May 23, 2003

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SUBJECT: RESULTS OF THE SEABROOK GENERATING STATION SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During February, 2003, NRC staff and contractors visited the Seabrook Generating Station in Seabrook, NH to compare the Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. The Seabrook PSA included external initiating events, so sensitivity studies were performed to assess the impact of these initiators on SDP color determinations. In addition, the results from analyses using the NRC's draft Revision 3i Standard Plant Analysis Risk (SPAR) model for Seabrook were also compared with the licensee's risk model. The results of the SPAR model benchmarking effort will be documented in next revision of the SPAR (revision 3) model documentation.

The benchmarking visit identified that there was good correlation between the Phase 2 SDP Notebook and the licensee's PSA. The results indicate that the Seabrook Phase 2 notebook was generally more conservative in comparison to the licensee's PSA. The revision 1 SDP notebook will capture 94.6% of the risk significance of inspection findings. A summary of the results of comparisons of hypothetical inspection findings between SDP notebook and the licensee's PSA are as follows.

0% Underestimates Risk Significance
43.2% Match Risk Significance
48.6% Overestimates Risk Significance by 1 Order of Magnitude
2.7% Overestimates Risk Significance by 2 Orders of Magnitude
5.4% Unable to compare with licensee's PRA.

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The sensitivity study performed on the impact of external initiators showed little effect on the benchmarking outcome. This comparison showed that the same colors are obtained with or without external initiators, except for two hypothetical findings: TDP of EFW fails and AMSAC fails. In these two cases the notebooks were non-conservative by one order of magnitude (color).

The Rev-1 SDP notebook has been greatly improved as a result of the benchmarking activity. The number of underestimates was reduced (from 4 to 0). The number of cases that Rev-1 SDP would match that of the updated licensee's PSA has increased from 12 to 16. Finally, some reduction was gained for the number of double overestimates.

The licensee's PSA staff was very knowledgeable of the plant model and provided very helpful comments during the benchmark visit.

Attachment A describes the process and results of the comparison of the Seabrook SDP Phase 2 Notebook and the licensee's PSA.

Attachments: As stated

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SUMMARY REPORT ON BENCHMARKING TRIP TO

SEABROOK STATION

(February 4-6, 2003)

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April 23, 2003

Table of Contents

List of Tables

1. INTRODUCTION

A benchmarking of the Seabrook Station Significance Determination Process (SDP) Risk-Informed Inspection Notebook was conducted during a plant site visit on February 4-6, 2003. Eugene Cobey, Richard Rasmussen, Wayne Schmidt, and Peter Wilson (NRC), supported by Gerardo Martinez-Guridi (BNL), participated in this benchmarking exercise.

In preparation for the plant site visit, BNL staff reviewed the Rev. 0 Seabrook SDP notebook and evaluated a set of hypothetical inspection findings using the Rev. 0 SDP notebook, plant system diagrams, and information in the licensee's updated PRA.

The major activities performed during this plant site visit were:

1. Discussed licensee's comments on the Rev. 0 SDP notebook.

2. Obtained listings of the Risk Achievement Worth (RAW) values for basic events of the internal events PRA model.

3. Identified a target set of basic events (hypothetical inspection findings) for the benchmarking exercise.

4. Performed benchmarking of the Rev. 0 SDP notebook considering the licensee's proposed modifications to this notebook.

5. Identified overestimates and reviewed the licensee's PRA model to determine the underlying reasons. Additional changes to the SDP notebook were proposed, as appropriate.

Thirty-seven cases of hypothetical findings were evaluated. The revised notebook prepared using the insights from the benchmarking exercise yielded fourteen matches, eighteen overestimates by one order of magnitude, one overestimate by two orders of magnitude, two findings that were not modeled by the licensee, and no underestimates.

The overestimate by two orders of magnitude is the battery charger of bus A fails.

Chapter 2 presents a summary of the results obtained during benchmarking. Chapter 3 discusses the proposed revisions to the Rev. 0 SDP notebook. Chapter 4 discusses the results from both internal and external events. Finally, Attachment 1 shows a list of the participants in the benchmarking activities.

