April 25, 2003

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SUBJECT: RESULTS OF THE EDWIN I. HATCH GENERATING STATION UNITS 1 AND 2 SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During November, 2002, NRC staff and contractors visited the Southern Nuclear Company in Birmingham, Al to compare the Edwin I. Hatch Generating Station Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. The Hatch 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 Hatch were also compared with the licensee's risk model. The results of the SPAR model benchmarking effort will be documented in next revision of the SPAR (revision 3) model documentation.

The benchmarking visit identified that there was good correlation between the Phase 2 SDP Notebook and the licensee's PSA. The results indicate that the Hatch Phase 2 notebook was generally more conservative in comparison to the licensee's PSA. The revision 1 SDP notebook will capture 90% of the risk significance of inspection findings. A summary of the results of comparisons of hypothetical inspection findings between SDP notebook and the licensee's PSA are as follows.

0%	Underestimates Risk Significance
63%	Match Risk Significance
27%	Overestimates Risk Significance by 1 Order of Magnitude
5%	Overestimates Risk Significance by 2 Orders of Magnitude
5%	Unable to compare with licensee's PRA.

CONTACT: Peter Wilson, SPSB/DSSA/NRR
301-415-1114

The Rev-1 SDP notebook has been greatly improved as a result of the benchmarking activity. Number of underestimates was significantly reduced (from 6 to 0). Number of cases that Rev-1 SDP would match that of the updated licensee's PSA has increased from 18 to 26. Finally, some reduction is gained for the number of overestimates.

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

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

Attachments: As stated

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

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

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SUMMARY REPORT ON RISK-INFORMED BENCHMARKING TRIP

TO THE EDWIN I. HATCH GENERATING STATION

UNITS 1 & 2

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February 2003

Attachment A

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1 INTRODUCTION

On November, 2002, the NRC conducted an SDP Benchmarking visit with the Hatch PRA staff in the Birmingham, AL corporate office (Attachment 1 provides a list of participants). The purpose of this visit was to validate the underlying assumptions of the Rev. 0, SDP Phase 2 Notebook. The validation was conducted by soliciting comments from the licensee's PRA staff; reviewing differences between the underlying assumption of the notebook and the licensee's PRA; and comparing the risk significance of hypothetical inspection findings using both the notebook and the licensee's PRA. The outcome of this SDP Benchmarking visit is the issuance of Rev. 1 of the SDP notebook. The SDP notebook is used by inspectors to make a preliminary risk assessment of inspection findings.

The Hatch SDP notebook was originally prepared in 2000. The notebook was updated in the Spring of 2000 following an April visit between the NRC, BNL, and the licensee's PRA staff. The Hatch notebook was reviewed prior to this benchmarking visit in order to identify potential changes that may be needed in order to address generic NRC changes for the Rev. 1 notebook update. These changes and questions were provided to the licensee prior to the benchmarking visit and are provided in Attachment 2.

2 SUMMARY RESULTS FROM BENCHMARKING

The benchmarking visit identified that the results obtained using the Hatch notebook were generally consistent with the risk significance calculated by the Hatch PRA. As expected, in some cases conservative results were obtained by the Hatch SDP notebook. The comparison of the significance between the licensee's PRA and the SDP Phase 2 notebook for hypothetical inspection findings is provided in Table 1. A summary of the results of the risk characterization of hypothetical findings by the SDP notebook are as follows.

0%	Underestimates Risk Significance
63%	Match Risk Significance
27%	Overestimates Risk Significance by 1 Order of Magnitude
5%	Overestimates Risk Significance by 2 Orders of Magnitude
5%	Unable to compare with licensee's PRA.

3 MODIFICATIONS TO SDP WORKSHEETS

3.1 Benchmarking Details

Benchmarking Methodology

The licensee's PRA information used during this benchmarking visit was based on the updated Revision 1A May 25, 2001 version of the Hatch PRA.[1] This PRA has an internal events CDF of 1.16E-05 events/reactor-year, including internal flooding.

The team computed the break points in RAW values for the different SDP colors based upon a current PRA total internal events CDF of 1.16E-05 events/reactor-year. The team pre-selected components and human actions, as listed in Table 1, that would be evaluated for the effect of having the component or human action fail. The team developed the color corresponding to failure of each item. The latest revised version of the notebook was used to develop the color corresponding to failure of each item and compared that to the color that would be implied by the items RAW value from the PRA. Table 1 tabulates the results of the benchmarking of both the Rev. 0 and the modified Rev. 1 worksheets that are contained in the risk-informed inspection notebook for Hatch.

