September 24, 2003

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SUBJECT: RESULTS OF THE VIRGIL C. SUMMER SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During May 2003, NRC staff and contractors visited the Summer Nuclear Power Plant in Jenkinsville, South Carolina to compare the Summer 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 risk assessment's (PRA's) internal event core damage frequency was 4.74E-5/year excluding internal flood events. The Summer PRA did not include an integrated PRA model with external initiating events (e.g. fire, seismic initiators). Therefore sensitivity studies were not performed to determine any impact of external events on SDP color determinations. In addition, the results from analyses using the NRC's draft Revision 3i Standard Plant Analysis Risk (SPAR) model for Summer 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 Summer SDP notebook for the benchmark efforts, the team determined that some changes to the SDP notebook were needed to reflect how the Summer is currently designed and operated. Thirty seven hypothetical inspection findings were processed through the SDP notebook and compared with the licensee's related importance measures. Using the Revision 0 SDP notebook, the team determined that 13.5 percent of the cases were less conservative, 48.5 percent of the cases were more conservative, 27 percent of the cases were consistent with the licensee's results, and 10.8 percent not modeled in the notebook. Of the conservative cases, 7 cases were two or more colors greater than the results obtained using the licensee's model. Consequently, 78 changes were made to the SDP notebook.

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Using the Revision 1 SDP notebook, the team determined that 0 percent of the cases were less conservative, 54 percent of the cases were more conservative, and 46 percent of the cases were consistent with the licensee's results. Of the conservative cases, 9 cases were two or more colors greater than the results obtained using the licensee's model.

The team identified several technical issues concerning the Summer PRA model. In some instances, a meaningful comparison between the licensee's PRA and the SDP notebook could not be obtained. These technical issues involved modeling differences for initiators such as loss of instrument air, loss of component cooling water, and loss of service water. Consequently, the team obtained many overestimates by two or more colors than what is typically achieved following benchmarking adjustments to an SDP notebook. The team recommends that the Summer Revision 1 SDP notebook be benchmarked against the licensee's revised PRA model subsequent to the licensee's evaluation and resolution of the team's comments and industry PRA certification comments.

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

Attachment: As stated

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SUMMARY REPORT ON BENCHMARKING TRIP TO

V. C. SUMMER NUCLEAR STATION

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ATTACHMENT

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1. Introduction

A benchmarking of the V. C. Summer Nuclear Station Significance Determination Process (SDP) Risk-Informed Inspection Notebook was conducted during a plant site visit on May 20-22, 2003. Rudolph Bernhard, Mike Franovich, and Walt Rogers (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 Summer 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 with considerations of 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.

Chapter 2 presents a summary of the results obtained during benchmarking, Chapter 3 discusses the proposed revisions to the Rev. 0 SDP notebook, and 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 V. C. Summer Nuclear 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.

Forty-one (41) cases of hypothetical findings were evaluated. Four (4) of them were not modeled by the licensee, so the results of these cases from the Rev.1 SDP notebook could not be compared with the results from the licensee's PRA. For the remaining 37 cases, a summary of the results of the risk characterization of hypothetical inspection findings is as follows:

0.0% (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 five orders of magnitude)
21.6% (8 of 37 cases)	Conservative; overestimation of risk significance (by two orders of magnitude)
29.7% (11 of 37 cases)	Conservative; overestimation of risk significance (by one order of magnitude)
45.9% (17 of 37 cases)	Consistent risk significance.

Detailed results of benchmarking are summarized in Table 1. This table consists of eight columns: 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 or component 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 and the outcome of comparing the results between the SDP Rev. 1 notebook and the plant PRA are shown in the seventh column. Finally, the eighth column presents some comments about the evaluations.

A comparative summary of the benchmarking results is provided in Table 2. This table shows the number of cases where the SDP was more or less conservative or the SDP matched the outcome from the licensee's PRA model. The percentages associated with these cases also are shown on this Table. The revised SDP notebook was consistent (same color) in 45.9% of the inspection findings, 54.1% of overestimates, and 0.0% of underestimates.

In comparing the Rev. 0 notebook with the Rev. 1 notebook, a significant improvement was achieved with the updated notebook. Four components that were not modeled by the Rev. 0 notebook are now modeled by the Rev. 1 notebook. All underestimates were eliminated. The two overestimates by three colors were eliminated. The number of matches was increased from 27.0%

to 45.9%. In addition, the Rev. 1 SDP notebook was improved from the Rev. 0 SDP notebook because it now incorporates plant-specific features of Summer.

Observations on the Licensee's PRA

The NRC team made the following observations on the licensee's PRA during the benchmarking visit:

1. The licensee's PRA does not credit the recovery of main feedwater. However, given a modification to allow bypass of FW isolation, the plant now has the capability to recover FW. Therefore, this recovery was credited in the worksheet for Transients (Reactor Trip) (TRANS).

2. A Westinghouse analysis (March 2003) for Summer indicated that a MAAP thermal-hydraulic analysis revealed that core damage will occur after failure of the function "Early Inventory, High Pressure Injection (EIHP)" for small LOCAs in the range of 1" to 2". Accordingly, the licensee models core damage after failure of EIHP.

3. Despite this Westinghouse analysis (March 2003), the licensee still credits a success path after SGTR and failure of EIHP. The NRC team considers that a SGTR is similar to a break in the range of 1" to 2", and therefore the SGTR event tree in the SDP notebook models core damage after failure of EIHP.

4. The licensee uses the charging/SI pumps for hot leg recirculation after a large LOCA.

5. The SDP notebook only models accumulators in large LOCA (LLOCA) based on generic review of 3-loop Westinghouse plants. The licensee only models accumulators in medium LOCA (MLOCA). Our understanding is that the licensee will model accumulators in LLOCA in the next PRA update.

6. The licensee does not model the operator refilling the RWST after a SGTR. However, the licensee's documentation regarding SGTR indicates that "...Recovery via EOP-4.3 would be used if the RWST were depleted below 55% level or if the ruptured SG is close to being overfilled (level greater than 96%). This recovery procedure would allow the operator to add water to the RWST while cooling down and depressurizing the RCS near saturation..." Therefore, credit to refilling the RWST is given in the SGTR worksheet.

7. The documentation provided by the licensee (document entitled "Core Damage Event Trees, DC00300-130, Rev. 0") on SGTR indicates that "...The RCS would also be depressurized (using either normal or auxiliary pressurizer spray or a PORV) to increase inventory and to minimize the break flow to the ruptured SG and the environment..." However, normal or auxiliary pressurizer spray are not modeled in the licensee's PRA to implement pressure equalization.