2. SUMMARY RESULTS FROM BENCHMARKING

Summary of Benchmarking Results

Benchmarking of the SDP Notebook for the Seabrook Station was conducted comparing the risk significance of the inspection findings obtained using the notebook with that obtained using the plant PRA. The benchmarking identified the hypothetical inspection findings for which the results of the evaluation using the notebook were under or overestimations compared to the plant PRA. As mentioned in the previous chapter, thirty-seven cases of hypothetical findings were evaluated. The revised notebook prepared using the insights from the benchmarking exercise yielded sixteen matches, eighteen overestimates by one order of magnitude, one overestimate by two orders of magnitude, two findings that were not modeled by the licensee, and no underestimates. A summary of the results of the risk characterization of hypothetical inspection findings is as follows:

0% (0 of 37 cases)	Non-conservative; underestimation of risk significance (by one order of magnitude)
2.7% (1 of 37 cases)	Conservative; overestimation of risk significance (by two orders of magnitude)
48.6% (18 of 37 cases)	Conservative; overestimation of risk significance (by one order of magnitude)
43.2% (16 of 37 cases)	Consistent risk significance
5.4% (2 of 37 cases)	Results could not be compared.

Detailed results of Benchmarking are summarized in Table 1 which consists of eight column headings. In the first two columns, the out-of-service components, including human errors, are identified for the case analyses. The colors assigned for significance characterization from using the Rev. 0 SDP notebook before incorporation of the licensee's comments are shown in the third column. The licensee's basic event for which the RAW was found, representing the hypothetical finding, is presented in the fourth column. The fifth and sixth columns show the RAW values and the associated colors, respectively, based on the licensee's latest PRA model. The colors assigned for significance characterization from using the SDP notebook after incorporation of the licensee's comments are shown in the seventh column. Finally, the eighth column presents the outcome of comparing the results between the SDP Rev. 1 notebook and the plant PRA.

A comparative summary of the benchmarking results is provided in Table 2. This table shows the number of cases where the SDP notebook was more or less conservative, the SDP notebook matched the outcome from the licensee's PRA model, and the cases not modeled by the licensee. The percentages associated with these cases also are shown on Table 2. The revised SDP notebook was consistent (same color) in 43.2% of the inspection findings, 51.4% of overestimates, and 0% of underestimates. The cases that are not modeled by the licensee, or that are modeled in a different way by the licensee, account for the remaining 5.4%.

Observations on the Licensee's PRA

During the benchmarking, some characteristics of the licensee's PRA are noted which contribute to the difference in results between the SDP notebook and the plant PRA. The Rev. 1 notebook includes two events that are not modeled by the licensee, or that are modeled in a different way by the licensee: one Main Steam Isolation Valve (MSIV) fails to close, and operator fails to refill RWST. They are discussed next.

One Main Steam Isolation Valve (MSIV) fails to close has a green color according to the licensee's PRA model, and a yellow color according to the SDP notebook. The notebook considers that if two or more MSIVs fail to close after a Main Steam Line Break (MSLB), pressurized thermal shock (PTS) will occur causing core damage. The licensee does not model PTS after a MSLB. Hence, the reason for the difference in colors is the difference in modeling.

Operator failing to refill RWST has a green color according to the licensee's PRA model, and a red color according to the SDP notebook. The licensee does not model this action in SGTR because the licensee analyzed that if high pressure injection is available, the plant can mitigate an SGTR for 24 hours without refill. This capability is because of the size of the RWST. The licensee also considers that this action is not necessary to mitigate an RCP seal LOCA resulting from a total loss of PCC or SWS. As a result, this action is not important in the licensee's PRA model. On the other hand, the SDP notebook's model considers that this action is necessary to mitigate an RCP seal LOCA resulting from a total loss of PCC or SWS. This is because the RWST is expected to be emptied before the mission time of 24 hours for those scenarios associated with relatively large leak rates. Hence, the difference of three orders of magnitude is due to this difference in modeling.

