August 26, 2002

NOTE TO: Cynthia Carpenter, Chief
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SUBJECT: RESULTS OF THE MILLSTONE PLANT UNIT 3 SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During May, 2002, NRC staff and a contractor visited the Millstone site to compare the Millstone Plant Unit 3 (MP3) Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. MP3'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 MP3 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 MP3 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 seven 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 37 percent, overestimated by 7 percent, and adequately estimated by 56 percent. The reviewers found that if eight fixes were made to the SDP notebook, the results would be 11 percent underestimation and 15 percent overestimation of risk impacts.

Attachment A describes the process and results of the comparison of the MP3 SDP Phase 2 Notebook and the licensee's PSA.

Attachments: As stated

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301-415-1114

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SUMMARY REPORT ON BENCHMARKING TRIP

TO THE MILLSTONE NUCLEAR POWER PLANT UNIT 3

(May 13-14, 2002)

PRANAB K. SAMANTA

Energy Sciences and Technology Department
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June 2002

Attachment A

Table of Contents

Page

1. Introduction 1

2. Summary Results from Benchmarking 2

3. Proposed Modifications to Rev. 0 SDP Notebook 7

   3.1 Specific Changes to the Rev. 0 SDP Notebook for Millstone, Unit 3 7
   3.2 Generic Change in 0609 for Inspectors 8
   3.3 Generic Change to the SDP Notebook 8

4. Discussion on External Events 9

5. List of Participants 10

List of Tables

Page

Table 1. Comparison Table for Millstone, Unit 3 Benchmarking 4

Table 2. Comparative Summary of the Benchmarking Results 6

1. Introduction

A benchmarking of the Risk-Informed Inspection Notebook for Millstone, Unit 3 was conducted during a plant site visit on May 13-14, 2002. NRC staff (J. Trapp and P. Wilson) and BNL staff (P. Samanta) participated in this Benchmarking exercise.

In preparation for the meeting, BNL staff reviewed the SDP notebook for Millstone, Unit 3 and evaluated a set of hypothetical inspection findings using the Rev. 0 SDP worksheets. In addition, a copy of the meeting protocol was sent to the licensee by P. Wilson of the NRC prior to the meeting.

The major milestones achieved during this meeting were as follows:

1. Licensee's comments on the Rev. 0 SDP notebook were discussed and applicable modifications are considered in the benchmarking exercise.

2. Importance measures, including the Risk Achievement Worths (RAWs) for the basic events in the internal event model for average maintenance, was obtained from the licensee.

3. Benchmarking was conducted using the Rev. 0 SDP model and the revised SDP model considering the licensee's inputs and other modifications that were judged necessary based on comparison of the SDP model and the licensee's detailed model.

4. For cases where the color evaluated by the SDP notebook differed from that determined based on the RAW values generated by the updated licensee's PRA, results of the licensee's model including the detailed minimal cutsets were requested from the licensee. The cutsets were reviewed to understand the reason for the differences. Applicable changes were defined for the SDP model.

The changes to be incorporated in the Millstone, Unit 3 notebook were identified based on the lessons learned from benchmarking. The results of the benchmarking show that with the revised notebook 3 of the 27 cases analyzed during the benchmarking will be underestimated by one color, i.e., will be non-conservative by one order of magnitude, and 4 cases (of the 27 cases) will be overestimated by one color, i.e., will be conservative by one order of magnitude. This is a significant improvement compared to the Rev. 0 version of the notebook which would have underestimated 10 cases and overestimated 2 cases. The differences in the results for the revised notebook, to be published as a Rev. 1 version, is discussed further later in this report.

2. Summary Results from Benchmarking

This Section describes the results of the benchmarking exercise. The results are summarized in Table 1. Table 1 consists of six columns. The first column identifies the components or the case runs. The assigned colors from the SDP Rev. 0 worksheets without incorporating any modification from the benchmarking exercise are shown in the second column. The third column shows the RAW and the fourth column shows the associated colors estimated based on the licensee's generated RAW values from their latest PRA model. The fifth column presents the colors for the inspection findings based on the revisions of the SDP Rev. 0 worksheets judged applicable during benchmarking. The last column provides comments explaining the differences between the SDP and plant PRA colors.

