September 22, 2003

MEMORANDUM TO: Stuart Richards, Chief
Inspection Program Branch
Division of Inspection Program Management
Office of Nuclear Reactor Regulation

Patrick D. O'Reilly
Operating Experience Risk Applications Branch
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research

FROM: Mark F. Reinhart, Chief **/RA/**
Licensing Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: RESULTS OF THE SHEARON HARRIS SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During June 2003, NRC staff and contractors visited the Shearon Harris Nuclear Power Plant to compare the Shearon Harris 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 4.35E-5/year excluding internal flood events and inter-system loss of coolant accidents. The Shearon Harris 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 fire 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 Shearon Harris 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 Shearon Harris SDP notebook for the benchmark efforts, the team determined that some changes to the SDP notebook were needed to reflect how the Shearon Harris plant is currently designed and operated. Thirty 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 obtained 13.3 percent of the cases were less conservative, 43.3 percent of the cases were more conservative, and 43.3 percent of the cases were consistent with the licensee's results. Of the less conservative cases, one case was under by two colors. Of the conservative cases, 2 cases were two colors greater than the results obtained using the licensee's model. Consequently, 49 changes were made to the SDP notebook.

CONTACT: Mike Franovich, SPSB/DSSA/NRR
415-3361

Using the revised SDP notebook, the team obtained 13.3 percent of the cases that were less conservative, 46.7 percent of the cases were more conservative, and 40 percent of the cases were consistent with the licensee's results. Of the less conservative cases, all were one color below the licensee's estimate. Of the conservative cases, all but two cases were one order of magnitude greater than the results obtained with the licensee's model and as such were generally consistent with the expectation that the notebooks should be slightly conservative when compared with the licensee's model.

The licensee's PRA staff had substantial knowledge of both the Shearon Harris PRA 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 Shearon Harris SDP Phase 2 Notebook and the licensee's PRA.

Attachment: As stated

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# SUMMARY REPORT ON BENCHMARKING OF

# SDP NOTEBOOK OF THE

# SHEARON HARRIS NUCLEAR POWER PLANT

**G. Martinez-Guridi**

**Brookhaven National Laboratory (BNL)**
**Energy Sciences and Technology Department**
**Upton, NY 11973**

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# 1. INTRODUCTION

A benchmarking of the Shearon Harris Nuclear Power Plant Significance Determination Process (SDP) Risk-Informed Inspection Notebook was conducted during a visit to the Progress Energy corporate office in Raleigh, North Carolina on June 25-27, 2003. Mike Franovich, Rudolph Bernhard 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 Shearon Harris 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 underestimates and overestimates and reviewed the licensee's PRA model to determine the underlying reasons. Additional changes to the SDP notebook were made, 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 Shearon Harris 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.

Thirty cases of hypothetical findings were evaluated. A summary of the results of the risk characterization of hypothetical inspection findings is as follows:

| | |
|---|---|
| 13.3% (4 of 30 cases) | Non-conservative; underestimation of risk significance (by one order of magnitude) |
| 6.7% (2 of 30 cases) | Conservative; overestimation of risk significance (by two orders of magnitude) |
| 40.0% (12 of 30 cases) | Conservative; overestimation of risk significance (by one order of magnitude) |
| 40.0% (12 of 30 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, as needed.

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, and the number of cases where the SDP matched the outcome from the licensee's PRA model. The percentages associated with these cases also are shown in this Table. The revised SDP notebook was consistent (same color) in 40.0% of the inspection findings, 46.7% of overestimates, and 13.3% of underestimates. Hence, the Rev. 1 notebook obtained 86.7% of cases that matched or were overestimated. The Rev. 0 notebook obtained one case (3.3%) that was less conservative by two colors; the Rev. 1 notebook removed this underestimate, so the Rev. 1 notebook did not yield any underestimate by two or more colors. In addition, the Rev. 1 SDP notebook was improved from the Rev. 0 SDP notebook because it now incorporates plant-specific features of Shearon Harris.

Observations on the Licensee's PRA

Two of the LOCA sizes have frequencies that are lower than those "generic" frequencies used in the SDP notebook. The PRA's medium LOCA (5"-13") frequency is 3.6E-6/year, and the PRA's small (class 2) LOCA (3"-5") frequency is 3.4E-6/year.