Discussion of Non-conservative Results by the Notebook

The Rev. 1 notebook did not yield any underestimate for the 37 hypothetical findings evaluated.

Discussion of Conservative Results by the Notebook

The Rev. 1 notebook produced 19 overestimates, 1 by two orders of magnitude, and eighteen overestimates by one order of magnitude. The overestimate by two orders of magnitude is battery charger of bus A fails. This failure has a white color according to the licensee's PRA model, and a red color according to the SDP notebook. The rules for SDP evaluation assume that the associated DC bus will be lost as a result of the failure of the battery charger because the associated battery will discharge under normal loads. On the other hand, the loss of the charger at Seabrook is annunciated in the main control room and, hence, the licensee's PRA model considers that both the battery and the charger have to be unavailable for the DC bus to be lost. In other words, the licensee's PRA model assumes that on loss of the charger, the battery will supply the normal loads for sufficient time for alternative power sources to be aligned to the bus, and that this recovery is successful. Hence, the reason for the difference in colors is the different treatment for the loss of the charger. If the failure of the battery charger was an actual finding, a recovery action would be added to the SDP model to take into account the licensee's recovery.

The eighteen overestimates by one color are: two cooler units (train A) of the Containment Enclosure Cooling System (Emergency Air Handling (EAH)) fail, one SI pump fails, one accumulator fails, MDP of EFW fails, TDP of EFW fails, start-up feed pump (SUFP) fails, one Atmospheric Relief Valve (ARV) fails to open, PORV A fails to open, one block valve fails to close, one primary safety valve fails to open, running pump of train A of SWS fails, AMSAC fails, operator fails to conduct Feed/Bleed, operator fails to switchover in HPR, operator fails to switchover in LPR, operator fails to recover AC power in less than 5 hrs after a LOOP, operator fails to depressurize RCS using SGs to less than setpoint of relief valves of SG after SGTR, and alternative cooling to one charging pump fails. The reasons causing these eighteen overestimates were not further investigated per the benchmarking process for these kinds of estimates.

Changes Incorporated Following Benchmarking Resulting in Updating of Benchmarking Results

Following benchmarking, we incorporated some additional changes to the Rev. 1 notebook as follows:

1. In several worksheets the SDVs were used as the steam relief path when secondary heat removal was provided by the EFW start-up feed pump in the function "Secondary Heat Removal (PCS)." This use of the SDVs was removed to avoid giving the impression that the SDVs are only available for this pump.

2. According to the SDP development guidelines, the steam relief paths for secondary heat removal are included in those worksheets where the PCS is considered to be lost. These paths were deleted from all worksheets where this condition is not satisfied.

3. In the worksheets for "Small LOCA (SLOCA)" and "Stuck-open PORV (SORV)," the original sequence "SLOCA - EFW - PCS - EIHP (12)" was removed because it is not minimal.

4. The success criteria for "Primary Heat Removal, Feed/Bleed (FB)" in the SORV and in the LEAC worksheets was changed to "1/1 remaining PORV opens ... for Feed/Bleed." This change was implemented to be consistent with the SDP assumption that the PORV that did not re-seat may be partially open, and thus not available for Feed/Bleed. In these worksheets, Feed/Bleed cannot be carried out using the SI pumps because this option requires both PORVs to fully open.

5. In the worksheet for "Main Steam Line Break (MSLB)," the SG safety valves were added as one of the steam relief paths for secondary heat removal. Also, the credit for "Primary Heat Removal, Feed/Bleed (FB)" was changed from operator action = 2 to operator action = 1 because the licensee estimated a HEP = 6E-2 for the operator action to carry out Feed/Bleed after failure of the EFW start-up feed pump.

6. The event tree used in "Loss of One Train of PCC" and "Loss of One Train of SW", with the initiating event LCOO, was modified to include secondary heat removal after total loss of cooling, that is, after loss of both trains of cooling. This modification required adding several sequences to the event tree; however, the sequences in the worksheets for "Loss of One Train of PCC" and "Loss of One Train of SW" remained the same after Boolean operations.