In developing the colors from the notebooks, the team evaluated all sequences in each worksheet that contained the item (component or human action). A number was obtained for each re-evaluated sequence. We then used a "counting rule" to cascade lower value sequences to higher value ones as follows. For example, three sequences of value 8 (shorthand for an estimated sequence frequency of 1E-8 events/reactor-year) were equivalent to one sequence of value 7. Likewise 3 sequences of value 7 (3-7s) were equivalent 1 sequence of value 6 (1-6). Also, 3-6s were equal to 1-5, and so on. Colors were developed as follows:

Sequences of value 7, 8, and higher	Green
Sequences of value 6	White
Sequences of value 5	Yellow
Sequences of value 4 or less	Red

Non-conservative Benchmarking Results

No non-conservative results were identified for the cases analyzed as part of the benchmarking.

Conservative Benchmarking Results

As stated above, there were 13 cases for which a conservative result was obtained using the SDP notebook compared to the plant PRA. Of these, the results were conservative by two colors (i.e., by two orders of magnitude) for two cases and were conservative by one color (i.e., by one order of magnitude) for the remaining eleven cases.

The team examined the cutsets for several items that were conservative to better understand the reasons for the conservatism. We first presented a general discussion of the reasons for obtaining conservative results using the SDP notebook compared to the plant PRA and then, specifically

discussed the two cases for which the SDP notebook results are conservative by more than one order of magnitude.

Two differences that generally contributed to the conservative results by the notebook can be summarized as follows:

1. In the Hatch SDP notebook, consistent with the approach for the notebooks, the containment heat removal (CHR) by 1/4 RHR pumps and 1/4 RHR SW pumps in ½ trains is assigned a credit of "1 multi-train system", a credit of 3 which is equivalent to 1E-3. In the plant PRA, the operator failure to carry out this function has a probability of 2E-05 and the hardware failure is approximately 8E-05. This order of magnitude difference contributes to the conservative results.

2. The ATWS frequency calculated in the plant PRA is approximately one order of magnitude lower than the generic value used in the SDP notebooks.

The reasons for overestimation by two colors for the two cases, operator failure to Level control and operator failure to control LPI (overfill), can be summarized as follows:

1 Operator failure to control level at the top of the active fuel is modeled in the Hatch PRA with another level control action, operator failure to control level near 100 inches. This modeling difference along with the difference in Hatch ATWS frequency resulted in the overestimation.

2. Operator failure to control LPI after DEP in ATWS (overfill) is modeled to be required following other failures in the plant PRA, which is different from the assumption in the notebook. This difference, along with the difference in ATWS frequency, resulted in the overestimation.

3.2 Specific Changes to the Rev. 0 SDP Worksheets for Hatch

A number of changes were made to the Hatch worksheets. Refer to Attachment 2 for a detailed list of changes. These changes will be included in Rev. 1 of the Hatch SDP notebook.

3.3 Generic Changes in IMC 0609 for Guidance to NRC inspectors

None.

3.4 Generic Changes to the SDP Notebooks

None.

4 DISCUSSION ON EXTERNAL EVENTS

The licensee's updated PRA does not have an quantitative external events model.

5 REFERENCES

a) Revision 1A version of the Hatch PRA dated May 25, 2001.

b) Risk-informed Inspection Notebook for Hatch Generating Station, Revision 1.

Table 1: Summary of Benchmarking Results for Edwin I. Hatch Units 1 & 2

Internal Events CDF is 1.16E-5 events/reactor-year excluding internal flooding
at a 1E-10 truncation limit
RAW thresholds are W = 1.09, Y = 1.86, R = 9.62

