June 10, 2002

NOTE TO: Cynthia Carpenter, Chief
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SUBJECT: RESULTS OF THE TURKEY POINT NUCLEAR PLANT UNITS 3 AND 4 SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During February, 2002, NRC staff and a contractor visited the Florida Power and Light company headquarters to compare the Turkey Point Nuclear Plant (TPNP) Units 3 and 4 Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. TPNP's PSA did not include external initiating events so no sensitivity studies were performed to assess the impact of these initiators on SDP color determinations. In addition, the results from analyses using the NRC's draft Revision 3i Standard Plant Analysis Risk (SPAR) model for TPNP were also compared with the licensee's risk model. The results of the SPAR model benchmarking effort will be documented in a separate trip report to be prepared by the Office of Research.

In the review of the TPNP SDP notebook, it was found that some changes to the SDP worksheets were needed to reflect how the plant is currently designed and operated. Twenty nine hypothetical inspection findings were processed through the SDP notebook. Results from this effort indicated that the total risk impacts modeled in the SDP notebook were underestimated by 11 percent, overestimated by 68 percent, and adequately estimated by 21 percent. The reviewers found that if twenty one fixes were made to the SDP notebook, the results would be 0 percent underestimation and 34 percent overestimation of risk impacts.

Attachment A describes the process and results of the comparison of the TPNP Units 3 and 4 SDP Phase 2 Notebook and the licensee's PSA.

If you have any questions regarding this effort, please contact Peter Wilson.

Attachments: As stated

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G://spsb/wilson/turkeypoint bench.wpd Accession#ML021610424 NRR-096

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SUMMARY REPORT ON BENCHMARKING TRIP TO

TURKEY POINT NUCLEAR PLANT

UNITS 3 AND 4 (Feb. 25 - 28, 2002)

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May 24, 2002

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1. Introduction

A benchmarking of the Turkey Point Nuclear Plant (TPNP) Units 3 and 4 Significance Determination Process (SDP) Risk-Informed Inspection Notebook was conducted during a plant site visit on February 25 - 28, 2002. NRC staff (Peter Wilson, Walt Rogers and Rudolph Bernhard) supported by BNL staff (Gerardo Martinez-Guridi and Pranab Samanta) participated in this benchmarking exercise.

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

The major activities performed during this plant site visit were:

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

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

3. Identified a target set of basic events for the benchmarking exercise.

4. Performed benchmarking of the Rev-0 SDP worksheets with considerations of the licensee's comments on the SDP notebook.

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

On March 21, 2002, BNL received an email from the licensee indicating that secondary cooling can be recovered following a loss of instrument air, either using MFW or standby steam generator feedwater pumps discharging through the MFW bypass valves. The licensee also sent a corresponding new set of values of risk achievement worth (RAW). The SDP notebook was again benchmarked against the licensee's updated model, and this report documents the results of the recent benchmarking.

The benchmarking exercise provided insights for significant improvement to the SDP notebook. Thirty hypothetical inspection findings were processed during the benchmarking effort. In 29 cases these hypothetical inspection findings could be compared with a risk achievement worth (RAW) generated by the licensee's PSA. In one case the licensee had not modeled the failure so no comparison could be made. In all of the 29 cases evaluated that could be compared with a risk achievement worth (RAW) generated by the licensee's PSA, the revised SDP notebook obtained either a match or one order of magnitude (color) higher than the result obtained using the licensee's PSA.

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

2. Summary Results From Benchmarking

This Section provides the results of the benchmarking exercise. The results of benchmarking analyses are summarized in Table 1 consists of six column headings. In the first column, the out-of-service components, including human errors are identified for the case analyses. The second and third columns show the RAW values and the associated colors based on the licensee's latest PSA model. The colors assigned for significance characterization from using the Rev-0 SDP worksheets before incorporation of the licensee's comments are shown in the fourth column. Finally, the colors assigned for significance characterization from using the SDP worksheets after incorporation of the licensee's comments are shown in the fifth column.

As mentioned in the previous chapter, in all 29 cases evaluated that could be compared with a RAW generated by the licensee's PSA, the revised SDP notebook obtains either a match or one order of magnitude (color) higher than the licensee's PSA. We also used the SDP notebook to evaluate the failure of one MSIV to close. We obtained a yellow color for the failure of one MSIV to close because the SDP's worksheet for Main Steam Line Break (MSLB) Outside Containment has the success criteria of "2/3 MSIVs close" to prevent pressurized thermal shock (PTS); the SDP worksheet assumes that PTS leads to core damage. Currently, the licensee's PRA model does not include PTS due to MSIV failures. Therefore, the SDP notebook's evaluation of this failure cannot be compared with a licensee's evaluation.

