September 22, 2003

NOTE 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 GINNA GENERATING STATION SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During July, 2003, NRC staff and contractors visited the Ginna Generating Station in Rochester, NY to compare the Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. The Ginna PSA included external initiating events, so 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 Ginna 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 Ginna Phase 2 notebook was generally more conservative in comparison to the licensee's PSA. The revision 1 SDP notebook will capture 95% 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.

5%	Underestimates Risk Significance
57%	Match Risk Significance
24%	Overestimates Risk Significance by 1 Order of Magnitude
12%	Overestimates Risk Significance by 2 Orders of Magnitude
2%	Overestimates Risk Significance by 3 Orders of Magnitude

CONTACT: Richard Rasmussen, SPSB/DSSA/NRR
301-415-8380

The sensitivity study performed on the impact of external initiators showed a significant effect on the benchmarking outcome. This comparison showed that the inclusion of external events increased 33% of the hypothetical events by one color. Considering external events the notebook becomes non-conservative for 24% of the findings.

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

Attachments: As stated

The sensitivity study performed on the impact of external initiators showed a significant effect on the benchmarking outcome. This comparison showed that the inclusion of external events increased 33% of the hypothetical events by one color. Considering external events the notebook becomes non-conservative for 24% of the findings.

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

Attachments: As stated

Distribution: spsb: r/f R. Rasmussen, M. Reinhart M. Parker P. Wilson

Accession #ML032660234
G:\SPSB\Rasmussen\Ginnabench.wpd NRR-

OFFICE	SPSB	SC:SPSB	SPSB:RGN-III
NAME	RRasmussen:nxh2	MReinhart	MParker/per telecon
DATE	08/29/03	09/22/03	09/07/03

OFFICIAL RECORD COPY

SUMMARY REPORT ON BENCHMARKING TRIP

TO R. E. GINNA NUCLEAR POWER PLANT

G. Martinez-Guridi

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

August 18, 2003

ATTACHMENT A

Table of Contents

Page

List of Tables

Page

1. INTRODUCTION

A benchmarking of the R. E. Ginna Nuclear Power Plant, Significance Determination Process (SDP) Risk-Informed Inspection Notebook was conducted during a plant site visit on July 29-31, 2003. Richard Rasmussen and Ogbana Hopkins (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 Ginna Nuclear Power Plant 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 overestimates and reviewed the licensee's PRA model to determine the underlying reasons. Additional changes to the SDP notebook were proposed, as appropriate.

Chapter 2 presents a summary of the results obtained during benchmarking, Chapter 3 discusses the proposed revisions to the Rev. 0 SDP notebook, and Chapter 4 discusses the results from both internal and external events. Finally, Attachment 1 shows a list of the participants in the benchmarking activities.

2. SUMMARY RESULTS FROM BENCHMARKING

Summary of Benchmarking Results

Benchmarking of the SDP Notebook for the Ginna Nuclear Power Plant was conducted comparing the risk significance of the inspection findings obtained using the notebook with that obtained using the plant PRA. The benchmarking identified the hypothetical inspection findings for which the results of the evaluation using the notebook were under or overestimations compared to the plant PRA.

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

4.76% (2 of 42 cases)	Non-conservative; underestimation of risk significance (by one order of magnitude)
2.38% (1 of 42 cases)	Conservative; overestimation of risk significance (by three orders of magnitude)
11.90% (5 of 42 cases)	Conservative; overestimation of risk significance (by two orders of magnitude)
23.81% (10 of 42 cases)	Conservative; overestimation of risk significance (by one order of magnitude)
57.14% (24 of 42 cases)	Consistent risk significance

Detailed results of Benchmarking are summarized in Table 1. This table consists of eight column headings: 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 events 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 are shown in the seventh column. Finally, the eighth column presents the outcome of comparing the results between the SDP Rev. 1 notebook and the plant PRA.

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, the SDP matched the outcome from the licensee's PRA model, and the cases not modeled by the licensee. The percentages associated with these cases also are shown in this table. The revised SDP notebook was consistent (same color) in 57.14% of the inspection findings, 38.09% of overestimates, and 4.76% of underestimates.