Component Out of Service or Failed Operator Action	**SDP Worksheet Results (Before)**	**Hatch Basic Event**	**Hatch RAW Ratio**	**Color by Hatch RAW**	**SDP Worksheets Results (After)**	**Comments**
Component						
HPCI	R	P6SR1E41C001	7.35	Y	R	conservative
RCIC	R	P7SR1E51C001	4.89	Y	Y	
PCS steam	R	%FL-BVSD	3.3	Y	R	conservative
PCS feed	G	Truncated	~1.0	G	G	
1 SRV fto	R	CDF Calculation	4.8	Y	Y	
1 SRV ftc	R	SORV1	5.57	Y	R	conservative
CS pump A	W	MNUNCS_TRNA	1.32	W	W	
RHR pump A	Y	STPL1E11A	2.69	Y	Y	See Note 1.
RHR HX A	R	HXPL1E11B001A	2.54	Y	R	conservative
RHR HX B	R	HXPL1E11B001B	2.74	Y	R	conservative
1 CV valve	R	AVF01T48F082	15.5	R	R	
1 condensate pump	G	Truncated	~1.0	G	G	

Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before)	Hatch Basic Event	Hatch RAW Ratio	Color by Hatch RAW	SDP Worksheets Results (After)	Comments
SBLC pump	G	Truncated	~1.0	G	G	
RPT 1 train	Y	Truncated	~1.0	G	G	
RPT both trains	Y	CBF01R22S001_1	2.21	Y	Y	
EDG 1A	W	CC-DGS-22	1.91	Y	Y	
EDG 1B (shared)	W	CC-DGS-23	1.87	Y	Y	
EDG 1C	W	CC-DGS-24	2.98	Y	Y	
4160 AC (Bus 1E)	R	1R22S005	12.5	R	R	
4160 AC (Bus 1F)	R	1R22S006	21.0	R	R	
600 VAC Bus C	R	BSSH1R23S003	53.1	R	R	
1 CRD pump	G	CC-RD-2	1.0	G	G	
1 PSW pump A	R	CC-PS-3	2.0	Y	R	conservative
RHR SW pump A	Y	CC-HS-3	1.79	W	Y	conservative
RBCCW pump	G	MNUNCW_TRNB	1.08	G	G	
DC Div A panel	R	BTFD1R42S002C	12.19	R	R	
DC Station Service Bus A	R	BSSH1R22S016	247.	R	R	
DC Charger A	W	BTFD1R42S002A	4.9	Y	Y	

Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before)	Hatch Basic Event	Hatch RAW Ratio	Color by Hatch RAW	SDP Worksheets Results (After)	Comments
DC Station Service Chargers (to Bus A)	Y	BTFD1R42S001A	16.2	R	R	
1 SP vac. bkr	W	Not modeled in the PRA			W	
Failed Operator Actions						
PCS	Y	Not modeled in the PRA			Y	
DEP	R	DEA	46.	R	R	
RHR suppression cooling mode	R	OLA	538.	R	R	
VOPA	Y	VOPA	10.3	R	R	
INH for ATWS	Y	OSA	1.16	W	Y	conservative
SBLC for ATWS	Y	OSA	1.82	W	Y	conservative
Overfill for ATWS	Y	LOA	1.06	G	Y	conservative (by two colors)
LC for ATWS	Y	HOA	1.01	G	Y	conservative (by two colors)
CV	R	OPHEQV1& OPHEQV1-OL-S	15.05	R	R	
RLOOP30min	G	GRF2&3	1.0	G	W	conservative

Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before)	Hatch Basic Event	Hatch RAW Ratio	Color by Hatch RAW	SDP Worksheets Results (After)	Comments
RLOOP2.5 hours	Y	GRA2&3	1.4	W	Y	conservative

Note::

1. The RAW for RHR pumps A and B are different for the plant. The RAW for RHR B pump is 1.04, which is “Green”. However, the reason for the difference is not known and the dependencies for RHR pumps A and B will be looked at and is expected to be modified by the licensee. At this time, the conservative RAW for the RHR pump is used.

General Comments for the Table:

1. Hatch RAW for internal events, average maintenance case.
2. The Δ CDF used in RAW value calculations represented the change in CDF due to the component being out of service for 1 year.
3. For a component such as a pump, we examined the RAW values for the basic events both for “failure to start” and “failure to run,” and either selected the highest (more conservative) value here or used a synthesized RAW value separately calculated by the licensee that included all failure modes. Where the basic event column indicates “System,” the licensee calculated a system RAW by setting all the appropriate system events to true (or failed) and resolving the model to obtain the new higher CDF.
4. For those items where the basic event column is noted as “not modeled”, the PRA did not separately model the item and so a PRA RAW value was not available. For those items where the basic event column has a dash (-), an appropriate basic event could not be identified (for a variety of different reasons) or the RAW could not readily be determined.
5. When comparing the modified SDP worksheet color to the color by Hatch RAW, we found some that were conservative. Each color of conservatism represents approximately one order of magnitude in Δ CDF. In the comments column, we indicate by many orders of magnitude the item is conservative.
6. We did not have sufficient information about several systems to be able to benchmark all of the selected items using the Rev. 0 SDP notebook before the benchmarking visit.