7. In the worksheet for "Loss of One Train of PCC," the name of the safety function "Redundant Train of CCW (RTC)" was changed to "Redundant Header of CCW (RTC)." We also changed the credit for this function from "1 train" to "1 multi-train system" because this "header" of CCW has two pumps.

8. In the worksheet for "Loss of One Train of SW," the name of the safety function "Redundant Train of SW (RTC)" was changed to "Redundant Header of SW (RTC)." We also changed the credit for this function from "1 train" to "1 multi-train system" because this "header" of SW has three pumps.

9. In the worksheet for "Loss of 125 VDC Vital Bus A (LDCA)," the EFW start-up feed pump was removed because it is considered to be unavailable after this loss.

10. After clarifying with the licensee the item to be used to represent “Operator fails to recover AC power in < 5 hrs after a LOOP,” the RAW assigned to this event for both internal events and internal and external events is 1.09.

Table 1 Summary of Benchmarking Results for Seabrook - Internal Events Only
Internal Events CDF is 2.54E-5/reactor-year (1) (2002 model) at a Truncation Limit = 1E-11
RAW Thresholds are W = 1.04, Y = 1.39, and R = 4.94

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before)	Basic Event Name	Internal RAW	Site Color	SDP Worksheet Results (After)	Comments
	Component						
1	Class 1E AC bus A fails	Red	EDESWG5.FX	325	Red	Red	Match
2	Class 1E AC bus B fails	Red	EDESWG6.FX	329	Red	Red	Match
3	Diesel generator of bus A fails	Yellow	DGDGIA.FR3	7.93	Red	Red	Match
4	Diesel generator of bus B fails	Red	DGDG1B.FS	8.43	Red	Red	Match
5	Vital 125 VDC bus A fails	Red	EDESWG11A.FX	209	Red	Red	Match
6	Vital 125 VDC bus B fails	Red	EDESWG11B.FX	208	Red	Red	Match
7	Battery of bus A fails	Yellow	EDEB1A.FP	7.96	Red	Red	Match
8	Battery of bus B fails	Red	EDEB1B.FP	8.45	Red	Red	Match
9	Battery charger of bus A fails	Red	EDEBC1A.FX	1.1	White	Red	Over by 2
10	Two cooler units (train A) of the Containment Enclosure Cooling System (Emergency Air Handling (EAH)) fail	Red	EAHFN5A.FR	2.16	Yellow	Red	Over by 1
11	One SI pump fails	White	SIP6A.FR	1.22	White	Yellow	Over by 1
12	One accumulator fails	Yellow	SITK9A, SIV6	1.37	White	Yellow	Over by 1
13	One CVCS centrifugal charging pump fails	White	CSP2A.FR	1.48	Yellow	Yellow	Match

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before)	Basic Event Name	Internal RAW	Site Color	SDP Worksheet Results (After)	Comments
14	RHR pump A fails	Red	RHP8A.FS	2.48	Yellow	Yellow	Match
15	MDP of EFW fails	Red	FWP37B.FS	3.75	Yellow	Red	Over by 1
16	TDP of EFW fails	Red	FWP37A.FS2	4.32	Yellow	Red	Over by 1
17	Start-up feed pump (SUFP) fails	Red	FWP113.FS	2.61	Yellow	Red	Over by 1
18	One compressor of IA fails	Green	Not available (NA)	NA	NA	Green	Match (2)
19	One Atmospheric Relief Valve (ARV) fails to open	Yellow	MSPV3001.FC	1.1	White	Yellow	Over by 1
20	One Main Steam Isolation Valve (MSIV) fails to close	Yellow	MSV86.FO	1.0	Green	Yellow	Not modeled by the licensee (3)
21	One steam dump valve (SDV) to condenser fails to open	White	ZZ.SDV.FP (all steam dumps)	1.0	Green	Green	Match
22	Running pump of train A of PCC fails	Red	CCP11A.FR	2.98	Yellow	Yellow	Match
23	PORV A fails to open	White	RCPCV456A.FC	1.29	White	Yellow	Over by 1
24	One block valve fails to close	White	RCV122.FO	1.0	Green	White	Over by 1
25	One primary safety valve fails to open	White	RCV115.FC	1.02	Green	White	Over by 1
26	Running pump of train A of SWS fails	Red	SWP41A.FS	1.06	White	Yellow	Over by 1
27	AMSAC fails	White	Specific basic event could not be identified	1.02	Green	White	Over by 1