8. Main Steam Line Break Outside Containment (MSLB) event tree and worksheet. The licensee models terminating safety injection after successful isolation (closing at least 2/2 MSIVs), EIHP and EFW. This event represents the operator action to terminate SI prior to pressurizer overfill. Failure implies the operator is unsuccessful in terminating SI, which will

require mitigation of a PORV or safety valve LOCA using HPR. This scenario was added to the SDP's event tree and worksheet.

9. Main Steam Line Break Outside Containment (MSLB) event tree. The licensee does not model pressurized thermal shock (PTS) leading directly to core damage in either of the following two scenarios: 1) failure to close at least 2/3 MSIVs, or 2) the sequence of a) failure to close 1/3 MSIVs, b) operators failing to close the FW isolation valves feeding the SG whose MSIV did not close, and c) operators fail to stop high pressure injection.

10. The licensee estimated the frequency of the initiating event "Loss of Instrument Air (LOIA)" = 9.17E-2/year. This frequency is higher than the "generic" credit for this initiating event used in the notebooks of other plants of similar design.

11. After a loss of Instrument Air, the operator has to control EFW flow locally and locally gag close SW supply valves to CCW; these actions are proceduralized. The licensee does not include these actions in its PRA model. There are air accumulators providing air for 3 hours for both EFW flow control valves and SW supply valves to CCW (XVG0967QA and B).

12. Component Cooling Water (CCW) provides cooling to the charging pumps, to the RCPs' thermal barrier heat exchangers, to the RCPs' motor bearing oil coolers, and to the RHR. The RCP seals are cooled by either the charging pumps to seal injection or CCW to the thermal barrier heat exchanger. Hence, loss of CCW causes a loss of cooling to the RCP seals, which may cause a RCP seal LOCA. CCW is cooled by Service Water (SW). Loss of Service Water or loss of Component Cooling Water results in loss of cooling to CCW and the equipment cooled by CCW. The following points were noted for the licensee's modeling of loss of SW or loss of CCW:

    a) As mentioned in point 22, "Tripping the RCP on loss of CCW," of section 2.1 of the SDP notebook, "Generic Guidelines And Assumptions (PWRs)," upon loss of CCW, cooling to the RCPs' motor bearing oil coolers will be lost. The operation of RCPs without motor cooling could result in overheating and failure of bearings. Bearing failure, in turn, could cause the shaft to vibrate and thereby result in the potential for seal failure if the RCP is not tripped. In such cases, the operator is instructed to trip the RCPs early in the scenario (from 2 to 10 minutes after detecting the loss of cooling). Failure to perform this action is conservatively assumed to result in seal failure and, potentially, in a LOCA. The licensee does not model the operator tripping the RCPs on loss of cooling to the RCPs' motor bearing oil coolers.

    b) The licensee models RCP seal LOCA due to loss of cooling to the RCP seals, and calls it a consequential small LOCA. Different leak rates due to RCP seal LOCA are possible. The licensee's leak rates are: 21 gallons per minute (gpm) per pump (gpmpp) with probability = 0.843, 57 gpmpp with probability = 0.0437, 76 gpmpp with probability = 0.0332, 183 gpmpp with probability = 0.0513 and 480 gpmpp with probability = 0.0283.

    c) Once the RCP seal LOCA due to loss of cooling to the RCP seals has occurred, the licensee models it with an event tree that is the same as a "conventional" small LOCA. Since high-pressure injection (HPI) is required to mitigate a small LOCA, the licensee credits the recovery of the operators providing alternative cooling to the HPI pumps (using demineralized water or fire service water pumps) so that the HPI pumps are available to provide makeup to the vessel. If HPI is successful, the sequences of success in the licensee's event tree eventually require high-pressure- or low-pressure-recirculation. The issue with this modeling is that the RHR pumps also are unavailable due to the loss of CCW or loss of SW. Hence, recirculation is not available, the RCP seal LOCA cannot be mitigated, and core damage is expected to follow.

The team also noted that the licensee's model applies an event called CNU-8 to model seal LOCA. However, CNU-8 is tabulated and involves an AC recovery curve that is not applicable to normal losses of CCW.

d) The SDP notebook credits the recovery of the operators providing alternative cooling to the HPI pumps (using demineralized water or fire service water pumps) so that the HPI pumps are available to provide seal injection to prevent a RCP seal LOCA from occurring. The actions required must be performed outside of the control room, stress is expected to be high, and the time available for the operator to provide alternative cooling to the HPI pumps is short (about fifteen minutes). Therefore, the SDP notebook assigned a credit = 1E-1. The licensee estimated the human error probability (HEP) of operators failing to provide alternative cooling to the HPI pumps is of the order of 1E-3 because it is the product of the operator fails to establish demin water cooling to charging pumps (event OAAC1, HEP = 1E-2) and the conditional failure of operator fails to establish fire system cooling to these pumps (event OAAC2) after failure of OAAC1 (1.6E-1).

e) The licensee's frequency of total loss of SW is 2.96E-5/year. The NRC staff pointed out that this value appears to be low compared to the "generic" frequency presented in NUREG/CR-5750, which is 9.7E-4/year. The comment was also made that fouling of the SW is one of the most likely ways to loose SW, and this mechanism is not taken into account in the licensee's evaluation of the frequency of loss of SW. Taking into account external impacts, such as bio-fouling, was also mentioned. The SDP notebook currently uses the licensee's frequency of loss of SW.

13. Four (4) out of the 41 hypothetical findings evaluated during the benchmarking visit are not modeled in the licensee's PRA. These 4 findings are: one fuel oil transfer pump fails to run, one pressurizer safety valve fails to open, pressurizer spray fails, and operator fails to provide a long-term RCS makeup source (such as refilling the RWST). The outcomes of the SDP evaluations of these 4 findings are included in Table 1, but they are not included in Table 2 because they could not be compared with results from the licensee's PRA.

Discussion of Non-conservative Results by the Notebook

The Rev. 1 notebook yielded no underestimates.