During the evaluation of the risk-significance of some components, we made the following considerations:

1. The licensee's PRA model has two separate event trees for loss of ICW and for loss of CCW, and it has fault trees to evaluate the frequency of these initiating events. An evaluation of the fault trees during the benchmarking visit yielded the frequencies of 2.44E-3 and 7.97E-4 for loss of ICW and for loss of CCW, respectively. Since the impact of these two losses on the plant is similar, the SDP notebook lumps them into a single event tree and worksheet, "Loss of ICW or CCW (LCOO)." The initiating event frequency used in the worksheet is the most conservative of the two frequencies, that is, a credit of 3. However, for evaluating the loss of one pump of CCW, we used the frequency of loss of CCW, which has a credit = 4. In the Rev 1 SDP notebook we will create two separate worksheets, one for loss of ICW and one for loss of CCW, to facilitate the use of the SDP notebook.

2. When evaluating the event PORV PCV-455C fails to close, we considered that the initiating event SORV had occurred, and made the credit of this event equal to 0. The worksheet "LOOP and Loss of 4.16kV AC Bus 3A or 4A (LEAC)" also has the safety function "PORV Recloses (PORV)." However, we consider that this worksheet does not have to be evaluated in this case because it would result in double counting the impact of the failure. A footnote will be added in Table 2 of the SDP notebook to indicate to the inspector that for findings of a PORV that could increase its probability to close following steam relief, only the worksheet "Stuck Open PORV (SORV)" should be used.

A comparative summary of the benchmarking results is provided on Table 2. Table 2 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 associated percentage of differences found for the 29 cases

that could be compared with a licensee evaluation also are shown on Table 2. We concluded that the pre-visit SDP notebook obtained only 21% of matches (same color) of the hypothetical inspection findings (see Table 2 summation of the cases matched and overestimated). However, the revised SDP notebook obtained 66% of the actual significance of inspection findings (same color), and 34% of cases were one order of magnitude (color) more conservative. The Rev 1 SDP notebook did not yield any underestimates.

Table 1 Comparison of Sensitivity Calculations Between SDP Phase 2 Worksheets and Turkey Point RAWs[1]

CDF = 8.08E-6/year, White = 1.124, Yellow = 2.238, Red = 13.376
Truncation = 1E-10 / year

Description	RAW	Plant Color	SDP Before	SDP After
Match or SDP one magnitude higher than licensee's PSA: Hardware failures				
Diesel Generator 3A fails to run	1.06	Green	Yellow	White
Motor-operated block valve MOV-*-535 fails to close	1.02	Green	Yellow	White
One motor-driven SSGFP	1.02	Green	White	White
PORV PCV-455C fails to close following steam relief	1.81	White	Red	Yellow
CCW pump train A fails to run	1.37[2]	White	Red	Yellow
Independent local faults at HHSI pump 4A	1.06	Green	Yellow	White
RHR train 3B in test or maintenance	1.09	Green	Yellow	White
Failure of charging pump A	1.02	Green	Yellow	Green
ICW pump train 3A fails to start	1.12	Green	Red	Green
125 VDC 3A Battery	1.36	White	Red	White
125 VDC 3B Battery	2.04	White	Red	White
Normal Spray	1.0	Green	White	Green
Auxiliary Spray	1.0	Green	White	Green
U4 diesel driven compressor fails to start	1.01	Green	Red	Green
AFW turbine-driven pump A fails to start	3.44	Yellow	White	Yellow
Independent faults at (main) feedwater pump 3P1A	1.08	Green	Green	Green
One Code Safety Valve	1.0	Green	White	Green
One diesel-driven SSGFP	1.76	White	White	White
Failure of boric acid pump 3B	1.14	White	Green	White