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before)	Basic Event Name	Internal RAW	Site Color	SDP Worksheet Results (After)	Comments
	<u>Operator Actions</u>						
28	Operator fails to conduct Feed/Bleed	Yellow	HH.OFB1.FA	2.63	Yellow	Red	Over by 1
29	Operator fails to switchover in HPR	Red	HH.OSUMPML.FA	3.36	Yellow	Red	Over by 1
30	Operator fails to switchover in LPR	Yellow	HH.OSUMPLL.FA	1.26	White	Yellow	Over by 1
31	Operator fails to recover AC power in < 2 hrs after a LOOP	White	Top event ROSP1	1.16	White	White	Match
32	Operator fails to recover AC power in < 5 hrs after a LOOP	Yellow	Split fraction ROSPW5	1.09	White	Yellow	Over by 1
33	Operator fails to depressurize RCS using SGs to less than setpoint of relief valves of SG after SGTR	Yellow	Top event OSG1	1.03	Green	White	Over by 1
34	Operator fails to conduct emergency boration after ATWS	White	HH.OBOR1.FA	1.06	White	White	Match
35	Operator fails to depressurize the RCS to conditions of low pressure injection	Yellow	HH.ODEP1.FA	1.0	Green	Green	Match
36	Refill RWST fails	Green	HH.ORM1SLOCA.FA	1.0	Green	Red	Not modeled by the licensee (4)
37	Alternative cooling to one charging pump fails	Green	HH.CSALTCO1.FA	1.07	White	Yellow	Over by 1

Notes:

1. This value includes internal flooding and weather-related loss of station power.

2. This is not modeled by the licensee. However, all findings related to IA are green, regardless of the duration of the finding. For this reason, this is considered a match.

3. The notebook considers that if two or more MSIVs fail to close after a Main Steam Line Break (MSLB), pressurized thermal shock (PTS) will occur causing core damage. The licensee does not model PTS after a MSLB.

4. The licensee does not model “Operator failing to refill RWST” in SGTR because the licensee analyzed that if high pressure injection is available, the plant can mitigate an SGTR for 24 hours without refill. This capability is because of the size of the RWST. The licensee also considers that this action is not necessary to mitigate an RCP seal LOCA resulting from a total loss of PCC or SWS. As a result, this action is not important in the licensee’s PRA model.

Table 2: Comparative Summary of the Benchmarking Results

Total Number of Cases Compared	**SDP Notebook Before (Rev. 0)**		**SDP Notebook After (Rev. 1)**	
	Number of Cases	Percentage	Number of Cases	Percentage
SDP: Less conservative	4	10.8%	0	0%
SDP: More conservative by one color	15	40.5%	18	48.6%
SDP: More conservative by two colors	4	10.8%	1	2.7%
SDP: Matched	12	32.4%	16	43.2%
Not modeled by licensee	2	5.4%	2	5.4%
Total	37	100%	37	100%

3. PROPOSED REVISIONS TO REV. 0 SDP NOTEBOOK

Based on insights gained from the plant site visit, a set of revisions are proposed for the Rev. 0 SDP notebook. The proposed revisions are based on the licensee's comments on the Rev. 0 SDP notebook, better understanding of the current plant design features, consideration of additional recovery actions, use of revised Human Error Probabilities (HEPs) and initiator frequencies, and the results of benchmarking.