Discussion of Conservative Results by the Notebook

The Rev. 1 notebook produced 20 overestimates, 1 by five orders of magnitude, 8 by two orders of magnitude, and 11 overestimates by one order of magnitude. The overestimate by five orders of magnitude is the (normal) battery charger of Safeguards Power 125 VDC bus A fails. The licensee's PRA obtained green, and the notebook yielded red (2). This difference is because of different assumptions in treating this failure by the notebook and the licensee. There is one battery charger in each DC bus and one swing battery charger that can be manually connected. A failure of a battery charger activates an alarm in the control room. Hence, the licensee considers that the failure of the charger would not cause the loss of its associated DC bus because corrective actions can be taken before this loss and therefore a limited exposure period. On the other hand, the current SDP evaluation rules assume that without the battery charger the associated battery will discharge under normal loads and result in a loss of the DC bus, and require that each worksheet specified by Table 2 (of the notebook) for the equipment powered by the affected DC train to be solved considering this equipment unavailable.

The 8 overestimates by two orders of magnitude are: one diesel-driven air compressor fails to start, one SG safety valve fails to open, one SG PORV fails to open, one MSIV fails to close, one pressurizer PORV fails to close, one running SW pump fails to run, diesel-driven fire pump fails to start, and demineralized water pump XPP-71A fails to run. They are discussed next.

One diesel-driven air compressor fails to start. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). This compressor is credited by the notebook to mitigate a loss of Instrument Air (LOIA). However, the licensee's current PRA does not credit this compressor to mitigate a LOIA. Therefore, this compressor becomes more important in the SDP notebook.

One SG safety valve fails to open. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). The SG safety valves are used for steam relief from the SGs. Since there is ample redundancy to satisfy this function, the licensee's model gives green for the loss of a single SG safety valve. On the other hand, the current SDP evaluation requires counting the base case of every sequence where this valve appears. Thus, while all these sequences are of value 6 or less, the counting rule used by the current SDP evaluation produces a yellow.

One SG PORV fails to open. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). The SG PORVs are used for depressurization and for steam relief from the SGs. Similar to the case of one SG safety valve, the plant has redundancy to satisfy these functions, so the licensee's model gives green for the loss of a single SG PORV. On the other hand, the current SDP evaluation requires, by the usage rules in NRC manual Chapter 0609, counting the base case of every sequence where this valve appears. Thus, while all these sequences are of value 6 or less, the counting rule used by the current SDP evaluation produces a yellow.

One MSIV fails to close. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). The cause of the overestimate by two colors of one MSIV failing to close is that the SDP notebook considers that pressurized thermal shock (PTS) occurs if more than one MSIV fails to close after an MSLB, while the licensee's PRA model does not include PTS due to MSIV failures.

One pressurizer PORV fails to close. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). Our evaluation using the SDP notebook considers that this failure causes the initiating event "Stuck-open PORV (SORV)," resulting in yellow. The licensee informed us during the benchmarking visit that this failure does not cause an initiating event in its PRA. A review of the licensee's dominant cutsets indicates that the licensee's PRA models one pressurizer PORV failing to close after an ATWS triggered by a transient (such as turbine trip). The most dominant cutset with this scenario has a frequency = 3.0E-11/year. Hence, the difference in resulting colors from the licensee's PRA and the notebook is due to this difference in modeling.

One running SW pump fails to run. The licensee's PRA obtained yellow, and the notebook yielded red (3) (over by 2). As mentioned before, the licensee's PRA and the SDP notebook model the recovery of the operators providing alternative cooling to the HPI pumps (using demineralized water or fire service water pumps) so that the HPI pumps are available. The main reason for the difference between the color obtained by the licensee's PRA and the one yielded by the notebook is that there is a difference of about two orders of magnitude between the "credit" given by these two models to this recovery. The SDP notebook assigned a credit = 1E-1, and the licensee estimated a HEP of the order of 1E-3 because it is the product of the operator fails to establish demin water cooling to charging pumps (event OAAC1, HEP = 1E-2) and the conditional failure of operator fails to establish fire system cooling to these pumps (event OAAC2) after failure of OAAC1 (1.6E-1).

Diesel-driven fire pump fails to start. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). This pump is used in scenarios of loss of cooling from the CCW to the thermal barrier of the RCPs and to the charging pumps. In the notebook model, the diesel-driven fire pump can be used to provide alternative cooling to the charging pumps before an RCP seal LOCA occurs. As described above, the main reason for the difference between the color obtained by the licensee's PRA and the one yielded by the notebook is that there is a difference of about two orders of magnitude between the "credit" given by these two models to this recovery. The SDP notebook assigned a credit = 1E-1, and the licensee estimated a HEP of the order of 1E-3.

Demineralized water pump XPP-71A fails to run. The licensee's PRA obtained green, and the notebook yielded yellow (over by 2). The reason for this difference is identical to the one for the diesel-driven fire pump fails to start. Please see the explanation above.

The 11 overestimates by one order of magnitude are: Safeguards Power 125 VDC bus A fails, Safeguards Power 125 VDC bus B fails, battery of Safeguards Power 125 VDC bus A fails, running CCW pump fails, MDEFW pump A fails to run, MDEFW pump B fails to run, one pressurizer PORV fails to open, one primary PORV block valve fails to close, spare SW pump C fails to start, operator fails to carry out pressure equalization after SGTR, and operator fails to conduct emergency boration (after ATWS).

The reasons causing the overestimates by one color were not further investigated per the benchmarking process for this kind of estimate. However, some of the issues identified in the section entitled "Observations on the Licensee's PRA" of this report may be contributing to these overestimates.

Changes Incorporated Following Benchmarking Resulting in Updating of Benchmarking Results

No changes were incorporated following benchmarking that resulted in updating of benchmarking results.

Table 1 Summary of Benchmarking Results for Summer

Internal Events CDF is 4.74E-5/year (excluding internal floods), at a truncation limit of 1.0E-11/year.
RAW Thresholds are White = 1.02, Yellow = 1.21, Red (4) = 3.11, and Red (3) = 22.10

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) [(1)]	Basic Event Name	Internal RAW	Plant CDF Color [(2)]	SDP Worksheet Results (After) [(1)]	Comments
	Component						
1	Bus A of Safeguards Power 7.2 KV fails	Red (3) (match)	AABS--XSW1DAOP	38.84	Red (3)	Red (3) (match)	
2	Diesel generator A fails to start	Yellow (under by 1)	AADG-----DGAFS	5.36	Red (4)	Red (4) (match)	
3	One fuel oil transfer pump fails to run	White (not modeled)	Licensee does not model in current PRA			White (not modeled)	
4	Safeguards Power 125 VDC bus A fails	Red (4) (under by 1)	Run carried out by licensee	38.09	Red (3)	Red (2) (over by 1)	
5	Safeguards Power 125 VDC bus B fails	Red (4) (match)	Run carried out by licensee	13.89	Red (4)	Red (3) (over by 1)	
6	Battery of Safeguards Power 125 VDC bus A fails	Red (4) (under by 1)	Run carried out by licensee	38.09	Red (3)	Red (2) (over by 1)	The licensee indicated that it was not sure that a battery charger had the capacity to start (and carry) the emergency loads without the battery on an Safety Injection (SI) signal. Accordingly, we used the RAW for the DC bus A.

