July 7, 2003

MEMORANDUM TO: Stuart Richards, Chief
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FROM: Mark F. Reinhart, Chief/**RA/** M. Caruso for
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SUBJECT: RESULTS OF THE CALLAWAY PLANT SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During August, 2002, NRC staff and contractors visited the Ameren Union Electric corporate office in St. Louis, Missouri to compare the Callaway Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. The current plant probabilistic safety assessment's (PSA's) internal event core damage frequency was 2.45 E-5/reactor-year excluding internal flood events. The Callaway PSA did not include external initiating events and therefore sensitivity studies were not performed to determine any 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 Callaway were also compared with the licensee's risk model. The results of the SPAR model benchmarking effort will be documented in the next revision of the SPAR (revision 3) model documentation.

In the review of the Callaway SDP notebook for the benchmark efforts, the team determined that some changes to the SDP notebook were needed to reflect how the Callaway plant is currently designed and operated. Thirty four hypothetical inspection findings were processed through the SDP notebook and compared with the licensee's related importance measures. Results from this effort indicated that the risk impacts modeled in the SDP notebook were less

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conservative by 21 percent, more conservative by 33 percent, consistently estimated by 38 percent, and 7 percent were not comparable. Consequently, 60 changes were made to the SDP notebook. Using the revised SDP notebook, the team obtained 2 percent of the cases that were less conservative, 29 percent were more conservative, 62 percent of the cases were consistent with the licensee's results, and 7 percent were not comparable. Of the conservative cases, all were one order of magnitude greater than the results obtained with the licensee's model and as such are generally consistent with the expectation that the notebooks should be slightly conservative when compared to the licensee's model.

The licensee's PSA staff had substantial knowledge of both the Callaway PSA model and conduct of plant operations. The licensee's comments greatly improved the quality and content of the SDP notebook.

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

Attachments: As stated

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SUMMARY REPORT ON BENCHMARKING TRIP TO

CALLAWAY NUCLEAR GENERATING STATION UNIT 1

(August 20-21, 2002)

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Attachment A

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1. Introduction

A benchmarking of the Callaway Nuclear Generating Station (CNGS), Unit 1 Significance Determination Process (SDP) Risk-Informed Inspection Notebook was conducted during a plant site visit on August 20-21, 2002. Mike Franovich and Troy Pruett (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 CNGS 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 PSA.

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 with considerations of the licensee's proposed modifications to this notebook.

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

Forty-two cases of hypothetical findings were evaluated. The RAWs for three of these findings were not found in the licensee's list of RAWs, nor could they be derived otherwise. For the remaining thirty-nine findings, the revised notebook prepared using the insights from the benchmarking exercise yielded twenty-six matches, one underestimate, and twelve overestimates. The underestimate is the failure of battery NK12.

The twelve overestimates are by one color (order of magnitude), and they are the failures of the following components and human errors: common cause failure to start of the motor-driven AFW pumps, one pump of (normal) Service Water system, one heat exchanger of CCW, one safety injection pump, one RHR pump, one heat exchanger of RHR, one pressurizer PORV fails to close, one block valve fails to close, one SG PORV fails to open, operator fails to align ECCS systems for cold-leg recirculation, operator fails to close pressurizer PORV block valve, and operator fails to cooldown and depressurize RCS (in SGTR event).

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

2. Summary Results From Benchmarking

This Section provides the results of the benchmarking exercise. The results of benchmarking analyses 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 based on the licensee's latest PRA model, respectively. 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 rule used to evaluate the hypothetical finding related to components of support systems, or other relevant comments.

As mentioned in the previous chapter, forty-two cases of hypothetical findings were evaluated. The RAWs for three of these findings were not found in the licensee's list of RAWs, nor could they be derived otherwise. For the remaining thirty-nine findings, the revised notebook prepared using the insights from the benchmarking exercise yielded twenty-six matches, one underestimate, and twelve overestimates. The underestimate is the failure of battery NK12.