3.1 Specific Changes to the Rev. 0 SDP Notebook for the Seabrook Station

The NRC staff participating in the benchmarking and the licensee provided several comments on the Rev. 0 SDP notebook. In addition, several major revisions that directly impacted the color assignments by the SDP evaluation were discussed with the licensee and their resolutions were identified in the meeting. Several significant changes that had an impact on the evaluation of the notebook were incorporated during the visit, including revised HEPs and initiator frequencies. The proposed revisions are discussed below:

1. Added "Transients with PCS Available (TRANS)" to the notebook.

2. Added "Loss of One Train of Service Water (LOSW)" to the notebook.

3. Table 1. Moved "Loss of One Train of Primary Component Cooling Water (LOPCC)" from row III to row II to reflect the licensee's current frequency that is about 2.6E-2/reactor-year.

4. Reactor Makeup Pumps, used to refill the RWST, were added to Table 2.

5. Added Refueling Water Storage Tank (RWST) to Table 2.

6. Table 2. A footnote was added in the column "Initiating Event" of Instrument Air (IA) to indicate that all findings related to IA are green, regardless of the duration of the finding. For this reason, a worksheet for loss of IA was not included in the notebook.

7. The CDF was updated. The 2002 model has a CDF = 2.54E-5/reactor-year (this value includes internal flooding and weather-related LOOP). With external events, the CDF = 4.28E-5/reactor-year.

8. The safety valves of the steam generators were included as part of the steam relief path from the steam generators.

9. In several worksheets the function "Early Inventory Pressure Injection (EIHP)" uses 1/2 charging pumps or 1/2 SI pumps. The Rev. 0 success criteria was 2 multi-train systems; it was changed to 1 multi-train system to take into account dependencies due to support systems.

10. The licensee estimated a HEP = 6E-2 for the operator action to carry out Feed/Bleed after failure of the EFW start-up feed pump. Accordingly, a credit = 1 was assigned for this action in those scenarios that included failure of this pump.

11. The credit for the human action for High Pressure Recirculation was changed to 3 to be consistent with the generic value for this action.

12. The steam relief path (ARVs or SG safety valves) was added to the worksheets where the PCS is lost (or is assumed to be lost).

13. The event trees and worksheets for “Small LOCA (SLOCA),” “Stuck-open PORV (SORV),” “LOOP and Loss of Class 1E 4.16 kV AC Bus A (E5) (LEACA),” and “LOOP and Loss of Class 1E 4.16 kV AC Bus B (E6) (LEACB)” were changed as follows: 1) if the EIHP fails, the licensee does not give credit to depressurization and use of low-pressure injection, and core damage follows. 2) if the EIHP is available, then shutdown cooling (SDC) is attempted instead of LPR. This exception to one “construction rule” was based on the licensee’s analysis that when high pressure injection and secondary heat removal are available, the plant can successfully reach the conditions for shutdown cooling, thus terminating the accident. It is implicitly assumed that LPR is not needed. If SDC fails, then HPR is attempted.

14. A separate safety function for PCS was created in the event trees and worksheets for “Small LOCA (SLOCA),” “Stuck-open PORV (SORV),” “Medium LOCA (MLOCA),” “Steam Generator Tube Rupture (SGTR),” “Loss of One Train of Primary Component Cooling Water (LOPCC),” and “Loss of Class 1E 4.16 kV AC Bus B (E6) (LACB)”.

15. The EFW start-up feed pump is currently powered from a non-safety AC bus. However, the licensee indicated that it will be aligned to a safety bus, and the change will be included in the licensee’s PRA. To be consistent with the licensee’s current PRA, the notebook models the current power source for this pump.

16. In the “Medium LOCA (MLOCA)” event tree and worksheet, with EIHP available, the scenario to depressurize the RCS and use LPR was removed because the licensee does not give credit to this mitigation path.

17. The event tree and worksheet for “Steam Generator Tube Rupture (SGTR)” were changed as follows: 1) if the EIHP fails, the licensee does not give credit to depressurization and use of low-pressure injection, and core damage follows. 2) if the EIHP and secondary heat removal are available, then “Pressure Equalization (EQ)” is attempted. If EQ fails, then “Refill RWST (RWST)” is required to prevent core damage.