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
7	(Normal) battery charger of Safeguards Power 125 VDC bus A fails	Red (4) (over by 3)	RABCI--XBC1AFA	1.0	Green	Red (2) (over by 5)	Battery charger XBC1A fails during operation
8	One accumulator fails	Green (under by 2)	NACVXVC8956AFO	1.3	Yellow	Yellow (match)	We used outlet check valve fails to open as surrogate.
9	Running CCW pump fails	Red (4) (over by 1)	Run carried out by licensee	2.79	Yellow	Red (4) (over by 1)	The licensee's model assumes that the 'A' train is running and the 'B' train is in standby. The 'C' CCW pump is aligned to backup the 'A' train so the 'A' pump's RAW is lower than the 'B' train pump.
10	'A' Charging/SI pump Fails to run	Red (4) (match)	Run carried out by licensee	3.41	Red (4)	Red (4) (match)	
11	Swing charging pump 'C' Fails to run	Yellow (under by 1)	Run carried out by licensee	3.45	Red (4)	Red (4) (match)	
12	One boric acid transfer pump fails	White (over by 1)	Run carried out by licensee	1.0	Green	Green (match)	
13	MDEFW pump A Fails to run	Yellow (match)	DAPM--XPP21AFR	1.96	Yellow	Red (4) (over by 1)	
14	MDEFW pump B Fails to run	Yellow (match)	DBPM--XPP21BFR	2.47	Yellow	Red (4) (over by 1)	
15	Turbine driven EFW pump Fails to run	Red (4) (match)	DBPT----XPP8FR	3.67	Red (4)	Red (4) (match)	

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) [1]	Basic Event Name	Internal RAW	Plant CDF Color [2]	SDP Worksheet Results (After) [1]	Comments
16	One motor-driven air compressor fails to start	White (match)	XCCM---XAC12FS	1.12	White	White (match)	Compressor XAC-12 fails to start
17	One diesel-driven air compressor fails to start	Yellow (over by 2)	XDCM--DIESELFS	1.00	Green	Yellow (over by 2)	This compressor is not credited to mitigate LIA in the licensee's current model.
18	One SG safety valve fails to open	Yellow (over by 2)	Run carried out by licensee	1.0	Green	Yellow (over by 2)	
19	One SG PORV fails to open	Yellow (over by 2)	Run carried out by licensee	1.00	Green	Yellow (over by 2)	
20	One MSIV fails to close	Yellow (over by 2)	EAAVXVM2801AFC	1.00	Green	Yellow (over by 2)	Licensee does not model PTS.
21	One pressurizer PORV fails to open	Yellow (over by 1)	WAAVPCV445ATFO	1.03	White	Yellow (over by 1)	Pressurizer PORV PCV-00445A-RC fails to open due to local fault
22	One pressurizer PORV fails to close	White (over by 1)	WAAVPCV0445AFC	1.00	Green	Yellow (over by 2)	Pressurizer PORV PCV-00445A-RC fails to reclose due to local faults (licensee does not model as IE)
23	One primary PORV block valve fails to close	White (over by 1)	Run carried out by licensee	1.00	Green	White (over by 1)	
24	One pressurizer safety valve fails to open	White (not modeled)	Not modeled			White (not modeled)	

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) [1]	Basic Event Name	Internal RAW	Plant CDF Color [2]	SDP Worksheet Results (After) [1]	Comments
25	Pressurizer spray fails	White (not modeled)	Not modeled			White (not modeled)	
26	One RHR/LHSI pump fails to run	Red (4) (over by 1)	GBPMXPP0031BFR	2.03	Yellow	Yellow (match)	
27	One containment sump valve fails to open	Red (4) (over by 1)	IAMVXVG8811AFO	2.93	Yellow	Yellow (match)	
28	One piggyback valve fails to open	Yellow (match)	GAMVXVG8706AFO	1.35	Yellow	Yellow (match)	
29	One running SW pump fails to run	Red (3) (over by 2)	Run carried out by licensee	1.30	Yellow	Red (3) (over by 2)	SW pump XPP-45A fails to run
30	Spare SW pump C fails to start	Red (4) (over by 1)	Run carried out by licensee	2.56	Yellow	Red (4) (over by 1)	
31	AMSAC fails to trip turbine	Not modeled by SDP notebook	AMS_1	1.07	White	White (match)	
32	RWST Level Transmitters fail high (mis cal)	Red (2) (over by 1)	Q-SIRWSTLOLOFA	74.29	Red (3)	Red (3) (match)	
33	Diesel-driven fire pump fails to start	Not modeled by SDP notebook	ASDXPP134BFS	1.01	Green	Yellow (over by 2)	
34	Demineralized water pump XPP-71A fails to run	Not modeled by SDP notebook	ASC--XPP71AFR	1.01	Green	Yellow (over by 2)	
	Operator Actions						
35	Operator fails to carry out Feed/Bleed during SLOCA and SGTR	Red (4) (over by 3)	OAB1HCD	1.0	Green	Green (match)	

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
36	Operator fails to switchover for high pressure recirculation	Red (4) (match)	OAR4	8.57	Red (4)	Red (4) (match)	
37	Operator fails to switchover for low pressure recirculation	Red (3) (match)	OAR2	67.11	Red (3)	Red (3) (match)	non-LLOCA
38	Operator fails to carry out pressure equalization after SGTR	Red (4) (over by 1)	OAD_1	2.13	Yellow	Red (4) (over by 1)	
39	Operator fails to provide a long-term RCS makeup source (such as refilling the RWST)	Yellow (not modeled)	Not modeled by licensee			Yellow (not modeled)	
40	Operator fails to conduct emergency boration (after ATWS)	White (over by 1)	Run carried out by licensee (event OAE_1)	1.00	Green	White (over by 1)	
41	Operator fails to align alternative cooling to a charging pump	Not modeled by SDP notebook	OAAC1 and OAAC2 and OAAC_C	5.71	Red (4)	Red (4) (match)	

Notes:

1. When the color of the result of the SDP notebook is red, the number in parenthesis after the word “Red” is the order of magnitude yielded by the SDP notebook.