For the failure of battery NK12, the licensee obtained a RAW of 3.77 (yellow), while the SDP revised notebook yields a white. Battery NK12 is connected to the 125 VDC bus NK02. On loss of a battery, the associated battery charger can carry the starting of the SI loads. Failure of this type of battery is evaluated by assuming the loss of the associated DC bus when offsite power is not available (i.e, LOOP, LEAC worksheets), and increasing the frequency of loss of DC initiator by one order of magnitude. However, for the case of battery NK12 the frequency of the LBDC initiator should not be increased because the LBDC worksheet models the loss of either vital 125 VDC bus NK01 or bus NK04, not bus NK02. However, loss of bus NK02 causes a reactor trip with PCS available; therefore, consistent with current SDP evaluation rules, the evaluation of the loss of battery NK12 includes:

1) Assuming the loss of the associated DC bus when offsite power is not available (i.e., LOOP and LEAC worksheets). According to a dependency matrix obtained from the licensee during the benchmarking visit, bus NK02 powers the TDAFW pump and one SI pump.

2) Increasing the initiating event for "Transients with PCS Available (Reactor Trip) (TRANS)" by one order of magnitude.

The dominant contributors to the risk significance of inspection findings related to battery NK12 result from station blackout scenarios where the AC power is not recovered. The Callaway PRA estimates a failure probability of 1.1E-2 for both diesel generators (DGs) and a failure probability of 0.22 for failure to recover AC power within 2 hours. On the other hand, the SDP revised notebook gives a credit of 3 (10^{-3}) to failure of both DGs, and credit of 1 (10^{-1}) to failure to recover AC power within 2 hours. The combination of these two different estimates resulted in the underestimate of battery NK12.

The twelve overestimates are by one color (order of magnitude), and they are the failures of the following components and human errors: common cause failure to start of the motor-driven AFW pumps, one pump of (normal) Service Water system, one heat exchanger of CCW, one safety injection pump, one RHR pump, one heat exchanger of RHR, one pressurizer PORV fails to close, one block valve fails to close, one SG PORV fails to open, operator fails to align ECCS systems for cold-leg recirculation, operator fails to close pressurizer PORV block valve, and operator fails to cooldown and depressurize RCS (in SGTR event).

The reasons causing these overestimates were not further investigated per the benchmarking process for overestimates by one color. However, it is noted that the licensee's values of the frequencies of small, medium, and large LOCAs are about half of the corresponding SDP's values. For example, for medium LOCA, the SDP uses a credit of 4 (for an exposure time greater than 30 days), while the licensee's initiating event frequency is 4.0E-5. These differences may have contributed to some of the overestimates, while some others are due to the assumptions in the SDP approach.

A comparative summary of the benchmarking results is provided in Table 2. Table 2 shows the number of cases where the SDP was more or less conservative, the SDP matched the outcome from the licensee's PRA model, or the cases which were not found in the licensee's list of RAWs, nor could they be derived otherwise. The associated percentage of differences found for the 39 cases that could be compared with the licensee's RAWs also are shown on Table 2. The revised SDP notebook obtained 61.9% of the actual significance of inspection findings (same color), 28.6% of overestimates, and 2.4% of underestimates. The cases for which a RAW could not be derived account for the remaining 7.1%.

Table 1 Comparison of Sensitivity Calculations between SDP Phase 2 Worksheets and Callaway RAWs

Internal Events CDF is 2.45 x 10^{-5}/yr

RAW Thresholds are W= 1.04, Y= 1.41, and R = 5.08

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	Accumulator A un-available	White	EP-TNK-TM-ACCUMA	Not found	Green	Green	
2	Diesel gen NE01 fails to run after start	Yellow	NE-DGN-FR-NE01	1.65	Yellow	Yellow	Rule 1.6 of usage rules.
3	Fuel transfer pump PJE01A fails to start	Yellow	JE-FOP-FS-PJE01A	4.58	Yellow	Yellow	Rule 1.6 of usage rules.
4	Bus NB01 fails (4kV)	Red	NB-BAC-LP-NB01	42.19	Red	Red	Rule 2.2 of usage rules.
5	MDAFP A fails to start	Yellow	AL-MDP-FS-MDAFPA	1.50	Yellow	Yellow	
6	Motor driven AFW pumps common cause fail to start	Red	AL-MDP-DF-ALPMPS	4.23	Yellow	Red	
7	TDAFP fails to start	Yellow	AL-TDP-FS-TDAFP	7.49	Red	Red	
8	Valve FCHV312 fails to open on demand (TDAFW trip or throttle valve)	Yellow	NA (1)	7.49	Red	Red	The licensee lumps the failure probability of this valve into the probability of loss of TDAFW pump. Hence, the valve's RAW is the same as the TDAFW pump's RAW.
9	ESW pump A (PEF01A) fails to start	Red	EF-MDP-FS-PEF01A	8.06	Red	Red	Rule 1.5 of usage rules.