18. In the worksheets for “Anticipated Transients Without Scram (ATWS)” and “Main Steam Line Break (MSLB)”, the SDVs were removed because the PCS is assumed to be unavailable.

19. The TDEFW pump was added in the worksheet for “Main Steam Line Break (MSLB).”

20. If following the initiating event “Loss of One Train of Primary Component Cooling Water (LOPCC),” the other train fails, the complete loss of PCC results in failure of CVCS and SI pumps. RHR also fails in the sump recirculation mode. RCP seal cooling is normally provided by charging pump seal injection and backed up by the Thermal Barrier Cooling System. Both seal cooling methods depend on the PCC and, hence, a total loss of PCC guarantees an RCP seal LOCA. The event tree and worksheet were modified to incorporate the licensee’s strategy to mitigate this LOCA by providing alternative cooling to one charging pump so that it can provide makeup to the vessel. If this recovery action is successful, then

it appears necessary to refill the RWST because recirculation is not available. The same changes were implemented in the event tree and worksheet of “Loss of One Train of Service Water (LOSW).”

21. The event tree and worksheets for “Loss of One Train of Primary Component Cooling Water (LOPCC)” and “Loss of One Train of Service Water (LOSW)” were modified to incorporate the manual trip of the RCPs after total loss of cooling.

22. The event tree and worksheet for “Loss of 125 VDC Vital Bus A (LDCA)” were modified to reflect that this initiator is similar to “Transients With Loss of PCS (TPCS)” with failure of one train of standby safety equipment (EFW, ECCS), and of one primary PORV.

23. The event tree and worksheet for “Loss of 125 VDC Vital Bus B (LDCB)” were modified to reflect that this initiator is similar to “Transients With PCS Available (TRANS)” with failure of one train of standby safety equipment (EFW, ECCS), and of one primary PORV.

24. The SUFP was removed from the worksheet “Loss of Class 1E 4.16 kV AC Bus A (E5) (LACA)” because valve V156 (in the injection path from SUFP) is normally closed, and it requires power from bus E5 to open. We also assumed in this worksheet that one primary PORV will not be available for Feed/Bleed because its associated DC bus will eventually be lost after the loss of the 4kV bus E5.

25. We also assumed in the worksheet “Loss of Class 1E 4.16 kV AC Bus B (E6) (LACB)” that one primary PORV will not be available for Feed/Bleed because its associated DC bus will eventually be lost after the loss of the 4kV bus E6.

26. The “Initiating Event” column in Table 2 was updated to reflect the changes above.

3.2 Generic Change in IMC 0609 for Guidance to NRC Inspectors

Based on the lessons from this benchmarking, a recommendation for improving 0609 is as follows:

For the loss of a battery charger of a DC bus, the rule for SDP evaluation assumes that the associated DC bus will be lost as a result of the failure of the battery charger because the associated battery will discharge under normal loads. On the other hand, the loss of the charger at Seabrook is annunciated in the main control room and, hence, the licensee’s PRA model considers that both the battery and the charger have to be unavailable for the DC bus to be lost. It is recommended that the rule for SDP evaluation of a battery charger be revised to account for the possibility that the associated DC bus will not be lost as a result of the failure of the battery charger. This issue also was observed while benchmarking at least one other nuclear plant.

3.3 Generic Change to the SDP Notebook

It was proposed that the following note be added to those worksheets using the accumulators: “SDP worksheets assume the loss of the accumulator unit associated with the failed leg in LOCA scenarios.”

4. DISCUSSION ON EXTERNAL EVENTS

The licensee has an integrated model containing internal and external events. The licensee's integrated 2002 model has a CDF = 4.28E-5/reator-year. We obtained the colors of the hypothetical findings that were evaluated in Chapter 2 using the RAW values from this model. The results are presented in Table 3.

We then compared the colors of the hypothetical findings between internal events only (results of Chapter 2) and both internal and external events. This comparison showed that the same colors are obtained between these two cases, except for two hypothetical findings: TDP of EFW fails and AMSAC fails. In other words, the findings with different colors are about 5.4% of the total number of findings that were evaluated.