Table 2 presents a summary of the comparisons between the results obtained using the Millstone, Unit 3 Notebook and the plant PRA. The results show that in 3 out of 27 cases, the notebook provides a "color" that is non-conservative by one order of magnitude and in 4 out of 27 cases, it provides a "color" that is conservative by one order of magnitude. In the remaining 20 cases, the results match, i.e., both the SDP notebook and the licensee's PRA determine the same color.

As noted in the table, an inspection finding associated with the following three cases will be underestimated: SBO diesel generator, the operator action to initiate feed and bleed, and the operator failure to block a stuck-open PORV. The reasons for these differences can be summarized as follows. The EDG failure to run in the plant PRA is 8.14E-02 and the EDG test and maintenance unavailability is 7.6E-03. In case of failure of the SBO diesel generator, failure of both the EDGs is approximately 1E-02 in the plant PRA, but the SDP notebook provides a credit of 3 for "1 multi-train system". This primarily contributes to the underestimation for the SBO diesel generator. For an inspection finding relating to operator action to initiate feed and bleed, the contribution of SGTR sequences is underestimated in the notebook because the SGTR frequency in the plant PRA is approximately a factor of 7 higher than that assumed in the SDP notebook. For the failure to block a stuck-open PORV, the difference results from the modeling in the SDP notebook. In the PRA, one of the contributing cutsets for a stuck-open PORV and operator failure to block is the failure of both trains of the service water (SW) system. The failure of both trains of the SW system results in failure of both HPI and direct injection by the RSS. In the notebook, a sequence due to the failure of both HPI and RSS is included, but their failure due to the common support system, the SW system, is not directly modeled. Including a SW system failure in the the SORV and SLOCA worksheets can be used to address this particular inadequacy. However, this would have deviated from the standard approach of SDP modeling and was not done.

Cases overestimated by the notebook were also analyzed and the reasons can be explained as follows:

1. MLOCA and LLOCA frequencies in the plant PRA are lower compared to the generic values used in the notebook. This difference in frequency contributed to the overestimation in the case of an accumulator. Differences in MLOCA frequency and in the probability of operator action to initiate sump recirculation in MLOCA contributed to the overestimation for 1 RSS pump.

2. Inspection finding related to 1 SW pump is overestimated because the SDP notebook conservatively increases the loss of SW frequency by one order of magnitude.

3. Overestimation for the turbine-driven AFW pump is due to small differences in a number of sequences which following the counting rule in using the notebook resulted in a higher color.

Table 1. Comparison Table for Millstone Unit 3 Benchmarking
CDF =2.04E- 5, W = 1.05(RAW), Y =1.5 (RAW), R =5.9(RAW)

Basic Event Name		SDP Before	RAW	Plant CDF Color	SDP After	Comments
1.	1 MDAFW train	Y (U)	20.24	R	R	
2.	1 TDAFW train	Y	3.51	Y	R	Over; by counting rule.
3.	1 PORV	W	1.28	W	W	
4.	1 HPSI train	W (U)	3.4	Y	Y	
5.	1 Charging train	W (U)	3.42	Y	Y	
6.	1 RSS pump	W (O)	1.034	G	W	Over; differences in MLOCA frequency and in the probability of operator failure to establish sump recirculation results in the overestimation.
7.	1 MFW pump	G	1.0	G	G	
8.	1 Condensate pump	G	1.0	G	G	
9.	1 Accumulator	R (O)	3.18	Y	R	Over; differences in MLOCA and LLOCA frequency contribute to the difference in results.
10.	1 RHS Pump	G (U)	1.054	W	W	
11.	1 BAT Pump	G	1.0	G	G	
12.	1 RPCCW Pump	G (U)	1.069	W	W	
13.	1 EDG	W (U)	3.32	Y	Y	

Basic Event Name		Before	RAW	Plant CDF Color	After	Comments
14.	2 EDGs	R	14.2	R	R	
15.	SBO DG	W (U)	1.69	Y	W	Under; EDG failure to run probabilities is 8E-02.
16.	1 IA Compressor	G	1.0	G	G	
17.	1 AC Bus	R	155.	R	R	
18.	1 DC Bus	R	322.5	R	R	
19.	1 SW train	Y	3.42	Y	R	Over; Increase in LOSW frequency by one order of magnitude is conservative.
20.	1 EGLS	W	1.43	W	W	
21.	1 TPCCW	G	1.0	G	G	
22.	1 MSIV	Y	2.19	Y	Y	
	Operator Actions					
23.	Feed and Bleed	Y (U)	5.98	R	Y	Under; SGTR frequency is a factor of 7 higher in the plant PRA.
24.	Fail to emergency borate	W	1.08	W	W	
25.	Fail to HPR	R	23.87	R	R	
26.	Fail to DEP following SLOCA	G (U)	1.108	W	W	
27.	Fail to block PORV	G (U)	1.51	Y	W	Under; common service water dependency of HPI and RSS contribute to the underestimation.