Description	RAW	Plant Color	SDP Before	SDP After
Local fault on 4160V bus 3A	274.88	Red	Yellow	Red
One Atmospheric Dump Valve (ADV)	1.0	Green	White	Green
One Steam Condenser Dump Valve (SCDV)	1.0	Green	White	Green
Charger 3A1 unavailable due to test and maintenance	1.24	White	White	White
One Main Steam Isolation Valve (MSIV)[3]	NA[4]	NA	Yellow	Yellow
Match or SDP one magnitude higher than licensee's PSA: Human Errors				
Failure to restore secondary cooling using standby steam generator feedwater	1.64	White	Yellow	Yellow
Failure to secure RHR pumps (after SI signal)	1.2[5]	White	NA[6]	Yellow
Failure to align service water to cool charging pump	1.10	Green	Red	White
Operating crew fails to implement bleed-and-feed	3.15	Yellow	Yellow	Yellow
Emergency Boration	1.49	White	White	White
Failure to implement HPR	1.54	White	Red	White

Notes:

1. There were a total of 30 cases evaluated using the Rev-1 SDP notebook.

2. RAW obtained from a run carried out by licensee on 5/16/02.

3. The failure of the MSIVs leading to PTS is not currently evaluated by the licensee's model. Therefore, the SDP notebook's evaluation of this failure cannot be compared with a licensee's evaluation.

4. NA means not available.

5. Value obtained from a run carried out by licensee during the benchmarking visit.

6. The failure to secure RHR pumps (after SI signal) was not explicitly modeled. Subsequently, it was incorporated in the SDP notebook to facilitate its evaluation.

Table 2 : Comparative Summary of the Benchmarking Results

Total Number of Cases Compared	**SDP Notebook Before (Rev 0)**		**SDP Notebook After (Rev 1)**	
	Number of Cases	Percentage	Number of Cases	Percentage
SDP: Less Conservative	3	11%	0	0%
SDP: More Conservative	19	68%	10	34%
SDP: Matched	6	21%	19	66%
Total	28	100%	29	100%

3. Proposed Revisions to Rev-0 SDP Notebook

Based on insights gained from the plant site visit, a set of revisions are proposed for the Rev-0 SDP notebook. The proposed revisions are based on licensee 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 Turkey Point Nuclear Plant

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 worksheets were incorporated during the visit, including revised HEPs and initiator frequencies. The remaining changes dealt mainly with updated footnotes to the dependency matrix and the worksheets. The proposed revisions are discussed below:

1. The SDP's medium LOCA worksheet and event tree were modified to model a break of up to 6", thus being similar to the licensee's small LOCA. The SDP's large LOCA worksheet and event tree were modified to model a break greater than 6", thus being similar to the licensee's medium and large LOCAs. The relationship between licensee's LOCAs and SDP's LOCAs is shown in the following table.

Relationship Between Licensee's LOCAs and SDP's LOCAs

Size of break	Licensee's LOCA	SDP's LOCA
Up to 2"	Small small, SGTR	Small, SORV, SGTR
Up to 6"	Small	Medium
Greater than 6"	Medium, Large	Large

2. A major contributor to core damage is the failure of the operators to secure RHR pumps (after SI signal) in scenarios (initiating events) that do not require them in the early term, such as small LOCA. The structure of the event trees and the worksheets of the following initiating events were modified to include this failure: Small LOCA (SLOCA), Stuck Open PORV (SORV), Medium LOCA (MLOCA), Steam Generator Tube Rupture (SGTR), and LOOP and Loss of 4.16kV AC Bus 3A or 4A (LEAC).

3. If high-pressure recirculation fails in one unit, the licensee credits the following recovery actions:

    1. Refill own RWST. The licensee's human error probability (HEP) = 2.1E-4.

    2. Use the other unit's RWST. The licensee's HEP = 5E-2.

The licensee can use both strategies in a LOOP scenario. We modified the SDP notebook as follows:

a) In SDP's medium LOCA, credit just the second recovery, i.e., use the other unit's RWST. Since the licensee's HEP = 5E-2, SDP proposed credit = 1.

b) In SDP's small LOCA, SORV, LOOP, SGTR, LCOO, LEAC, and in all sequences of transients involving Feed and Bleed, credit both recoveries. SDP proposed credit = 2 because a dependency is expected between both human actions.

4. The worksheets and event trees of "Loss of ICW (LICW)" and "Loss of CCW (LCCW)" were modified to implement the licensee's strategy to mitigate an RCP seal LOCA. This strategy consists of using the high-head safety injection pumps of the other unit (cooled by the other unit's CCW system) and providing a long-term RCS makeup source by switching to RWST of the other unit or by refilling the unit's own RWST.