"TDP of EFW fails" has a yellow from internal events only, and a red from internal and external events. " AMSAC fails" has a green from internal events only, and a white from internal and external events. Therefore, in both findings, evaluating both internal and external events yields one order of magnitude (color) higher than the color obtained from internal events only.

Table 3 Summary of Benchmarking Results for Seabrook - Internal and External Events
Internal and External Events CDF is 4.28E-5/reactor-year (2002 model) at a Truncation Limit = 1E-11
RAW Thresholds are W = 1.02, Y = 1.23, and R = 3.34

No.	Component Out of Service or Failed Operator Action	Site Color from Internal only	Internal and External RAW	Site Color from Internal and External	Comments
	Component				
1	Class 1E AC bus A fails	Red	194	Red	
2	Class 1E AC bus B fails	Red	203	Red	
3	Diesel generator of bus A fails	Red	6.16	Red	
4	Diesel generator of bus B fails	Red	6.67	Red	
5	Vital 125 VDC bus A fails	Red	133	Red	
6	Vital 125 VDC bus B fails	Red	132	Red	
7	Battery of bus A fails	Red	6.19	Red	
8	Battery of bus B fails	Red	6.69	Red	
9	Battery charger of bus A fails	White	1.06	White	
10	Two cooler units (train A) of the Containment Enclosure Cooling System (Emergency Air Handling (EAH)) fail	Yellow	1.69	Yellow	
11	One SI pump fails	White	1.15	White	
12	One accumulator fails	White	1.23	White	
13	One CVCS centrifugal charging pump fails	Yellow	1.32	Yellow	
14	RHR pump A fails	Yellow	1.94	Yellow	

No.	Component Out of Service or Failed Operator Action	Site Color from Internal only	Internal and External RAW	Site Color from Internal and External	Comments
15	MDP of EFW fails	Yellow	3.28	Yellow	
16	TDP of EFW fails	Yellow [(1)]	3.63	Red	Site color from internal and external events is larger by one color.
17	Start-up feed pump (SUFP) fails	Yellow	2.13	Yellow	
18	One compressor of IA fails	NA	NA	NA	
19	One Atmospheric Relief Valve (ARV) fails to open	White	1.07	White	
20	One Main Steam Isolation Valve (MSIV) fails to close	Green	1.0	Green	
21	One steam dump valve (SDV) to condenser fails to open	Green	1.0	Green	
22	Running pump of train A of PCC fails	Yellow	2.62	Yellow	
23	One PORV fails to open	White	1.19	White	
24	One block valve fails to close	Green	1.01	Green	
25	One primary safety valve fails to open	Green	1.01	Green	
26	Running pump of train A of SWS fails	White	1.04	White	
27	AMSAC fails	Green [(2)]	1.04	White	Site color from internal and external events is larger by one color.

No.	Component Out of Service or Failed Operator Action	Site Color from Internal only	Internal and External RAW	Site Color from Internal and External	Comments
	Operator Actions				
28	Operator fails to conduct Feed/Bleed	Yellow	2.02	Yellow	
29	Operator fails to switchover in HPR	Yellow	2.26	Yellow	
30	Operator fails to switchover in LPR	White	1.16	White	
31	Operator fails to recover AC power in < 2 hrs after a LOOP	White	1.09	White	
32	Operator fails to recover AC power in < 5 hrs after a LOOP	White	1.09	White	
33	Operator fails to depressurize RCS using SGs to less than setpoint of relief valves of SG after SGTR	Green	1.01	Green	
34	Operator fails to conduct emergency boration after ATWS	White	1.04	White	
35	Operator fails to depressurize the RCS to conditions of low pressure injection	Green	1.0	Green	
36	Refill RWST fails	Green	1.0	Green	
37	Alternative cooling to one charging pump fails	White	1.04	White	

Notes:

1. The licensee's PRA for internal events yields a RAW of 4.32 for this event, corresponding to yellow.
2. The licensee's PRA for internal events yields a RAW of 1.02 for this event, corresponding to green.

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