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
10	One pump of Service Water system	Yellow (solving LSW only)	EA-MDP-FR-PUMPA	1.06	White	Yellow	Rule 1.3 of usage rules.
11	(CCW) Motor driven pump PEG01A fails to start	White (using Table 2 literal instruction)	EG-MDP-FS-PUMPA	3.69	Yellow	Yellow	Apply rule 1.4 of usage rules. However, solve only base sequences since the train of CCW is not lost (still have another 100% pump).
12	CCW HX fails	White (solving only LCCW)	EG-HTX-TM-CCWHXB	1.66	Yellow	Red	Rule 1.5 of usage rules.
13	Centrifugal charging pump A fails to run	Yellow	BG-MDP-FR-CCPA	1.19	White	White	
14	Valve EMHV8801A fails to open (CCP discharge to cold legs on SI)	Yellow	EM-MOV-CC-V8801A	1.10	White	White	This is 1 of 2 valves in parallel; consider loss of redundancy rule.
15	Safety injection pump A (PEM01A) fails to start	White	EM-MDP-FS-PEM01A	1.00	Green	White	
16	RHR pump A fails to start	Red	EJ-MDP-FS-PEJ01A	2.22	Yellow	Red	
17	RHR HX fails	Yellow	EJ-HTX-LK-EEJ01A	1.17	White	Yellow	
18	Containment recirculation sump valve EJHV8811A fails to open	Yellow	EJ-MOV-CC-V8811A	2.02	Yellow	Yellow	

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
19	Miscalibration of all RWST level instruments (too low)	Red	BN-XHE-MC-RWST	27.02	Red	Red	Rule 2.2 of usage rules.
20	No RWST low level signal available (SEP GRP 1)	Yellow	SA-ICC-AF-RWSTL1	2.10	Yellow	Yellow	Separation group 1 has 2 level transmitters. Therefore, the RWST low level logic is down to 2/2. Rule 2.2 of usage rules.
21	Valve EJHV8804B fails to open (ECCS piggy back valve)	Green	EJ-MOV-CC-V8804B	1.13	White	White	
22	Pressurizer PORV PCV455A fails to open	White	BB-PRV-CC-V455A	3.06	Yellow	Yellow	
23	Both primary PORVs fails to open	Yellow	BB-MOV-D2-BLKVLV	NA [(2)]	NA	Red	
24	Pzr PORV fails to close	White	BB-PRV-OC-V455A	1.23	White	Yellow	
25	Block valve common cause failure (fails to open)	Red	BB-MOV-D2-BLKVLV	5.14	Red	Red	
26	Block valve A (HV8000A) fails to close	White	BB-MOV-OO-V8000A	1.01	Green	White	
27	Primary Safety Valve 8010A fails to open	White	NA	NA [(2)]	NA	White	The licensee does not include the Primary Safety Valves in its PRA model. The licensee uses a generic probability for failure of pressure relief in an ATWS.

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
28	AMSAC system fails (AM)	White	AMSACFAILS	1.07	White	White	
29	DC electrical bus NK01 fails	Green (see comment below)	NK-BDC-LP-NK01	16.00	Red	Red	Rule 1.4 of usage rules.
30	Battery NK12 fails to provide power	Green (applying instructions in Table 2 literally)	NK-BAT-LP-NK12	3.77	Yellow	White	
31	MSIV "B" (AB-HV-17) fails to close on demand	Green	AB-PHV-OO-ABHV17	1.85	Yellow	Yellow	
32	SG PORV ABPV0004 fails to open	White	AB-ARV-CC-ABPV04	1.18	White	Yellow	
33	Air compressor ‘C’ fails to start on demand	White	NA	1.0 (3)	Green	Green	Rule 1.3 of usage rules.
34	Failure of MD MFW startup pump	Green	AE-MD-FS-PAE02	1.0	Green	Green	
	Operator Actions						
35	Operator fails to start and align ESW 8 hours after SW loss	White	OP-XHE-FO-ESW8HR	1.08	White	White	
36	Operator fails to go to long term S/D after ATWS event	White	OP-XHE-FO-ATWSLT	1.14	White	White	