Table 2 also can be used to compare the Rev. 1 notebook with the Rev. 0 notebook. The Rev. 1 notebook does not have any underestimate by 2 colors, and it reduced the number of underestimates by 1 color from 6 (14.29%) to 2 (4.76%). The Rev. 1 notebook also increases the number of matches from 17 (40.48%) to 24 (57.14%).

Observations on the Licensee's PRA

Two main observations on the licensee's PRA are:

1. As noted in point 22 "Tripping the RCP on loss of CCW," of the subsection 2.1 of the "Generic Guidelines and Assumptions (PWRs)" of the SDP notebook, upon loss of CCW, the motor cooling will be lost. The operation of RCPs without motor cooling could result in overheating and failure of bearings. Bearing failure, in turn, could cause the shaft to vibrate and thereby result in the potential for seal failure if the RCP is not tripped. In such cases, the operator is instructed to trip the RCPs early in the scenario (from 2 to 10 minutes after detecting the loss of cooling). Failure to perform this action is conservatively assumed to result in seal failure and, potentially in a LOCA. This failure mechanism (occurrence of seal LOCA) due to failure to trip the RCPs upon loss of motor cooling is not believed by the licensee and, hence, it is not included in its PRA model.

   To ensure consistency in the SDP notebooks, the trip of the RCPs is modeled in the SDP worksheets for special initiators involving loss of motor cooling to the RCPs, and the operator failure to do this is assumed to result in a LOCA. The Ginna SDP notebook includes failure of the operators to trip the RCPs on loss of RCP motor cooling in the "Loss of Service Water (LSSW)" and "Loss of Component Cooling Water (LCCW)" worksheets. These worksheets assume that this failure causes an RCP seal LOCA that cannot be mitigated and, hence, leads to core damage directly. Based on this model, the hypothetical finding "Operator fails to trip the RCPs after loss of RCP motor cooling" yields a color of red (3). Since the licensee does not model tripping the RCPs on loss of RCP motor cooling, this color cannot be compared with a result from the licensee's PRA. This PRA models RCP seal LOCA as a result of loss of RCP seal cooling.

2. The frequencies of some of the initiating events used in the licensee's PRA are lower than the "generic" frequencies used in the SDP notebook or in NUREG/CR-5750. The following differences were noted:

Initiating Event	Initiating Event Frequency	
	Licensee's PRA	SDP Notebook or NUREG/CR-5750
Medium LOCA	6.10E-5	1E-4 (Notebook)
Large LOCA	7.20E-6	1E-5 (Notebook)
Loss of Instrument Air	4.98E-3	9.6E-3 (NUREG)

   The values of the frequencies of these initiating events used in the licensee's PRA are believed to contribute to some of the overestimates. Some specific examples are discussed below.

Discussion of Non-conservative Results by the Notebook

The Rev. 1 notebook yielded 2 underestimates out of the 42 hypothetical findings evaluated: loss of PCS as initiator, and loss of FW/PCS as mitigation and initiator. They are discussed next.

Loss of PCS as initiator. The licensee's PRA yields white, and the notebook obtains green. On loss of main feedwater the licensee considers that according to WCAP-11992 there is a period of time during the initial portion of the cycle in which there is insufficient moderator feedback and pressurizer relief capacity to limit RCS pressure below 3200 psig when the rods cannot be manually inserted. Hence, the dominant scenario in the licensee's PRA is an ATWS that leads directly to core damage and this ATWS is triggered by the loss of main feedwater. The conditional probability of this ATWS after such loss is about 4.9E-7. The reason for the difference in colors is that the notebook currently does not model such an ATWS.

Loss of FW/PCS as mitigation and initiator. The licensee's PRA yields white, and the notebook obtains green. The main reason for the difference in colors is that the notebook currently does not model an ATWS that leads directly to core damage and this ATWS is triggered by the loss of main feedwater, as mentioned above. It is also worthwhile noting that the frequency of reactor trip in the licensee's PRA is 1.25, and the credit given by the notebook to this frequency is the generic value 1, that is, 1E-1. Hence, the sequences in the TRANS worksheet are underestimated by about one order of magnitude.

