another area where conservatisms in the model can hamper its functionality. The efforts from a PSR should be focused on those areas where the biggest safety gain is to be found. The risk drivers from the PSA do not automatically relate to improvements in the plant. The highest contributing initiating event is a small LOCA at power with about 10% of the Core Damage Frequency. The underpinning success criteria analysis is for the worst location where the leak can occur. Improvements in the mitigating systems would be overrated as most of the break locations will be in less penalizing areas.

Many scenarios have bigger or smaller conservatisms like this one that pile up in the model. In review and discussions with the consultancy companies it is felt that it is easier to plead for best estimate solutions when it involves the baseline results than on other places. Given the day to day use of the Borssele PSA continuous effort is required to keep the PSA best estimate throughout the model.

The update of the PSA in light of the PSR following the IAEA review required several man-years of work. Interaction in the work between the different PSA areas required full time work coordination. Despite a big effort in work coordination it was unavoidable that different update tasks had to wait for each other. Scheduling a PSA update with topic areas that influence each other makes updating a PSA more difficult than many other projects.

4. CONCLUSION

After 20 years of PSA work the Borssele PSA received a major update following an IAEA review mission. Guidance on the update was derived from IAEA publications.

A high degree of confidence in the results is obtained by intensive review of the work. The confidence in the results was strengthened by the outcome of the IPSART follow-up mission. Long term full confidence can only be obtained by using the PSA and fine tuning it where necessary.

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