There were two hypothetical findings evaluated by the SDP notebook that were not modeled by the licensee's PRA: one MSIV fails to close, and operator fails to trip the RCPs after loss of cooling. These two findings are included in Table 1, but they are not included in Table 2 because no comparison of results could be done.

Discussion of Non-conservative Results by the Notebook

The Rev. 1 notebook yielded 4 underestimates by one color out of the 30 hypothetical findings evaluated: diesel generator A fails, air compressor 1C of IA fails, one primary safety valve fails to open, and operator fails to depressurize RCS using SGs to less than setpoint of relief valves of SG after SGTR. They are discussed next.

Diesel generator A fails. The licensee's PRA obtained red (4), and the Rev. 1 notebook yielded yellow. The main reason for this difference is that the licensee's PRA estimates that the failure probability of a single EDG is about 5E-2, while the notebook assigns a credit of 1E-2 (1 train). In addition, the licensee's PRA estimates that the frequency of LOOP is about 3E-2, while the notebook assigns a credit of 2 (i.e., 1E-2). Hence, the reason for the difference in colors between the licensee's PRA and the Rev. 1 notebook is that the notebook assigns lower credits to major contributors than the licensee's PRA does.

Air compressor 1C of IA fails. The licensee's PRA obtained yellow, and the Rev. 1 notebook yielded white. The two main reasons for this difference are: 1) a loss-of-IA-triggered ATWS, with a contribution to CDF of about 2.4E-6/year, and 2) the licensee's PRA estimates that the failure probability of all pumps (CCF) of AFW is 4E-4, while the notebook assigns a credit of 1E-4 (1 multi-train system and 1 ASD train). Therefore, the reason for the difference in colors between the licensee's PRA and the Rev. 1 notebook is that the notebook does not model a loss-of-IA-triggered ATWS, and that the notebook assigns lower "credit" to AFW than the licensee's PRA does.

One primary safety valve fails to open. The licensee's PRA obtained yellow, and the Rev. 1 notebook yielded white. The licensee models ATWS triggered by transients (mainly total and partial loss of main feedwater), with a total frequency of the order of 1E-5/year. The licensee's ATWS sequences are dominated by failure of main feedwater occurring early in core life when the moderator temperature coefficient is not sufficiently negative to adequately cope with the power transient, causing an RCS pressure transient beyond the capability of the piping and vessel. The specific sequence of events occurs in seconds and involves a transient initiator, a failure to trip the reactor automatically or manually, and main feedwater failure, all occurring early in core life. The RCS pressure increases rapidly, causing reactor vessel rupture beyond the capacity of the emergency systems to mitigate. Core damage is assumed to occur, and no recovery actions are assessed for this sequence due to the rapid timing of events. The Rev. 1 notebook models a similar sequence of events, but with a frequency of 1E-6/year. Hence, the reason for the difference in colors between the licensee's PRA and the Rev. 1 notebook is that the notebook currently assigns lower "credit" to the frequency of ATWS than the licensee's PRA does.

Operator fails to depressurize RCS using SGs to less than setpoint of relief valves of SG after SGTR. The licensee's PRA obtained red (4), and the Rev. 1 notebook yielded yellow. The notebook's credit for the initiating event frequency of SGTR is 3 (1E-3/year), while the licensee's frequency is 4.5E-3/year. Hence, the reason for the difference in colors between the licensee's PRA and the Rev. 1 notebook is that the notebook assigns lower "credit" to the initiating event frequency of SGTR than the licensee's PRA does.

Discussion of Conservative Results by the Notebook

The Rev. 1 notebook produced 14 overestimates, 2 by two orders of magnitude, and 12 overestimates by one order of magnitude. The 2 overestimates by two orders of magnitude are: battery charger of bus B fails, and operator fails to switchover in LPR. They are discussed next.

Battery charger of bus B fails. The licensee's PRA obtained red (4), and the Rev. 1 notebook yielded red (2). After the failure of the charger, the notebook assumes that the associated DC bus is lost. On the other hand, the licensee's PRA considers that the bus will be powered by the associated battery, and that the failure of the battery charger is annunciated in the main control room, so the licensee can implement corrective measures before the DC bus is lost and therefore a small exposure period. Hence, the difference in colors is due to different assumptions between the licensee's PRA and the SDP notebook in evaluating the charger's failure.