Discussion of Conservative Results by the Notebook

The Rev. 1 notebook produced 16 overestimates, 1 by three orders of magnitude, 5 by two orders of magnitude, and 10 by one order of magnitude. The overestimate by three orders of magnitude is loss of 1A or 1B battery charger. The licensee's PRA yields green, and the notebook obtains red (4). There are two battery chargers for each train, one is the "main" charger, and the other is the alternate charger. A single charger is designed to provide the necessary DC power for each train. Both chargers are operated in parallel. Hence, on loss of one charger, the other charger automatically picks up the loads of the associated bus, and the impact on CDF of this loss is small (green). On the other hand, according to "evaluation rule 2.1" of Inspection Manual Chapter (IMC) 0609 Appendix A, this hypothetical finding is evaluated by assessing the "base case" value of all sequences affected by one train of DC power. This approach to evaluating this finding, in combination with the "counting rule," leads to this overestimate.

The 5 overestimates by two orders of magnitude are one SW pump train fails, one Accumulator fails, failure of a containment sump valve for recirculation, one MSIV fails to close, and operator fails to align fire water to SAFW pump suction during LSSW. They are discussed next.

One SW pump train fails. The licensee's PRA yields green, and the notebook obtains yellow. There are three contributors to this difference in colors: (1) the licensee estimates a failure probability of about 1E-2 for the TDAFW pump, while the notebook assigns a generic credit of 1, that is, 1E-1. (2) The licensee estimates a HEP of 1.39E-2 for the operator aligning 1/2 SAFW trains and aligning fire water to SAFW train suction. However, since aligning fire water to SAFW train suction has to be carried out outside of the control room and the time available to implement this action is limited by the time before steam generator dryout, we assigned a credit = 1, that is, 1E-1. (3) The licensee estimates the frequency of total loss of SW as 5.80E-5 per year. Since this

frequency is close to the next category of initiating events, we gave it a credit = 4, that is, 1E-4 per year.

One Accumulator fails. The licensee's PRA yields green, and the notebook obtains yellow. There are two contributors to this difference in colors: (1) the licensee estimates a probability of 0.019 for the break of a large LOCA to be in a location preventing the injection of an accumulator, while the SDP notebook assumes (with a probability of 1) that one accumulator is not available for injection due to the large LOCA. (2) The licensee estimates the frequency of large LOCA as 7.20E-6 per year, while the SDP notebook uses a generic credit = 5, that is, 1E-5 per year.

Failure of a containment sump valve for recirculation. The licensee's PRA yields green, and the notebook obtains yellow. The licensee considers that on loss of this valve, both trains of RHR are still available for high-pressure and low-pressure recirculation (HPR and LPR). Therefore, the impact on CDF of this loss according to the licensee's PRA is small (green). On the other hand, according to "evaluation rule 2.1" of IMC 0609 Appendix A, this hypothetical finding is evaluated by assessing the "base case" value of all sequences involving HPR and LPR. This approach to evaluating this finding, in combination with the "counting rule," leads to this overestimate.

One MSIV fails to close. The licensee's PRA yields green, and the notebook obtains yellow. The SDP notebook considers that after a main steam line break, failure of both MSIVs to close causes pressurized thermal shock (PTS) and core damage. This scenario is not modeled by the licensee and, hence, the loss of one MSIV has more impact on CDF in the model of the SDP notebook than in the licensee's PRA model.

Operator fails to align fire water to SAFW pump suction during LSSW. The licensee's PRA yields green, and the notebook obtains yellow. There are two contributors to this difference in colors: (1) the licensee estimates a failure probability of about 1E-2 for the TDAFW pump, while the notebook assigns a generic credit of 1, that is, 1E-1. (2) The licensee estimates the frequency of total loss of SW as 5.80E-5 per year. Since this frequency is close to the next category of initiating events, we gave a credit = 4, that is, 1E-4 per year.

The 10 overestimates by one order of magnitude are one MDP AFW fails, one primary PORV fails to open, one primary PORV fails to close, one primary block valve fails to close, loss of Battery A (BTRYA), loss of Battery B (BTRYB), operator fails to switchover in HPR, operator fails to switchover in LPR, operator fails to recover AC power in < 3 hours after a LOOP, and operator fails to align fire water for TDAFW lube cooling in LSSW. The reasons causing the overestimates by one color were not further investigated per the benchmarking process for this kind of estimate. However, as mentioned above, the values of the frequencies of some of the initiating events used in the licensee's PRA are believed to contribute to some of the overestimates.