5. A new worksheet for "Loss of DC Bus 3B or 4A (LDCP)" was developed in addition to the worksheet for "Loss of DC Bus 3A or 4B (LDC)" because Main Feedwater can be used after the former loss, and it is not available after the second loss. In both losses, the two SSGFPs are available, and the worksheets were modified accordingly.

6. A new worksheet for "Loss of IA (LIA)" was developed because secondary cooling can be recovered following a loss of instrument air, either using MFW or standby steam generator feedwater pumps discharging through the MFW bypass valves. This loss was modeled using the event tree of "Transients with Loss of PCS (TPCS)."

7. A new worksheet for "Loss of 120V Instrument Panel (L120)" was developed because this loss causes the unavailability of two AFW pumps.

8. The success criteria for the HHSI pumps for feed and bleed is 2/4. This updated success criteria was used in all worksheets where feed and bleed is used.

9. There are three turbine-driven AFW pumps. The credit for this pumps was assigned as follows: 1 pump = 1 ASD train (credit = 1), 2 pumps = 1 train (credit = 2), 3 pumps = 1 multi-train system (credit = 3).

10. The credit for one diesel-driven SSGFP was changed to 1 to be consistent with SDP's treatment of this kind of component.

11. The requirement that CSS or CVHRS is necessary to operate to maintain the environmental qualification of MOVs within containment was removed from all sequences involving a LOCA or feed and bleed.

12. The credit for the operator restoring feedwater to SGs using Main Feedwater trains was changed from 1 to 2 to reflect the average credit of similar plants.

13. The credit for the operator using ½ SSGF trains to provide secondary heat removal was changed from 1 to 2 because the licensee's HEP is 1.2E-2. There is no generic average for this action.

14. The credit for the operator implementing high-pressure- or low-pressure-recirculation was changed to 3 to reflect the average credit of similar plants.

15. The credit for the operator depressurizing the RCS in a small LOCA, SORV, and LEAC was changed from 2 to 3 because we give credit to a slow depressurization, so there are several hours available to carry out this action.

16. The credit for the operator using one of the other unit's EDGs was changed from 1 to 2.

17. The success criteria for "Emergency Boration (EMBO)" in an ATWS was changed from "Operator conducts emergency boration using 3/3 CVCS pump trains..." to "Operator conducts emergency boration using 1/3 CVCS pump trains..."

18. The success criteria for "Primary Relief (SRV)" in an ATWS was changed from "3/3 SRVs or (2/3 SRVs with 2/2 PORVs) open..." to "2/3 SRVs or (1/3 SRVs with ½ PORVs) open..."

19. The human action "Operators open CCW crosstie from other unit before RCP seal LOCA" was removed from the worksheets "Loss of ICW (LICW)" and "Loss of CCW (LCCW)" because the licensee does not give credit to this recovery anymore.

20. The following changes were implemented in Table 1 of the SDP notebook:

    1. LOOP was moved from row II to row I because its frequency (5.30E-02 / year) was in the middle range of row 2. "LOOP and Loss of 4.16kV AC Bus 3A or 4A (LEAC)" was moved to row IV because the EDGs of the other unit can be used to provide power to an emergency AC bus.

    2. Loss of one DC bus was moved from row IV to row III because it has an updated frequency = 1.05E-3 / year.

21. The following changes were implemented in Table 2 of the SDP notebook:

    1. The MFW pumps are cooled by Turbine Plant Cooling Water (TPCW), not CCW.

    2. A row for TPCW was added.

    3. A row for refilling a unit's own RWST was added.

    4. The diesel compressors of the Instrument Air system do not depend on any other system.

    5. The following components do not require HVAC: CVCS pumps, 4.16 kV AC buses, 125 VDC buses, high-head safety injection pumps, and LHSI/RHR pumps.

3.2 Generic Change in IMC 0609 for Guidance to NRC Inspectors

No specific recommendation for changes to IMC 0609 was identified as a result of this benchmarking exercise. Progress has been made in using the SDP notebook for evaluating inspection findings; however, additional training may be needed to resolve some of the remaining issues.

3.3 Generic Change to the SDP Notebook

No generic change was identified.

List of Participants

Rudolph Bernhard	(NRC/Region II)
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Craig Mowrey	(FPL)
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