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
37	Fail to trip RCP on loss of thermal barrier cooling	Yellow	NA	NA (2)	NA	Yellow	
38	Operator fails to align ECCS systems for cold leg recirc	Red	OP-XHE-FO-ECLFB1	4.47	Yellow	Red	This operator action is only used in the following scenarios: SLOCA, LOOP, LSWS, LCCW, and LBDC.
39	Operator fails to close PORV block valve	White	BB-XHE-FO-BLOCK	1.02	Green	White	
40	Operator fails to isolate the faulted S/G following SGTR	Yellow	OP-XHE-FO-SGISO	1.92	Yellow	Yellow	
41	Operator fails to cooldown and depressurize RCS (in SGTR event)	Yellow	OP-XHE-FO-SGTRDP	1.08	White	Yellow	
42	Failure to re-establish MFW flow due to human errors	Green	AE-XHE-FO-MFWFLO	1.17	White	White	It is assumed that it contributes to a TPCS, so TPCS = 0.

Notes:

1. NA stands for not available.
2. The RAW for this item was not found in the licensee's list of RAWs.
3. The licensee does not include IA in its PRA model. We assumed the loss of a compressor has a RAW = 1 (green).

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	9	21.4	1	2.4
SDP: More Conservative	14	33.3	12	28.6
SDP: Matched	16	38.1	26	61.9
No RAW that can be derived	3	7.1	3	7.1
Total	42	100	42	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 Callaway Nuclear Generating Station, Unit 1

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. The worksheet and event tree for "Loss of Service Water (LSW)" were substituted by the corresponding ones for "Loss of (Normal) Service Water System (LSWS)." The loss of the (normal) Service Water System (EA) causes a turbine trip and a reactor trip. The operators then have to manually start the ESW. If the ESW fails, a loss of all service water occurs. The licensee's PRA currently defines loss of service water as the loss of both the Service Water and Essential Service Water systems. "Loss of (Normal) Service Water System (LSWS)" was assigned to row II of Table 1 such that the results are consistent with the licensee's combined initiator. "Loss of Service Water (LSW)" was removed from Table 1. The column "Initiating Event Scenarios" of Table 2 for the Essential Service Water System (ESW) was changed from LSW to All. LSWS was assigned to the column "Initiating Event Scenarios" of the (Normal) Service Water System.

2. Table 2. A separate row was developed for the AMSAC.

3. Table 2. The CST was added as a support system for the AFW. A footnote was added indicating CST's capacity.

4. Table 2. The turbine-driven pump of AFW does not require ESW, so ESW was removed from the support systems of this pump.

5. Table 2. A footnote was added to indicate that the Standby Diesel Generators rooms are cooled by the Diesel Generator Supply Fans.

6. Table 2. The column "Initiating Event Scenarios" for the Class 1E (Vital) DC Power System was changed to All.

7. Table 2. A footnote was added to indicate that following a station blackout, the batteries have a capacity of 8 hours.

8. Table 2. A separate row was developed for the Chemical and Volume Control System (CVCS). This row was in turn subdivided into two rows, one for the boric acid transfer pumps, and the other for the normal charging pump (NCP).

9. Table 2. A footnote was added to indicate that the normal charging pump (NCP) does not require CCW or ESW.

10. Table 2. The Class 1E 125 VDC Power system has four buses. Loss of either vital 125 VDC bus NK02 is not considered initiating events. Loss of either vital 125 VDC bus NK01 or bus NK04 progresses as a transient without main feedwater where one train of frontline and support safety systems will be rendered unavailable. Separate rows were created for buses NK01 and NK04, and for buses NK02 and NK03. Loss of NK03 will cause a reactor trip with loss of the TDAFW pump and one SI pump.

11. Table 2. On loss of a battery, the associated battery charger can carry the starting of the SI loads. There is one battery charger per DC bus, plus 1 swing charger that can be aligned to either bus. A footnote was added with this information.