<u>Changes Incorporated Following Benchmarking Resulting in Updating of Benchmarking Results</u>

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

Table 1 Summary of Benchmarking Results for Ginna - Internal Events
Internal Events CDF is 1.40E-5 per year (truncation value = 1E-10 per year) (Revision 4.3 of PRA)
RAW Thresholds are White = 1.07, Yellow = 1.72, and Red = 8.15

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
	Component						
1	480 VAC Emergency Bus 16 fails	Red (4) (match)	ACB2FBUS16	11.65	Red (4)	Red (4)	Match
2	Diesel generator A fails	White (under by 1)	DGDGF0001A DGTM00001A DGTM0OUT1A DGDGA0001A DGTM00001AX	7.23	Yellow	Yellow	Match
3	One MDP AFW fails	White (over by 1)	AFMMMDFP1A AFMPAPAF1A AFTMMAFSGA AFMPFPAF1A AFTMMAFSGAX	1.02	Green	White	Over by 1
4	TDP AFW fails	Yellow (match)	AFTPFTDAFW AFMM0TDAFW AFTM0TDAFWX AFTPATDAFW AFTM0TDAFW	1.73	Yellow	Yellow	Match
5	One CCW pump train fails	Red (3) (over by 2)	CCMPFTPMPA CCMPFIPMPA CCMPAPMPAI CCMMPUMPAI CCMMPUMPAT	4.31	Yellow	Yellow	Match
6	One SW pump train fails	Red (4) (over by 3)	SWMPFISW1A SWMPFSW01A SWMPASW1AI	1.0	Green	Yellow	Over by 2

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
7	One IA compressor fails	Green (match)	IAAMA_C02C IAAMFIC02C IAMMCIA2CI	1.0	Green	Green	Match
8	One service air compressor fails	Green (match)	IAMMISERAR IAMMSERAIR IATMSACOMP IAAMFICSA2 IAAMA_SAC0 IAAMFCSA02	1.0	Green	Green	Match
9	Loss of IA	White (match)	TIIALOSS	1.34	White	White	Match
10	One CS pump train fails	Green (match)	CSTMTRAINA CSMMPSI02A CSTMTRAINAX CSMPFSI02A CSMPASI02A	1	Green	Green	Match
11	One SAFW pump train fails	White (match)	AXMMSAFWPC AXTMSAFSGAX AXMPFPSF1A AXMPAPSF1A AXTMSAFSGA	1.17	White	White	Match
12	One SI pump fails	Yellow (over by 1)	SIMPFSI01A SRMPASI01A SIMPASI01A SRMPFSI01A SITM0PSI1A SITM0PSI1AX SIMMPSI01A	1.61	White	White	Match

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
13	One SI train fails	Yellow (match)	SITMTRAINA SRMMINJECB SIXVR0878A SIXVK0878D SIMVK0871A SRXVK0878D SIXVK0871A SIPPJMBL0A SIPPJLBL0A	2.69	Yellow	Yellow	Match
14	One charging pump fails	Green (match)	CVTMCHPMPAX CVMPAPCH1A CVMPFPCH1A CVMMPCH1AA CVMMPCH1AF CVTMCHPMPA	1.01	Green	Green	Match
15	One RHR pump fails	Yellow (match)	RHTM00000A RRMMAC01AA RHMMAC01AA RRMMAC01AF RHTM00000AX RRMPFAC01A RHMMAC01AF RRMPZPUMPB RHMPAAC01A RHMPFAC01A RRMPAAC01A	2.24	Yellow	Yellow	Match
16	One CRFC fails	Green (match)	HVMFFACF8A HVTMCTMT_A HVTMCTMT_AX HVMMACF8AF HVMMACF8AA HVMFAACF8A	1	Green	Green	Match