2. When the color corresponding to the plant’s CDF is red, the number in parenthesis after the word “Red” is the order of magnitude obtained from the following calculation: (Base-case CDF) * RAW.

Table 2: Comparative Summary of the Benchmarking Results

SDP Notebook is...	SDP Notebook Before (Rev. 0)		SDP Notebook After (Rev. 1)	
	Number of Cases	Percentage	Number of Cases	Percentage
Not modeled by notebook	4	10.8	0	0.0
Less conservative by two colors	1	2.7	0	0.0
Less conservative by one color	4	10.8	0	0.0
More conservative by one color	11	29.7	11	29.7
More conservative by two colors	5	13.5	8	21.6
More conservative by three colors	2	5.4	0	0.0
More conservative by four colors	0	0.0	0	0.0
More conservative by five colors	0	0.0	1	2.7
Matched	10	27.0	17	45.9
Total	37	99.9 (1)	37	99.9 (1)

Note:

1. The total percentage is not exactly 100.0 due to roundoff error.

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 V. C. Summer Nuclear 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. Table 1. Moved "Loss of Service Water (LSSW)" from row VI to row V because the licensee's updated frequency for this loss is 2.96E-5/year.

2. Table 1. Loss of Instrument Air (LOIA) has a frequency = 9.175E-2/reactor-year. It was moved from row II to row I after the benchmarking on May 20-22, 2003.

3. Table 1. Added footnote indicating that the loss of one 125 VDC Vital bus has a frequency of about 8.8E-4/year. Since this frequency is close to the upper end of range IV, it was moved from row IV to row III during the benchmarking on May 20-22, 2003.

4. Table 2. Modified footnote indicating that the Summer PRA is an internal events only PRA. The internal events (excluding internal flood) core damage frequency (CDF) is 4.74E-5/year at a truncation limit of 1.0E-11/year. Seismic events are not incorporated into the Summer PRA at present. However, the licensee considers that seismic is not a large contributor to risk. A seismic margins analysis was performed for the IPEEE. Also, a Probabilistic Seismic Hazard Evaluation was performed. High winds, external floods and transportation accidents are not incorporated into the Summer IPEEE. The licensee stated that the evaluation performed for Generic Letter 88-20, Supplement 4, shows that the risk posed by these potential initiating events is very small. Fire is not incorporated into the Summer PRA model. An addendum study was performed for the IPEEE RAI response. The addendum study is the latest fire risk analysis for Summer.

5. Table 2. Added footnote indicating that a loss of a 7.2 KV-AC bus of the Safeguards Power System does not cause a plant trip. Technical Specifications require shutdown in 8 hours.

6. Table 2. Added row for "ATWS Mitigating System Actuation Circuitry (AMSAC)," including the columns for "Major Components," "Support Systems," and "Initiating Event Scenarios."

7. Table 2. Added note indicating that the three pumps of CCW are configured in two split loops.

8. Table 2. Added footnote indicating that the three CCW booster pumps provide cooling for the RCPs' thermal barrier. They are powered by non-safety AC power.

9. Table 2. Added footnote indicating that backup cooling to any of the three charging/SI pumps can be provided by 1) demineralized water, 2) fire service water, and 3) chilled water. The licensee does not give credit in its PRA model to backup cooling provided by chilled water.

10. Table 2. Changed the number of boric acid transfer pumps from 1 to 2.

11. Table 2. Added footnote indicating that the capacity of CST is 500,000 gallons. 180,000 gallons are reserved for EFW.

12. Table 2. Added footnote indicating that the flow control valves of the EFW are powered from 125 VDC.

13. Table 2. Added row for "Fire Service Water," including the columns for "Major Components," "Support Systems," and "Initiating Event Scenarios."

14. Table 2. Split the row for "Instrument Air (IA)" into four rows, one row for each of the two motor-driven air compressors, one row for the motor-driven breathing-air compressor, and one row for the diesel-driven air compressor (Sullair). The specific support systems for each compressor were added.

15. Table 2. Added footnote indicating that the SG PORVs have accumulators as backup and can be manually opened.

16. Table 2. Added footnote indicating that two SG PORVs are powered by DC bus A, and one SG PORV is powered by DC bus B.

17. Table 2. Added footnote indicating that there is one PORV and one atmospheric steam dump valve per SG. The SG PORV is upstream of the MSIV, and the atmospheric steam dump valve is downstream of the MSIV.

18. Table 2. Added Fuel oil transfer pumps as support system of the "Onsite Standby Power System." Added footnote indicating that there are two 100% capacity fuel oil transfer pumps for each EDG. The fuel oil day tank capacity is 550 gallons. The day tank will provide 90 minutes of EDG run time at full load.

19. Table 2. Added footnote indicating that the primary PORVs fail closed on loss of air or DC power.

20. Table 2. Added footnote indicating that two primary PORVs are powered by DC bus A, and one primary PORV is powered by DC bus B.

21. Table 2. Modified footnote indicating that the primary PORVs are air-operated and fail closed. Two PORVs (PCV-445A and PCV-444B) have a tank of air as a backup supply that permits up to six valve strokes for each PORV. Feed and bleed can be done by opening the PORVs once, and then keeping them open.

22. Table 2. Added footnote indicating that primary block valves A and C are powered from safeguards 7.2 KV-AC bus B, and primary block valve B is powered from safeguards 7.2 KV-AC bus A.

23. Table 2. Added "Pressurizer auxiliary spray," including the columns for "Support Systems," and "Initiating Event Scenarios."

24. Table 2. Added "Pressurizer normal spray," including the columns for "Support Systems," and "Initiating Event Scenarios."

25. Table 2. Added footnote indicating that the licensee's current PRA models "unqualified" (old) RCP seals.

26. Table 2. Added row for "Reactor Makeup Pumps," including the columns for "Major Components," "Support Systems," and "Initiating Event Scenarios."

27. Table 2. Added row for "Reactor Water Storage Tank (RWST)," including the columns for "Major Components," "Support Systems," and "Initiating Event Scenarios." Added footnote indicating that the useable capacity of the RWST is 450,000 gallons. Technical specification 3.5.4 requires a minimum contained borated water volume of 453,800 gallons. The conservative value for useable water volume can be estimated to be 443,939 gallons.

28. Table 2. Revised the column "Initiating Event Scenarios" for all systems/components in Table 2 according to the changes to the dependencies and to the worksheets, as described in this section.