12. Table 2. The inspection findings related to the batteries of buses NK01 or NK04 should be evaluated by assuming the loss of the associated DC bus when offsite power is not available (i.e., LOOP and LEAC worksheets), and increasing the frequency of the LBDC initiator by one order of magnitude. A footnote was added with this information.

13. Table 2. The inspection findings related to the batteries associated with buses NK02 or NK03 should be evaluated by assuming the loss of the associated DC bus when offsite power is not available (i.e., LOOP and LEAC worksheets). For this purpose, it is necessary to find out the impact of the loss of the affected bus on mitigating equipment. The frequency of the LBDC initiator should not be increased because the LBDC worksheet models the loss of either vital 125 VDC bus NK01 or bus NK04. A footnote was added with this information.

14. Table 2. A footnote was added to indicate that cooling of certain pumps are not required.

15. Table 2. The dependency of the Engineered Safety Feature Actuation System (ESFAS) on 125 VDC was confirmed. Footnote 1 of the Rev. 0 (pre-benchmarking) SDP notebook was deleted.

16. Table 2. One cooling tower was added as one of the major components of the Essential Service Water (ESW).

17. Table 2. Two footnotes were added for the Essential Service Water (ESW): 1) room cooling is provided by fans and dampers, and 2) the licensee credits recovering ESW by using the Service Water System (EA).

18. Table 2. A separate row was developed for the Instrument Air (IA).

19. Table 2. A footnote was added for the Main Feedwater System (MFW) to indicate that room cooling is not required.

20. Table 2. Instrument Air (IA) was added as a support system for the Main Feedwater System (MFW).

21. Table 2. A note was added to indicate that for findings in the hardware of the Main Feedwater System (MFW), the TPCS initiating frequency should be increased by one order of magnitude, in addition to assessing the other worksheets in the column “Initiating Event Scenarios.”

22. Table 2. The row for Pressurizer Power-Operated Relief Valves (PORVs) was subdivided into two rows: PORVs and block valves. The support systems and initiating event scenarios were then assigned to each of them.

23. Table 2. A note was added to indicate that the block valves are normally open.

24. Table 2. A footnote was added to indicate that the PORVs fail closed on loss of DC power.

25. Table 2. A separate row was developed for the Refueling Water Storage Tank (RWST).

26. Table 2. In the row for the Residual Heat Removal System (RHRS), a note was added to indicate that the CCWS is only required for recirculation.

27. Table 2. The RHRS was removed from the support systems of the Safety Injection (SI). The dependency of SI on RHR during recirculation is explicitly modeled in the worksheets that use recirculation.

28. Table 2. For the Main Steam Isolation Valves (MSIVs), the Main Steam & Feed Isolation System (MSFIS) was added as a support system, and SGTR was added as an initiating event scenario.

29. Table 2. For the steam generator Atmospheric Steam Dump (ASD or SG PORV), a note was added to indicate that there is nitrogen backup.

30. Table 2. SGTR was added as an initiating event scenario for the main steam dump valves.

31. Table 2. Non-safety related DC was added as a support system for the Service Water System (EA). Footnote 7 of the Rev. 0 (pre-benchmarking) SDP notebook was deleted.

32. Table 2. A footnote was added to indicate that room cooling is not required for the Service Water System (EA).

33. Table 2. The CDF was updated to 2.45×10^{-5}/year (not including floods).

34. Table 2. The column “Initiating Event Scenarios” of Table 2 was updated according to the modifications in the worksheets described below.

35. In all worksheets having the function “Early Inventory, HP Injection (EIHP)” with a credit equal to “½ CCP trains (1 multi-train system) or ½ SIP trains (1 multi-train system),” the credit was changed to “½ CCP trains or ½ SIP trains (1 multi-train system).” This change was implemented for consistency with other Westinghouse plants in treating dependencies on common support systems.

36. TRANS worksheet. The success criteria for Feed/Bleed was updated to 2/2 PORVs.

37. TPCS worksheet. The success criteria for Feed/Bleed was updated to 2/2 PORVs.

38. SLOCA worksheet. The success criteria for "Rapid Cooldown and Depressurization (DEPR)" was updated.

39. SORV worksheet. An event tree for SORV was added to the notebook, and the sequence numbers of the worksheet were updated.