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
17	One Accumulator fails	Yellow (over by 2)	SITKGSI3AN SITKGSI3AS SITKGSI3AL	1	Green	Yellow	Over by 2
18	Loss of PCS as initiator	Green (under by 1)	TIFWLOSS	1.08	White	Green	Under by 1
19	Loss of FW/PCS as mitigation and initiator	Green (under by 1)	TIFWLOSS	1.08	White	Green	Under by 1
20	Failure of an ARV to open	White (under by 1)	MSRVN03410	2.96	Yellow	Yellow	Match
21	Failure of a containment sump valve for recirculation	White (over by 1)	RHMVC0850A RRMVN0850A RRMM00850A	1.00	Green	Yellow	Over by 2
22	One MSIV fails to close	Yellow (over by 2)	MSAVC03516	1	Green	Yellow	Over by 2
23	One primary PORV fails to open	White (over by 1)	RCRZN00430	1	Green	White	Over by 1
24	One primary PORV fails to close	Yellow (over by 1)	RCRZT00430	1.68	White	Yellow	Over by 1
25	One primary block valve fails to close	White (over by 1)	RCMM000515 RCMVC00515	1.02	Green	White	Over by 1
26	One primary safety valve fails to open	White (match)	RCRYN00434	1.22	White	White	Match
27	Loss of Battery A (BTRYA)	Red (4) (over by 2)	DCBTD0001A DCBTF0001A	1.28	White	Yellow	Over by 1
28	Loss of Battery B (BTRYB)	Red (4) (over by 2)	DCBTD0001B DCBTF0001B	1.26	White	Yellow	Over by 1

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) (1)	Basic Event Name	Internal RAW	Plant CDF Color (2)	SDP Worksheet Results (After) (1)	Comments
29	Loss of DC bus A or B	Red (3) (match)	DCBDFMAINA	74.61	Red (3)	Red (3)	Match
30	Loss of 1A or 1B battery charger	Yellow (over by 2)	DCBCF0000A DCBCF000A1	1	Green	Red (4)	Over by 3
	Operator Actions						
31	Operator fails to conduct Feed/Bleed	Green (under by 1)	RCHFP01BAF	1.11	White	White	Match
32	Operator fails to switchover in HPR	Yellow (over by 1)	SRHFDRECRC	1.28	White	Yellow	Over by 1
33	Operator fails to switchover in LPR	Red (3) (over by 1)	RRHFDRECRC-SS	12.58	Red (4)	Red (3)	Over by 1
34	Operator fails to recover AC power in < 1 hour after a LOOP	Green (under by 1)	ACAZDLOSP1	1.39	White	White	Match
35	Operator fails to recover AC power in < 3 hours after a LOOP	Yellow (over by 1)	ACAZDLOSP2	1.15	White	Yellow	Over by 1
36	Operator fails to depressurize RCS and perform rapid cool down	Yellow (match)	RCHFDCD0SS	2.49	Yellow	Yellow	Match
37	Operator fails to isolate the ruptured SG	Yellow (match)	MSHFPISOLR	4.4	Yellow	Yellow	Match
38	Operator fails to equalize in SGTR	Green (under by 2)	RCHFPCDDPR	8.09	Yellow	Yellow	Match
39	Operator fails to align RHR/SDC	Yellow (match)	RRHFDCLXH2	1.96	Yellow	Yellow	Match

No.	Component Out of Service or Failed Operator Action	SDP Worksheet Results (Before) [1]	Basic Event Name	Internal RAW	Plant CDF Color [2]	SDP Worksheet Results (After) [1]	Comments
40	Operator fails to align fire water for TDAFW lube cooling in LSSW	Yellow (over by 1)	AFHFDALTTD	1.37	White	Yellow	Over by 1
41	Operator fails to conduct emergency boration after ATWS	White (match)	CVHFDBORAT	1.11	White	White	Match
42	Operator fails to align fire water to SAFW pump suction during LSSW	Yellow (over by 2)	AXHFDCITYW	1.01	Green	Yellow	Over by 2

Notes:

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

2. When the color corresponding to the plant’s CDF is red, the number in parentheses 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 - Ginna Nuclear Power Plant

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	2.38	0	0.00
Less conservative by one color	6	14.29	2	4.76
More conservative by one color	10	23.81	10	23.81
More conservative by two colors	7	16.67	5	11.90
More conservative by three colors	1	2.38	1	2.38
Matched	17	40.48	24	57.14
Total	42	100.0	42	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 the Ginna Nuclear Power Plant

The NRC staff participating in the benchmarking and the licensee provided several comments on the Rev. 0 SDP Notebook. In addition, several major revisions that directly impacted the color assignments by the SDP evaluation were discussed with the licensee and their resolutions were identified in the meeting. Several significant changes that had an impact on the evaluation of the notebook were incorporated during the visit, including revised HEPs and initiator frequencies. The proposed revisions are discussed below:

1. Table 2. Updated the Core Damage Frequency (CDF) for Internal Events only (not including floods) to 1.40E-5 per year (Revision 4.3 of PRA). Also included the CDF from internal events and external events (flooding and fires): 3.86E-5 per year. These values were obtained using a truncation value = 1E-10 per year.