29. All worksheets using the function "High Pressure Recirculation (HPR)." Changed the credit to "operator action = 2" because the licensee's human error probability (HEP) = 1.5E-2. Added footnote with this information.

30. Transients (Reactor Trip) (TRANS) worksheet. Added footnote indicating that the licensee's PRA does not credit the recovery of main feedwater. However, given a modification to allow bypass of FW isolation, the plant now has the capability to recover FW. Accordingly, this worksheet gives credit to this recovery. We gave a minimum credit of "operator action = 1" to this recovery.

31. Transients (Reactor Trip) (TRANS) worksheet. Removed the steam relief path from the steam generators because this worksheet now credits the PCS.

32. Small LOCA (SLOCA) event tree and worksheet. A Westinghouse analysis (March 2003) for Summer indicated that a MAAP thermal-hydraulic analysis revealed that core damage will occur after failure of the function "Early Inventory, High Pressure Injection (EIHP)" for small LOCAs in the range of 1" to 2". Accordingly, the licensee models core damage after failure of EIHP. Therefore, removed from the event tree the sequences of success after failure of EIHP, and modified the sequences in the worksheet accordingly. Added footnote with this information.

33. Small LOCA (SLOCA) worksheet. Changed the credit for the function "RCS Cooldown/Depressurization (DEP)" to "operator action = 2" because the licensee assessed a HEP = 5.1E-3. Added footnote with this information.

34. Small LOCA (SLOCA) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as “[(1/5 SG safety valves or 1/1 steam generator PORV or 1/1 atmospheric dump valve) per SG or 1/2 condenser dump valves].”

35. Stuck-open PORV (SORV) event tree and worksheet. A Westinghouse analysis (March 2003) for Summer indicated that a MAAP thermal-hydraulic analysis revealed that core damage will occur after failure of the function “Early Inventory, High Pressure Injection (EIHP)” for small LOCAs in the range of 1" to 2". Accordingly, the licensee models core damage after failure of EIHP. Therefore, removed from the event tree the sequences of success after failure of EIHP, and modified the sequences in the worksheet accordingly. Added footnote with this information.

36. Stuck-open PORV (SORV) worksheet. Changed the credit for the function “RCS Cooldown/Depressurization (DEP)” to “operator action = 2” because the licensee assessed a HEP = 5.1E-3. Added footnote with this information.

37. Stuck-open PORV (SORV) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as “[(1/5 SG safety valves or 1/1 steam generator PORV or 1/1 atmospheric dump valve) per SG or 1/2 condenser dump valves].”

38. Medium LOCA (MLOCA) event tree and worksheet. Modified the tree to require the function “RCS Cooldown/Depressurization (DEP)” after success of the function “Early Inventory, High Pressure Injection (EIHP)” to reach the conditions for the function “Low Pressure Recirculation (LPR).” On failure of DEP after successful EIHP, the function “High Pressure Recirculation (HPR)” is asked. The sequences in the worksheet were modified accordingly.

39. Medium LOCA (MLOCA) worksheet. Changed the credit for the function “RCS Cooldown/Depressurization (DEP)” to “operator action = 2” because the licensee assessed a HEP = 5.1E-3. Added footnote with this information.

40. Large LOCA (LLOCA) event tree and worksheet. Removed the function “Early Inventory, High Pressure Injection (EIHP)” from the event tree, and the sequences in the worksheet were modified accordingly.

41. Large LOCA (LLOCA) worksheet. The original function “Early Inventory, Low Pressure Injection (LPI)” was divided into two functions to give appropriate credit to the accumulators and the RHR trains: “Accumulators (ACCUM)” with a credit of “2/2 remaining accumulators (1 train)” and “Low Pressure Injection (LPI)” with a credit of “1/2 RHR trains (1 multi-train system).”

42. Large LOCA (LLOCA) worksheet. Added footnote indicating that the licensee uses the charging/SI pumps for hot leg recirculation.

43. Loss of Offsite Power (LOOP) worksheet. Added footnote indicating that the licensee assessed a probability of failure to recover AC power within 1 hour = 3.68E-1.

44. Loss of Offsite Power (LOOP) worksheet. Changed the credit for the function “Recovery of AC Power in < 5 Hrs (REC5)” to “operator action = 1” because the licensee assessed a

probability of failure to recover AC power within 4 hours = 1.83E-1, conditional on failing to recover AC power within 1 hour. Added footnote with this information.

45. Steam Generator Tube Rupture (SGTR) event tree and worksheet. A Westinghouse analysis (March 2003) for Summer indicated that a MAAP thermal-hydraulic analysis revealed that core damage will occur after failure of the function “Early Inventory, High Pressure Injection (EIHP)” for small LOCAs in the range of 1" to 2". However, the licensee still credits a success path after SGTR and failure of EIHP. The SDP event tree considers that a SGTR is similar to a break in this range. Therefore, removed from the event tree the sequences of success after failure of EIHP, and modified the sequences in the worksheet accordingly. Added footnote with this information.

46. Steam Generator Tube Rupture (SGTR) worksheet. Changed the success criteria of the function “Long-Term RCS Makeup Source (LTMS)” to “Operator refills RWST using 1/2 reactor makeup pumps and 1/2 boric acid transfer pumps.” Added footnote indicating that the licensee does not model the operator refilling the RWST. However, the licensee’s documentation regarding SGTR indicates that “...Recovery via EOP-4.3 would be used if the RWST were depleted below 55% level or if the ruptured SG is close to being overfilled (level greater than 96%). This recovery procedure would allow the operator to add water to the RWST while cooling down and depressurizing the RCS near saturation...” Therefore, credit to refilling the RWST is given in this worksheet with a credit = 1.

47. Steam Generator Tube Rupture (SGTR) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as “[(1/5 associated SG safety valves or 1/1 steam generator PORV or 1/1 atmospheric dump valve) per steam line not connected to damaged SG or 1/2 condenser dump valves].”

48. Anticipated Transients Without Scram (ATWS) worksheet. Changed the success criteria of the function “Emergency Boration (EMBO)” to “Operator conducts emergency boration using 1/2 charging pumps trains with 1/2 boric acid transfer pumps.”

49. Anticipated Transients Without Scram (ATWS) worksheet. Changed the credit for the function “Secondary Heat Removal (EFW)” to “1 ASD train” because the success criteria for this function is “2/2 MDPs of EFW with 1/1 TDP of EFW.” Updated the numerical value of the credit in the sequence that uses the function EFW.