Table 2: Comparative Summary of the Benchmarking Results

Comparisons	Rev. 0 SDP Notebook		Following Benchmarking	
	Total Number of Cases Compared = 27			
	Number of Cases	Percentage	Number of Cases	Percentage
SDP: Less Conservative	10	37	3	11
SDP: More Conservative	2	7.4	4	15
SDP: Matched	15	55.6	20	74

3. Proposed Modifications to Rev. 0 SDP Notebook

A set of modifications were proposed for the Rev. 0 SDP notebook as a result of the site visit. These proposed modifications are driven by the licensee's comments on the Rev. 0 SDP notebook, better understanding of the current plant design features, revised Human Error Probabilities (HEPs), modified initiator frequencies, and the results of benchmarking.

3.1 Specific Changes to the Rev. 0 SDP Notebook for Millstone, Unit 3

The licensee provided comments in the Rev. 0 SDP notebook. Most of these comments clarify the detail design, procedure, and operational features in the plant and they will be incorporated in the next revision of the SDP. The following comments were considered to be important for the Benchmarking exercise and were considered for color determination.

1. Adjustments were made to the mitigation capability of the safety functions and the credits defined consistent with the plant PRA information and guidance for notebook development. They are as follows:

    - Credit for the feed and bleed function (FB) is defined as operator action = 1, since the associated error probability in the PRA is 6E-02.

    - Credit for the high pressure injection (HPI) is revised to "1 multi-train system", since both the charging and HPSI trains are supported by the same two-train component cooling water system.

    - Credit for high pressure recirculation (HPR) in MLOCA and LLOCA is changed to 2 because of the higher operator error probability assigned for this action under these scenarios.

2. For SLOCA and SORV worksheets and event trees, PDEP function is not required and is removed.

3. For different LOCA and SORV events, LPR is removed. Sump recirculation or high pressure recirculation (HPR) or direct injection using the RSS pumps is used.

4. For the SGTR worksheet, in depressurizing RCS under the EQ function operators can use the PORVs. Use of PORVs is included. Also, 1 MDAFW train, as opposed to both MDAFW trains, is credited to be consistent with the success criteria in the PRA.

5. The MSLB worksheet and event tree are modified by removing the requirement for controlled HPI following successful HPI, AFW, and FWI.

6. The ATWS event tree and worksheet are modified to remove credit for primary pressure relief and turbine trip. With successful emergency boration, success of 1 train of AFW is required.

7. In the LEAC worksheet and event tree, operator failure to align seal injection by starting the spare charging train is modeled. Failure of this action leads to a small LOCA.

8. A separate worksheet for Loss of instrument air (LOIA) is added.

3.2 Generic Change in 0609 for Inspectors

None identified during this benchmarking.

3.3 Generic Change to the SDP Notebook

During this benchmarking, for the high pressure injection function (HPI) which can be conducted using 1/2 charging or 1/2 SI pumps was reduced to 1 multi-train system. This is because both the charging and SI pumps need the component cooling water system (a two-train system). This situation may apply to other Westinghouse 4-loop plants.

The underestimation noted in case of the operator failure to block the stuck-open PORV resulted from the modeling approach. In this case, two functions which are modeled separately have a common support system. Under two initiating events, these two functions appeared in the same sequence and caused an underestimation. This situation can be addressed by directly modeling the support system in the applicable initiators. Such modification to the SDP modeling approach can be considered if such situations arise in other plants.

4. Discussion on External Events

The integrated external event PRA model was not available for the Millstone Unit 3 plant. No evaluation was conducted for the external event risk during the benchmarking exercise.

5. List of Participants

Peter Wilson	USNRC - NRR
James Trapp	USNRC - Region I
Pranab Samanta	BNL