Table 2: Comparative Summary of the Benchmarking Results

	Rev. 0 SDP Worksheets		Rev. 1 SDP Worksheets, as Modified	
	Number of Cases	**Percentage**	**Number of Cases**	**Percentage**
SDP: Non-Conservative	6	15	0	0
SDP: Conservative	(15)	(36)	(13)	(32)
by one order	12	29	11	27
by two orders	3	7	2	5
by three orders	0	0	0	0
SDP: Matched	18	44	26	63
RAW values not available	2	5	2	5
Total	41	100	41	100

Notes:

1. Prior to the onsite adjustments in the notebook, there were 15 conservative items. Of these, 3 were conservative by two orders of magnitude. After the adjustments to the notebook, there were 13 conservative items. Two of these items were two orders of magnitude conservative.

2. The 2 items that were two orders of magnitude conservative after the benchmarking were both related to ATWS and were LC and Overfill.

3. Prior to the onsite adjustments in the notebook, there were 6 non-conservative items. After benchmarking and related changes to the notebook, there were no non-conservative items remaining.

ATTACHMENT 1

List of Participants

Pete Wilson	NRC/NRR
Rudy Bernard	NRC/Region II
James Higgins	BNL
Bob Buell	INEEL
William E. Burns	Hatch; Southern Nuclear Operating Co.
Edward I. Ingram	Hatch; Southern Nuclear Operating Co.

ATTACHMENT 2

Questions and Changes to Notebook

Questions Provided to Licensee

General

1. Need latest updated PRA information, including: internal events CDF, initiating event frequencies, contribution from internal flooding, external events CDF (if available), and contributions to CDF of each major initiator.
2. Need RAW values for PRA basic events that correspond to the components, trains, and human actions listed in Table 1, attached. Ideally we need RAW values based on both internal events PRA only and on the total combined internal and external events PRA. However, the internal events RAW are most important for our benchmarking.
3. Need latest operator action HEPs, e.g., for PCS, CV, LI with condensate, LI with RHR-SW cross-tie, DEP, VOPA,, and on ATWS (CHR, OVERFILL, SBLC, LC, & INH) in worksheets.
4. Verify date and reference for new PRA information.
5. What is the preferred name and abbreviation for the Hatch Generating Station, (e.g., see top of each worksheet)?
6. Does the PRA model a loss of Instrument Air?
7. Is there a need for us to include a worksheet for LOOP combined with loss of one emergency AC bus and an SORV?
8. On a failure of CHR and CV do you assume containment failure and core damage?
9. The notebook states that "CRD pumps are modeled in the Hatch ETs to provide HPI; however, they are not sufficient by themselves to prevent CD and hence do not appear in the success criteria. CRD use provides more time for depressurization or recovery of HPI." Please discuss and update this info as necessary.

Table 2

10. Is drywell cooling credited in PRA for level I?
11. What systems require HVAC for operability? Consequences of HVAC failure as assumed in PRA?
12. If possible, provide information on the voltage levels for AC and DC system by system on Table 2.
13. What is the latest credited time for batteries on an SBO?
14. Do you have a dedicated DC supply (with battery and charger) for switchgear/circuit breaker operation?
15. Can the battery chargers supply the safety loads without the batteries?
16. Confirm support systems and components for PCS (steam cycle and feed cycle) in Table 2.
17. What is normal mode of operation (e.g., cross-tied or split train) for the following support systems: IA, PSW, RBCCW, Nitrogen?
18. Consequences of a loss of RBCCW?
19. Provide details of CV operations: valving, support systems, operator actions, and HEP. Does failure of one valve inop CV?

20. Is the N_2 system credited in PRA? Consequences of its loss?
21. Is the TBCCW (or equivalent system) credited in PRA? Consequences of its loss?