50. Anticipated Transients Without Scram (ATWS) worksheet. Added the steam relief path in the function “Secondary Heat Removal (EFW)” as “1/5 SG safety valves on 3/3 SGs.”

51. Main Steam Line Break Outside Containment (MSLB) event tree and worksheet. The licensee models terminating safety injection after successful isolation (closing at least 2/2 MSIVs), EIHP and EFW. This event represents the operator action to terminate SI prior to pressurizer overfill. Failure implies the operator is unsuccessful in terminating SI, which will require mitigation of a PORV or safety valve LOCA using HPR. This scenario was added to the SDP’s event tree and worksheet. Added footnote with his information.

52. Main Steam Line Break Outside Containment (MSLB) worksheet. Changed the credit for the function “Stop Injection (STIN)” to “operator action = 2” because the licensee’s HEP = 5.2E-3. Added footnote with this information.

53. Main Steam Line Break Outside Containment (MSLB) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as "(1/5 SG safety valves or 1/1 steam generator PORV) per SG."

54. Loss of Instrument Air (LOIA) worksheet. Changed the credit for the function "Secondary Heat Removal (EFW)" to "operator action = 2" because the operator has to control EFW flow locally and locally gag close SW supply valves to CCW; these actions are proceduralized. The licensee does not include these actions in its PRA model. Since there are air accumulators providing air for 3 hours for both EFW flow control valves and SW supply valves to CCW (XVG0967QA and B), we consider that these actions have a credit = 2. Added footnote with this information.

55. Loss of Instrument Air (LOIA) worksheet. Added footnote indicating that the primary PORVs are air-operated and fail closed. Two PORVs (PCV-445A and PCV-444B) have a tank of air as a backup supply that permits up to six valve strokes for each PORV. Feed and bleed can be done by opening the PORVs once, and then keeping them open.

56. Loss of Instrument Air (LOIA) worksheet. Added footnote indicating that the licensee's HEP for the function "Operator Starts Backup Source of IA (OAA)" = 1.0E-2. Hence, this action has a credit = 2.

57. Loss of Instrument Air (LOIA) worksheet. Added footnote indicating that the steam admission valve (IFV2030) of the turbine-driven pump of EFW is an air operated valve with DC solenoids supplied from either DC train. It has a slow opening feature to admit steam slowly to prevent overspeed of this pump. On loss of instrument air or DC it would fail open.

58. Loss of Instrument Air (LOIA) worksheet. Modified footnote indicating that the initiating event Loss of Instrument Air (LOIA) has a frequency = 9.17E-2/year. Since this frequency is close to the upper end of range II of Table 1, it was assigned a credit = 1 during the benchmarking on May 20-22, 2003.

59. Loss of Instrument Air (LOIA) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as "(1/5 SG safety valves or 1/1 SG PORV) per SG."

60. Loss of Service Water (LSSW) event tree and worksheet. Developed a new event tree with just one successful sequence comprised of three functions: "RCP Trip (RCPT)," "Operator Provides Alternative Cooling (COOL)," and "Secondary Heat Removal (EFW)." Failure of any of these functions causes core damage.

61. Loss of Service Water (LSSW) worksheet. Changed the credit of the initiating event because the licensee's updated frequency for this event is 2.96E-5/year. Added footnote indicating that the frequency of total loss of SW is 2.96E-5/year. Service water provides cooling to CCW which, in turn, provides cooling to the charging pumps, to the RCPs' thermal barrier heat exchangers, to the RCPs' motor bearing oil coolers, and to the RHR. The operators have to trip the RCPs in less than 3 minutes after loss of cooling to the RCPs' motor bearing oil coolers to avoid a RCP seal LOCA. If this action fails, it is considered that core damage follows. Backup cooling to any of the three charging/SI pumps can be provided by 1) demineralized water, 2) fire service water, and 3) chilled water. The licensee does not give credit in its PRA model to backup cooling provided by chilled water. Backup cooling to any of the three charging/SI pumps has to be provided within fifteen minutes after loss of RCP

seal cooling to prevent a RCP seal LOCA. If backup cooling fails and this LOCA occurs, core damage follows because the RHR system is not available to provide recirculation.

62. Loss of Service Water (LSSW) worksheet. Added footnote indicating that since the actions required to provide alternative cooling to the HPI pumps must be performed outside of the control room, stress is expected to be high, and the time available for the operator to provide alternative cooling to the HPI pumps is short (about fifteen minutes), we assigned a credit = 1.

63. Loss of Service Water (LSSW) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as "[(1/5 SG safety valves or 1/1 steam generator PORV or 1/1 atmospheric dump valve) per SG or 1/2 condenser dump valves]."

64. Loss of Component Cooling Water (LCCW) event tree and worksheet. Developed a new event tree with just one successful sequence comprised of three functions: "RCP Trip (RCPT)," "Operator Provides Alternative Cooling (COOL)," and "Secondary Heat Removal (EFW)." Failure of any of these functions causes core damage.

65. Loss of Component Cooling Water (LCCW) worksheet. Added footnote indicating that the frequency of total loss of CCW is 1.32E-4/year. CCW provides cooling to the charging pumps, to the RCPs' thermal barrier heat exchangers, to the RCPs' motor bearing oil coolers, and to the RHR. The operators have to trip the RCPs in less than 3 minutes after loss of cooling to the RCPs' motor bearing oil coolers to avoid a RCP seal LOCA. If this action fails, it is considered that core damage follows. Backup cooling to any of the three charging/SI pumps can be provided by 1) demineralized water, 2) fire service water, and 3) chilled water. The licensee does not give credit in its PRA model to backup cooling provided by chilled water. Backup cooling to any of the three charging/SI pumps has to be provided within fifteen minutes after loss of RCP seal cooling to prevent a RCP seal LOCA. If backup cooling fails and this LOCA occurs, core damage follows because the RHR system is not available to provide recirculation.

66. Loss of Component Cooling Water (LCCW) worksheet. Added footnote indicating that since the actions required to provide alternative cooling to the HPI pumps must be performed outside of the control room, stress is expected to be high, and the time available for the operator to provide alternative cooling to the HPI pumps is short (about fifteen minutes), we assigned a credit = 1.

67. Loss of Component Cooling Water (LCCW) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as "[(1/5 SG safety valves or 1/1 steam generator PORV or 1/1 atmospheric dump valve) per SG or 1/2 condenser dump valves]."