Operator fails to switchover to LPR mode. The licensee's PRA obtained yellow, and the Rev. 1 notebook yielded red (3). For SLOCA (0.375"-3"), the notebook uses HPR and LPR. On the other hand, the licensee's model for this type of LOCA uses shutdown cooling (SDC). For inability to align SDC in normal residual heat removal mode (e.g. failure to open of RCS drop line valve to SDC suction), the licensee models operators use of cold-leg recirculation. Therefore, recirculation is less important in the licensee's model because it is used upon failure to align SDC.

The reasons causing the overestimates by one color were not further investigated per the benchmarking process for this kind of estimate. However, a contributing factor to some of these overestimates may be that, as mentioned above, two of the LOCA sizes in the licensee's PRA have frequencies that are lower than those "generic" frequencies used in the SDP notebook.

The 12 overestimates by one order of magnitude are: 6.9 kV bus A fails, TDP of AFW fails, one AHU of CSIP HVAC fails, Vital 125 VDC bus A fails, Vital 125 VDC bus B fails, one standby CSIP fails, one running NSW pump fails, one primary PORV fails to close, one primary block valve fails to close, one SG PORV fails to open, operator fails to switchover in HPR, and operator fails to refill the RWST after SGTR.

Changes Incorporated Following Benchmarking Resulting in Updating of Benchmarking Results

No additional changes to the Rev. 1 notebook resulting in updating of benchmarking results were incorporated.

**Table 1 Summary of Benchmarking Results for Shearon Harris**
**Internal Events CDF (without internal flooding and ISLOCA) is 4.35E-5/year (truncation = 4E-9/year)**
**RAW Thresholds are White = 1.02, Yellow = 1.23, Red (4) = 3.30, Red (3) = 24.0, and Red (2) = 231.0**

| No. | Component Out of Service or Failed Operator Action | SDP Worksheet Results (Before) (1) | Basic Event Name | Internal RAW (Highest) | Plant CDF Color(2) | SDP Worksheet Results (After) (1) | Comments |
|---|---|---|---|---|---|---|---|
| | ***Component*** | | | | | | |
| 1 | 6.9 kV bus A fails | Red (2) (over by 1) | JBS1A-SAFN | 113.67 | Red (3) | Red (2) (over by 1) | RAW for mitigating part only. |
| 2 | Diesel generator A fails | Yellow (under by 1) | PDGE1ASAFS | 3.76 | Red (4) | Yellow (under by 1) | |
| 3 | One MDP of AFW fails | Red (4) (match) | FPM1A-SAFS | 23.71 | Red (4) | Red (4) (match) | |
| 4 | TDP of AFW fails | Yellow (match) | Run by licensee | 1.35 | Yellow | Red (4) (over by 1) | |
| 5 | Running pump of CCW fails | White (match) | KHXCCWTBFN | 1.06 | White | White (match) | |
| 6 | Standby pump of CCW fails | Yellow (match) | KTMCCWA | 1.66 | Yellow | Yellow (match) | |
| 7 | One AHU of CSIP HVAC fails | Red (4) (over by 1) | ZFNAH-9ANN | 1.64 | Yellow | Red (4) (over by 1) | |
| 8 | Vital 125 VDC bus A fails | Red (2) (over by 1) | DBSDP1ASFN | 113.67 | Red (3) | Red (2) (over by 1) | |
| 9 | Battery of bus A fails | Red (4) (match) | DBA1A-SAFN | 3.53 | Red (4) | Red (4) (match) | |
| 10 | Battery charger of bus B fails | Red (2) (over by 2) | Run by licensee | 3.68 | Red (4) | Red (2) (over by 2) | |
| 11 | Vital 125 VDC bus B fails | Red (2) (over by 1) | DBSDP1BSFN | 113.67 | Red (3) | Red (2) (over by 1) | |
| 12 | One ESW pump fails | Red (3) (over by 1) | WPM/ESWAWS | 3.5 | Red (4) | Red (4) (match) | |