TRANS Worksheet

22. Do you credit the 4 non-ADS SRVs for DEP?
23. Do you credit the shutdown cooling mode of RHR for the CHR function?
24. Do you credit the drywell vent path for CV?
25. Are any firewater pumps credited in the PRA?

TPCS

26. Is the HEP for DEP still in the E-2 range in the current version of the PRA?

SLOCA

27. On an SLOCA with failure of the PCS & HPCI and successful RCIC, is LPI necessary?
28. Is Early Containment Control (EC) required on an SLOCA, as we have shown for MLOCA & LLOCA?

SORV

29. Since you model both SORV and IORV, what are the initiating event frequencies /failure probabilities for each portion?
30. Do you credit the stuck open SRV for DEP on an SORV event?
31. Following successful HPI with either HPCI or RCIC, is LPI still needed or can HPI last 24 hours?

MLOCA

32. What is the correct number of SRVs required for DEP on MLOCA?
33. Does Hatch still require 12/12 vacuum breakers to remain closed for Suppression Pool success?

LLOCA

34. Confirm the injection source credited for LI.

LOOP

35. Is the LOOP modeled in the Hatch PRA a single unit or dual unit LOOP?
36. Need specific times and non-recovery probabilities modeled in PRA for recovery of offsite power.
37. Verify use and credit for cross tie of the shared EDG to supply Emergency AC to Div. 1 or 2.
38. Discuss your crediting of LPCI after failure of CHR and successful CV. (Similar question for LOPSW event tree and worksheet)

ATWS

39. Are 1 or 2 SBLC pumps needed? What is the timing on the operator action for 1 versus 2 pumps?
40. Do you credit an alternate to SBLC with the TBVs and/or reactor water level control?

LODC

41. Confirm that only loss of DC Bus A is modeled. Provide the DC loads lost on LODCA.

ISLOCA and LOCA outside containment

42. Is the discussion in the notes to Worksheet 3.12 still correct for the current PRA treatment of these events?

These questions were provided to the licensee along with the updated notebook about one week prior to the benchmarking.

Notebook Changes Prior to Onsite Visit

1. Changed IORV worksheet to SORV.
2. Dropped credit for PCS from the SORV & ATWS worksheets.
3. Editorial changes.
4. Added base case credits to the worksheet sequences.
5. Corrected LOOP sequences.

Notebook Changes Made During and Following Benchmarking Visit

1. Table 1 was revised to include Large LOCA/Spurious SRV actuation (LLOCAS) and a footnote was added for placing LOPSW in Row IV.

2. Table 2 was updated considering the licensee's input.

3. Changes to the event trees and worksheets were made to give credit for throttling CV and continued use of LPI. This resulted in eliminating the need for LI following successful CV, as defined in the Rev. 0 version of the notebook.

4. Credit for DEP was changed to 1, 2, or 3 depending on the plant-specific HEPs as applicable for each of the worksheets.

5. Credit for CV was changed to 1 based on the licensee's HEP. In the licensee's PRA, only in LOPSW, the HEP for CV was assigned a value of 1E-03. No clear explanation was available for using a different credit in one scenario. In this notebook, the credit of 1 for CV remained unchanged for all scenarios modeled. The licensee plans to reevaluate the HEPs associated with CV.

6. For the CHR function, it is noted that shutdown cooling is single train.

7. SLOCA event tree and worksheet are modified to require LPI following successful HPI.

8. In MLOCA worksheet, credit for CHR using the shutdown cooling mode is removed.

9. In SORV worksheet and event tree, credit for PCS is removed to capture transients without PCS that result in a SORV.

10. Changed success criteria for EC for MLOCA and LLOCA to 11/12 vacuum breakers.

11. Large LOCA/Spurious actuation of SRVs (LLOCAS) worksheet and event tree are added.

12. LOOP event tree and worksheet are modified to drop HPCI credit on SBO sequences due to need for HVAC. Footnotes are modified.

13. ATWS worksheet and event tree are modified to remove PCS credit and to include level control (LC) as a separate function. RPT is revised to a multi-train credit.

14. Revised LODCA and LBUSC worksheets and event trees to credit crosstie of 120 VAC to allow operation of CV. LODCA is revised to credit both trains of LPCI and CS.

15. Updated LOPSW worksheet and event tree to require success of VOPA, DEP, LPI, and CV.