68. Split the worksheet for "Loss of One 125 VDC Vital Bus (LBDC)" into two worksheets for "Loss of 125 VDC Vital Bus A (LDCA)" and "Loss of 125 VDC Vital Bus B (LDCB)" because each of these two losses has a different impact on the plant.

69. Loss of 125 VDC Vital Bus A (LDCA) worksheet. Added footnote indicating that the loss of 125 VDC Vital bus A has a frequency = 8.79E-4/year. Since this frequency is close to the upper end of range IV of Table 1, it was assigned a credit = 3 during the benchmarking on May 20-22, 2003. The following conditions result from the loss of bus 1HA:

Only the train of safeguards equipment aligned to DC bus 1HB would be operable.
The EFW turbine-driven pump will autostart on a signal from train B.
Steam dump to condenser and atmospheric dump valves are not available (MSIVs are closed).
Two steam generator PORVs lose DC power. The operator can open them using local manual control, but this recovery action is not credited here.
Two pressurizer PORVs are inoperable (fail closed).
Since two pressurizer PORVs are inoperable, feed and bleed cannot be implemented. EFW is the only way to remove decay heat.

70. Loss of 125 VDC Vital Bus A (LDCA) worksheet. Added footnote indicating that the steam admission valve (IFV2030) of the turbine-driven pump of EFW is an air operated valve with DC solenoids supplied from either DC train. It has a slow opening feature to admit steam slowly to prevent overspeed of this pump. On loss of instrument air or DC it would fail open. There are no other steam valves to (or from) this pump with a DC power dependency.

71. Loss of 125 VDC Vital Bus B (LDCB) worksheet. Added footnote indicating that the loss of 125 VDC Vital bus B has a frequency = 8.80E-4/year. Since this frequency is close to the upper end of range IV of Table 1, it was assigned a credit = 3 during the benchmarking on May 20-22, 2003. The following conditions result from the loss of bus B:
Only the train of safeguards equipment aligned to DC bus A would be operable.
The EFW turbine-driven pump will autostart on a signal from train A.
Steam dump to condenser and atmospheric dump valves are not available (MSIVs are closed).
One steam generator PORV loses DC power. The operator can open it using local manual control, but this recovery action is not credited here.
One pressurizer PORV is inoperable (fails closed).
The event tree for Loss of 125 VDC Vital Bus B (LDCB) is the same as the one for Transients Without PCS (TPCS).

72. Loss of 125 VDC Vital Bus B (LDCB) worksheet. Added footnote indicating that the steam admission valve (IFV2030) of the turbine-driven pump of EFW is an air operated valve with DC solenoids supplied from either DC train. It has a slow opening feature to admit steam slowly to prevent overspeed of this pump. On loss of instrument air or DC it would fail open. There are no other steam valves to (or from) this pump with a DC power dependency.

73. LOOP with Loss of One Division of AC (LEAC) event tree and worksheet. A Westinghouse analysis (March 2003) for Summer indicated that a MAAP thermal-hydraulic analysis revealed that core damage will occur after failure of the function “Early Inventory, High Pressure Injection (EIHP)” for small LOCAs in the range of 1" to 2". Accordingly, the licensee models core damage after failure of EIHP. Therefore, removed from the event tree the sequences of success after failure of EIHP, and modified the sequences in the worksheet accordingly. Added footnote with this information.

74. LOOP With Loss of One Division of AC (LEAC) worksheet. Modified footnote indicating that on Loss of One Division of AC, one train of safeguard equipment is unavailable. The pressurizer PORVs’ block valves are powered by 480 VAC. Block valves A and C are powered from safeguards 7.2 KV-AC bus B, and block valve B is powered from safeguards 7.2 KV-AC bus A. After a Loss of One Division of AC, at least one of the three block valves cannot be closed to isolate a pressurizer PORV that fails to close.

75. LOOP With Loss of One Division of AC (LEAC) worksheet. Added footnote indicating that the LEAC initiator and worksheet apply to loss of either bus A or B. Feed/Bleed (FB) is credited because one PORV is stuck open, initially there is DC power from the batteries to operate the remaining PORVs, and continued operation of one PORV would be sufficient for FB after battery depletion.

76. LOOP With Loss of One Division of AC (LEAC) worksheet. For the sake of clarity, re-arranged the success criteria of the steam relief from the steam generators as "(1/5 SG safety valves or 1/1 steam generator PORV or 1/1 atmospheric dump valve) per SG."

77. Interfacing System LOCA (ISLOCA) worksheet. Added to the worksheet the 4 significant plant-specific ISLOCA flow paths identified by the IPE's ISLOCA analysis. Added footnote with this information.

78. Interfacing System LOCA (ISLOCA) worksheet. Added footnote indicating that the suction lines of the Residual Heat Removal System are considered by the licensee to be the pathway with the most severe ISLOCA due to its effect on the long-term heat removal capability of the plant.

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:

3.3 Generic Change to the SDP Notebook

No generic change to the SDP notebook was identified.

4. Discussion on External Events

The Summer PRA is an internal events only PRA. The internal events (excluding internal flood) core damage frequency (CDF) is 4.74E-5/year at a truncation limit of 1.0E-11/year.

Seismic events are not incorporated into the Summer PRA at present. However, the licensee considers that seismic is not a large contributor to risk. A seismic margins analysis was performed for the IPEEE. Also, a Probabilistic Seismic Hazard Evaluation was performed.

High winds, external floods and transportation accidents are not incorporated into the Summer IPEEE. The licensee stated that the evaluation performed for Generic Letter 88-20, Supplement 4, shows that the risk posed by these potential initiating events is very small.

Fire is not incorporated into the Summer PRA model. An addendum study was performed for the IPEEE RAI response. The addendum study is the latest fire risk analysis for Summer.

Attachment 1. List of Participants

Rudolph Bernhard	Nuclear Regulatory Commission/Region II
Mike Franovich	Nuclear Regulatory Commission/Office of Nuclear Reactor Regulation
Walt Rogers	Nuclear Regulatory Commission/Region II
Dennis Baker	South Carolina Electric and Gas Co.(SCE&G), Operations
John Cobb	SCE&G, PRA
Tyndall Estes	SCE&G, PRA
Leo J. Kachnik	SCE&G, PRA
Gerald A. Loignon, Jr.	SCE&G, Quality Assurance
Robert Buell	Idaho National Engineering and Environmental Laboratory
Gerardo Martinez-Guridi	Brookhaven National Laboratory