| No. | Component Out of Service or Failed Operator Action | SDP Worksheet Results (Before) [1] | Basic Event Name | Internal RAW (Highest) | Plant CDF Color[2] | SDP Worksheet Results (After) [1] | Comments |
|---|---|---|---|---|---|---|---|
| 13 | One standby CSIP fails | Red (4) (over by 1) | HTMCSIPA | 1.24 | Yellow | Red (4) (over by 1) | |
| 14 | Air compressor 1C of IA fails | Green (under by 2) | ACPRACOMNN | 1.47 | Yellow | White (under by 1) | |
| 15 | One RHR pump fails | Red (4) (match) | LPM1A-SALS | 3.93 | Red (4) | Red (4) (match) | |
| 16 | One MSIV fails to close | Yellow | Not found | | | Yellow (not found) | |
| 17 | One running NSW pump fails | White (over by 1) | VPM1ANNSXR | 1.01 | Green | White (over by 1) | |
| 18 | One feedwater pump fails | White (match) | Run by licensee | 1.15 | White | White (match) | |
| 19 | One condensate pump fails | White (match) | Run by licensee | 1.15 | White | White (match) | |
| 20 | One primary PORV fails to open | White (match) | Run by licensee | 1.14 | White | White (match) | |
| 21 | One primary PORV fails to close | Yellow (over by 1) | RPVRC114FF | 1.20 | White | Yellow (over by 1) | |
| 22 | One primary block valve fails to close | White (over by 1) | RMVRC113TT | 1.01 | Green | White (over by 1) | |
| 23 | One primary safety valve fails to open | White (under by 1) | RRSRC123FF | 1.56 | Yellow | White (under by 1) | |
| 24 | One SG PORV fails to open | Yellow (over by 1) | Run by licensee | 1.14 | White | Yellow (over by 1) | |

| No. | Component Out of Service or Failed Operator Action | SDP Worksheet Results (Before) (1) | Basic Event Name | Internal RAW (Highest) | Plant CDF Color(2) | SDP Worksheet Results (After) (1) | Comments |
|---|---|---|---|---|---|---|---|
| 25 | One ECCS piggy back valve fails to open | Yellow (match) | HMV1RH25TN | 2.82 | Yellow | Yellow (match) | |
| | ***Operator Actions*** | | | | | | |
| 26 | Operator fails to conduct Feed/Bleed | Red (4) (match) | OPER-3 | 6.65 | Red (4) | Red (4) (match) | |
| 27 | Operator fails to switchover in HPR | Red (4) (match) | OPER-17 | 6.63 | Red (4) | Red (3) (over by 1) | |
| 28 | Operator fails to switchover in LPR | Red (3) (over by 2) | OPER-1 | 1.63 | Yellow | Red (3) (over by 2) | |
| 29 | Operator fails to depressurize RCS using SGs to less than setpoint of relief valves of SG after SGTR | Yellow (under by 1) | OPER-41 | 4.2 | Red (4) | Yellow (under by 1) | |
| 30 | Operator fails to refill the RWST after SGTR | Yellow (over by 1) | OPER-64 | 1.2 | White | Yellow (over by 1) | |
| 31 | Operator fails to conduct emergency boration after ATWS | White (match) | Run by licensee | 1.22 | White | White (match) | |

| No. | Component Out of Service or Failed Operator Action | SDP Worksheet Results (Before) (1) | Basic Event Name | Internal RAW (Highest) | Plant CDF Color(2) | SDP Worksheet Results (After) (1) | Comments |
|---|---|---|---|---|---|---|---|
| 32 | Operator fails to trip the RCPs after loss of cooling | Yellow | Not found | | | Yellow (not found) | |

**Notes**:

- 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.
- When the color corresponding to the plant's CDF is red, the number in parenthesis after the word "Red" is the order of magnitude of the delta CDF (updated CDF - base-case CDF). For example, if the delta CDF is of the order of 1E-3, then the color is characterized as Red (3).

**Table 2: Comparative Summary of the Benchmarking Results - Shearon Harris**

| SDP Notebook is... | SDP Notebook Before (Rev. 0) | | SDP Notebook After (Rev. 1) | |
|---|---|---|---|---|
| | Number of Cases | Percentage | Number of Cases | Percentage |
| Less conservative by two colors | 1 | 3.3 | 0 | 0.0 |
| Less conservative by one color | 3 | 10.0 | 4 | 13.3 |
| More conservative by one color | 11 | 36.7 | 12 | 40.0 |
| More conservative by two colors | 2 | 6.7 | 2 | 6.7 |
| Matched | 13 | 43.3 | 12 | 40.0 |
| Total | 30 | 100.0 | 30 | 100.0 |

# 3. PROPOSED REVISIONS TO THE 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 Shearon Harris

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. The revisions are discussed below:

1. Table 1. Removed "Loss of NSW and one train of ESW" from Table 1 because the frequency of this initiator is below the licensee's analysis cutoff.