40. SORV worksheet. The mitigating credit of "Isolation of Small LOCA (BLK)" was changed to 1 train because it requires an operator action, but it is limited by hardware failure. This information was included in a footnote.

41. SORV worksheet. The success criteria for "Rapid Cooldown and Depressurization (DEPR)" was updated.

42. MLOCA worksheet. The condenser steam dumps were added for "Rapid Cooldown and Depressurization (DEPR)." The success criteria for this function was updated.

43. LOOP worksheet. The SI pumps are not credited for high pressure injection because the RCS pressure is expected to be above their shut-off head. This information was included in a footnote. The Rev. 0 (pre-benchmarking) functions EIHP and EIHPC were consolidated into the Rev. 1 (post-benchmarking) single function EIHP that only gives credit to the CCPs. Accordingly, the structure of the associated event tree and the sequences of the worksheet were updated.

44. SGTR worksheet. The equipment used and detailed success criteria were added for isolating the affected SG (ISOL), pressure equalization (EQ), and depressurization of the RCS (DEPR).

45. SGTR worksheet. A footnote was added to indicate that no credit is given to the affected SG and its associated equipment.

46. ATWS worksheet. The equipment used and success criteria for the steam relief path was updated to 4/5 safety valves per SG. Note 1 of the worksheet was deleted.

47. ATWS worksheet. The emergency boration function (EMBO) was updated to ½ CCP trains taking suction from (RWST or 1/2 boric acid transfer pumps).

48. MSLB worksheet. The generic event tree and worksheet were implemented.

49. LSWS worksheet. The recovery action of the operator using the NCP for RCP seal injection was included in the event tree and worksheet.

50. LSWS worksheet. The licensee credits recovering service water within 2 hours after the loss of service water. The licensee's human error probability for this recovery is 5.04E-1. Accordingly, no credit is given to this recovery, which required removing several branches of the event tree.

51. LCCW worksheet. An event tree for LCCW was developed. The event tree gives credit to the operator using the NCP for RCP seal injection. On success of low pressure injection (LPI), the SDP event tree asks for the recovery of CCW. If recovery is successful, the event tree asks for low pressure recirculation (LPR); if it is not, core damage follows.

52. A worksheet for “Loss of Instrument Air (LIA)” was included to be consistent with developing guidelines for SDP notebooks. We assigned a generic frequency of 3 to Loss of Instrument Air.

53. LBDC worksheet. An event tree for LBDC was developed showing explicitly the dependency of mitigating systems on one remaining train of ESW. The sequences of this event tree were used in the worksheet.

54. LEAC worksheet. The sequences where PORV successfully re-closes were deleted.

55. LEAC worksheet. The SI pumps are not credited for high pressure injection because the RCS pressure is expected to be above their shut-off head. This information was included in a footnote. The Rev. 0 (pre-benchmarking) functions EIHP and EIHPC were consolidated into the Rev. 1 (post-benchmarking) single function EIHP that only gives credit to the CCPs. Accordingly, the structure of the associated event tree and the sequences of the worksheet were updated.

56. LEAC worksheet. The success criteria for the cooling down and depressurizing the RCS was updated to 2/4 steam generator PORVs. The condenser steam dumps were removed from this function because they are not available after a LOOP.

57. LEAC worksheet. The credit for HPR was updated to 1 train. The sequences containing HPR were also updated.

58. SLOCA, SORV, SGTR, and LCCW worksheets. The heading “Secondary Heat Removal (SHR)” was divided into the headings “Secondary Heat Removal (AFW)” and “Power Conversion System (PCS)” to be consistent with the naming of event tree headings throughout the notebook.

59. The steam relief path was removed from the following worksheets: TRANS, SLOCA, SORV, MLOCA, SGTR, and LCCW.

60. LSWS and LCCW worksheets. The credit for the operator cooling down and depressurizing the primary system is given a 1 because it is considered to be dependent on a previous action, operator uses NCP for RCP seal injection.

3.2 Generic Change in IMC 0609 for Guidance to NRC Inspectors

No specific recommendation for changes to IMC 0609 was identified as a result of this benchmarking exercise.

3.3 Generic Change to the SDP Notebook

No generic change is proposed.

Attachment 1. List of Participants

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