2. Table 1. The Rev. 0 notebook contained one initiating event "Loss of 6.9 kV Bus A or B When Powering Equipment (LACB)." Separate initiating events for "Loss of 6.9 kV Bus A When Powering Equipment (LACA)" and "Loss of 6.9 kV Bus B When Powering Equipment (LACB)" were included in the Rev. 1 notebook.

3. Table 1. Updated footnote 2 that is related to initiating events associated with service water.

4. Table 2. Updated footnote indicating that the steam admission valves of the TDAFW pump depend on 125 VDC. The discharge valves fail open on a loss of power.

5. Table 2. Added row for Accumulators (Passive Safety Injection (PSI)), including the columns for "Major Components," "Support Systems" and "Initiating Event Scenarios."

6. Table 2. Added row for AMSAC, including major components, support system and relevant initiating event.

7. Table 2. Updated footnote to indicate that the core damage frequency (CDF) from internal events (without internal flooding and ISLOCA) is 4.35E-5/year with a truncation = 4E-9/year, and to indicate that the licensee's current PSA Model of Record (MOR2001) is based on the plant configuration as of May 12, 2000, update of plant-specific data through December 1999, and incorporation of RFO10 plant modifications and plant procedure changes due to Steam Generator Replacement and Power Uprate of approximately 4.5%. The MOR was last updated June 2002 and was documented for configuration control purposes by Calculation HNP-F/PSA-0001.

   The footnote also indicates that the Shearon Harris' PRA addresses internal events including internal flooding due to pipe breaks. The total CDF, including internal flooding, is

4.87E-5/year with a truncation = 4E-9/year. The licensee's PRA does not address fire scenarios or external events such as earthquakes. It does not address external events such as hurricanes or external flooding because the licensee determined that they do not contribute significantly to the overall frequency of severe accidents for Shearon Harris.

8. Table 2. For Charging/Safety Injection Pump (CSIP) Heating Ventilation and Air Conditioning (HVAC), replaced the support system ESW by Chilled Water.

9. Table 2. Added row for Chilled Water, including major components, support systems and relevant initiating events.

10. Table 2. Updated footnote indicating that a third CCW pump is normally racked out. It is only used to recover from a loss of CCW. The licensee estimates that it takes between 30 minutes and 1 hour to use this pump for this recovery.

11. Table 2. For DC Power System, updated the note indicating that without AC, battery capacity is 4 hours without load shed.

12. Table 2. Added footnote indicating that each DC bus has two battery chargers. However, one battery charger is included in the licensee's PRA model, and the other is not included.

13. Table 2. Added footnote indicating that the battery charger capacity is adequate to carry the SI loads. The inspection findings related to the batteries 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 corresponding loss of DC initiator by one order of magnitude.

14. Table 2. Added row for non-vital DC, including major component, support system and relevant initiating event. Added footnote indicating that the frequency of the initiating event "Loss of Non-vital DC Bus DP-1A" is 2.9E-3/year. It causes a recoverable LOOP. It is considered to be included in the LOOP worksheet.

15. Table 2. Added row for Demineralized Water Pumps, including major components, support systems and relevant initiating events.

16. Table 2. Added footnote indicating that there is one fuel oil transfer pump per EDG. The capacity of the EDG fuel oil day tank is 3,196 gal. The licensee estimates that an EDG can run on just the day tank for about 6.3 hours. A recovery action for supplying an alternate supply of fuel oil is included in the licensee's PRA model; however, no credit is taken for this action in the licensee's PRA model due to the absence of procedural guidance.

17. Table 2. Updated footnote indicating that manual action is required for ESW to provide backup water to the AFW.

18. Table 2. Added footnote indicating that one HHSI pump is racked out. The licensee's PRA only gives credit to this pump to mitigate a loss of CVCS.

19. Table 2. Added footnote indicating that since the high head pumps have a shutoff head of 2,700 psi, feed and bleed could be performed either by PORVs or SRVs. These success

criteria are based on the licensee's MAAP thermal-hydraulic code run which was outside the team's scope of review.

20. Table 2. For Instrument Air (IA), updated the number of compressors to three, and removed the dependency on NSW.

21. Table 2. Added footnote for the three compressors of IA indicating that the compressor that is normally running has 100% capacity and is fed by non-safety AC. On loss of this compressor, the other two compressors provide backup air; each of these compressors has 50% capacity (during normal operation), and is fed by one of the emergency AC buses. During accident conditions, each of these two compressors can provide air to all necessary loads. The three compressors are air cooled.

22. Table 2. Added two heat exchangers as major components of Low Head Safety Injection (LHSI). Added footnote indicating that the recirculation switchover is automatic, except that the operators have to provide CCW cooling to the RHR heat exchangers.

23. Table 2. Added dependency of Main Steam Isolation Valves (MSIVs) on DC power. Added footnote indicating that the MSIVs require IA and DC to open. They fail closed on loss of IA or DC.

24. Table 2. Added dependency of Normal Service Water (NSW) on non-safety DC (to start a pump).

25. Table 2. Added dependency of Power Conversion System (PCS) on non-safety DC and IA. Added footnote indicating that the PCS is lost on loss of non-safety DC or loss of IA.

26. Table 2. For the Reactor Coolant Pumps (RCPs), changed the number of CCW pumps available to provide cooling to the RCP's thermal barrier heat exchanger from 3 to 2.

27. Table 2. Added footnote indicating that the RCPs have a mixture of high- and low-temperature O-seals.

28. Table 2. Updated the major components of Refueling Water Storage Tank (RWST) to tank and 4 level indicators. Added footnote indicating that the RWST has a capacity = 470,000 gal., and a minimum volume of 436,000 gal. (per Technical Specifications). Added another footnote indicating that to refill the RWST the following three pieces of equipment are necessary: Demineralized water pump, Reactor Makeup Water Storage Tank (80,000 gal.), and boric acid transfer pump.

29. Table 2. Added dependency of Refueling Water Storage Tank (RWST) on Instrument power.

30. Table 2. Updated the column "Initiating Event Scenarios" for each system (row) in Table 2 according to the changes incorporated in the worksheets and to other changes incorporated in Table 2.

31. All worksheets using the function "Early Inventory, High Pressure Injection (EIHP)". Changed the success criteria for EIHP from "1/2 CSIPs or use of spare pump" to "1/2 CSIP trains".

Added footnote indicating that a third (spare) pump is racked out. The licensee's PRA only gives credit to this pump to mitigate a loss of CVCS.

32. Added event tree for Transients with Loss of PCS (TPCS).

33. Small LOCA (SLOCA) worksheet. Added footnote indicating that the licensee also uses accumulators to provide makeup on loss of high pressure injection. We consider that they are not necessary to accomplish this objective.

34. Added event tree for Stuck-open PORV (SORV).

35. Stuck-open PORV (SORV) worksheet. Changed the success criteria of the function "Primary Heat Removal, Feed/Bleed (FB)" from "1/3 SRVs or 1/3 PORVs open" to "1/3 SRVs or 1/2 PORVs open" because the stuck-open PORV is not credited in this worksheet.

36. Medium LOCA (MLOCA) worksheet and event tree. Changed the function "Low Pressure Recirculation (LPR)" to "High Pressure Recirculation (HPR)" because the latter type of recirculation is required to mitigate a MLOCA.

37. Large LOCA (LLOCA) worksheet and event tree. Added the function "Accumulators (ACC)" because they are required to mitigate a LLOCA in Shearon Harris.

38. Loss of Offsite Power (LOOP) worksheet. Modified footnote indicating that the licensee estimated a probability of failure to recover AC power within 90 minutes after the onset of SBO equal to about 5.4E-2. Accordingly, it has a credit = 1.

39. Loss of Offsite Power (LOOP) worksheet. Modified footnote indicating that the treatment of the performance of RCP seals in this worksheet is based on item 20, "RCP Seal LOCA for Westinghouse Plants during SBO scenarios" of section 2.1, "Generic Guidelines and Assumptions (PWRs)" of this notebook. According to this item, in an SBO situation, a RCP seal LOCA may occur, with subsequent core damage at about 5 hours after the onset of SBO. The WOG-2000 RCP seal model and NRC staff position will be considered in the next revision of the notebook.

40. Loss of Offsite Power (LOOP) worksheet. Modified footnote indicating that the SDP model considers recovery of AC power in less than 5 hours after the onset of SBO. A similar recovery is estimated by the licensee as recovery within 6 hours after the onset of SBO with a probability of failure equal to about 3.2E-2. Accordingly, it has a credit = 2.

41. Anticipated Transients Without Scram (ATWS) worksheet. Added 1/2 boric acid transfer pumps to success criteria of the function "Emergency Boration (HPI)."

42. Anticipated Transients Without Scram (ATWS) worksheet. Changed success criteria of the function "Secondary Heat Removal (AFW)" from "2/2 MDPs of AFW (1 train) or 1/1 TDP of AFW (1 ASD train)" to "2/2 MDPs of AFW with 1/1 TDP of AFW (1 ASD train)." Accordingly, changed the credit for the function "AFW" from 3 to 1.

43. Anticipated Transients Without Scram (ATWS) worksheet. Added success criteria for steam relief (4/5 SG safety valves open on each SG) to the function "Secondary Heat Removal

(AFW)."  The licensee currently does not model the steam relief from the steam generators after an ATWS.  The team used a "generic" success criteria for this function.

44. The worksheet and event tree for "Loss of NSW and one train of ESW" were removed from the notebook because the frequency of this initiator is below the licensee's analysis cutoff.

45. The Rev. 0 notebook contained one worksheet and event tree for the initiating event "Loss of 6.9 kV Bus A or B When Powering Equipment (LACB)."  The following modifications were implemented in the Rev. 1 notebook: 1) the event tree was expanded with those sequences with successful function "Redundant Train of CCW (TCCW)," and 2) separate worksheets were developed for "Loss of 6.9 kV Bus A When Powering Equipment (LACA)" and "Loss of 6.9 kV Bus B When Powering Equipment (LACB)" because the TDAFW pump is not available in a LACB.

46. Loss of DC Bus A (DP-1A-SA) (LDCA) worksheet.  Updated footnote containing the frequency of this loss to 2.9E-3/year.

47. Loss of DC Bus B (DP-1B-SB) (LDCB) worksheet.  Updated footnote containing the frequency of this loss to 2.9E-3/year.

48. Loss of Instrument Air (LOIA) worksheet and event tree.  Removed the credit for PCS because a review of the licensee's cutsets revealed that no credit was given to the PCS.  The sequences in the worksheet were updated with this change.

49. LOOP with Loss of One Division of Emergency AC (LEAC) worksheet.  Loss of 6.9 kV bus B is modeled in this worksheet because it is the worst case, causing loss of the TDAFW pump and 2 block valves.  As a consequence, removed the TDAFW pump from the function "Secondary Heat Removal (AFW)."  Modified footnote to include this information.

### 3.2 Generic Change in IMC 0609 for Guidance to NRC Inspectors

No recommendation for improving 0609 was identified.

### 3.3 Generic Change to the SDP Notebook

No generic change to the SDP notebook was identified.

# 4. DISCUSSION ON EXTERNAL EVENTS

The Shearon Harris PRA addresses internal events including internal flooding due to pipe breaks. The total CDF, including internal flooding, is 4.87E-5/year with a truncation = 4E-9/year. The licensee's PSA does not address fire scenarios or external events such as earthquakes. It does not address external events such as hurricanes or external flooding because the licensee determined that they do not contribute significantly to the overall frequency of severe accidents for Shearon Harris.

# 5. LIST OF PARTICIPANTS

| | |
|---|---|
| Mike Franovich | Nuclear Regulatory Commission/Office of Nuclear Reactor Regulation |
| Rudolph Bernhard | Nuclear Regulatory Commission/Region II |
| Walt Rogers | Nuclear Regulatory Commission/Region II |
| Andrew Howe | Progress Energy |
| Steven L. Mabe | Progress Energy |
| Scott Brinkman | Progress Energy |
| John Poloski | Idaho National Engineering and Environmental Laboratory |
| Gerardo Martinez-Guridi | Brookhaven National Laboratory |