2. Table 2. Added row for Accumulators, including major components and relevant initiating events.

3. Table 2. Added row for AMSAC, including support system and relevant initiating event. Also added footnote indicating that AMSAC has 6 actuation channels; 4 from MFW and 2 from the main turbine.

4. Table 2. Added row for Containment Recirculating Fan Coolers (CRFCs), including support systems and relevant initiating events.

5. Table 2. Created separate rows for the following components of Chemical and Volume Control System (CVCS): Charging pumps and Boric Acid Transfer pumps. Assigned each type of pump to its unique support systems and relevant initiating event.

6. Table 2. Removed SGTR, MSLB from the Initiating Events impacted by the "Condensate/MFW" because the PCS is considered to be unavailable after these initiating events.

7. Table 2. Added row for Fire water (used in LSSW), including support systems and relevant initiating event. Also added footnote indicating that the motor-driven pump of Fire water does not require component cooling nor room cooling.

8. Table 2. Added one diesel compressor to IA.

9. Table 2. Updated support systems of IB, and added footnote indicating that buses A and C of IB are normally powered by DC (inverters A and B). Backup power is supplied by 480 VAC.

10. Table 2. Created separate rows for the following components of Main Steam: ARV, MSIV, and MSSVs. Assigned each component to its unique support systems and relevant initiating events.

11. Table 2. Created separate rows for the following components of Pressurizer Pressure Relief: PORV, block valves, safety valves, and spray valves. Assigned each component to its unique support systems and relevant initiating events.

12. Table 2. Added a note indicating that SW provides the suction source for SAFW.

13. Table 2. Added a footnote indicating that in the event of a loss of the battery of one DC train, the Technical Support Center (TSC) battery may be manually cross-tied to this train. The station batteries are designed to provide a minimum of 4 hours of service after a loss of AC power. They can provide up to 6 hours for the TDAFW pump.

14. Table 2. Added a footnote indicating that there are two battery chargers for each DC bus, one is the “main” charger, and the other is the alternate charger. Both chargers are operated in parallel. A single charger is designed to provide the necessary DC power for each train. Each charger is capable of starting and carrying the SI loads.

15. Table 2. Added a footnote indicating that for each DC train, the battery and two battery chargers supply a main fuse cabinet, which supplies the main DC distribution panel and other distribution panels in the DG room, the main control board, the Auxiliary Building, and the Screenhouse.

16. Table 2. Added a footnote indicating that the ARVs are energized to open, and fail closed on deenergization.

17. Table 2. Added a footnote indicating that the pneumatical supply to the ARVs is provided by the IA system, and backup supply is provided by the nitrogen supply systems. The ARVs can be manually operated with a handwheel mounted on each valve.

18. Table 2. Added a footnote indicating that the MSIVs are air-operated swing check valves which fail closed on loss of air.

19. Table 2. Added a footnote indicating that an MSIV fails as is on loss of DC.

20. Table 2. Changed the Initiating Events impacted by the “Two block valves (of PORVs)” to just “SORV” because this is the only scenario in which these valves are evaluated.

21. Table 2. Removed ATWS from the Initiating Events impacted by the “RHR” because the RHR is not used in the worksheet for ATWS.

22. Table 2. Added a footnote indicating that Ginna has qualified, high temperature O-rings in its RCP seals.

23. Table 2. Added a footnote indicating that the SAFW motor-driven pumps do not require any cooling water.

24. Table 2 and LSSW worksheet. Added a footnote indicating that the SAFW system is located in the SAFW building. The room cooling consists of two Service Water System-cooled HVAC units (one unit dedicated to each SAFW pump area) that are automatically started whenever the pumps are started. The cooling units are safety-related and required to be available during all modes of operation. If the room coolers are lost to the SAFW Building, the door can be opened and fans installed to provide cooling. The licensee considers that 1) this is a relatively simple action as the SAFW Building is located south of the Aux Bldg and has its own entrance to the outside, and 2) all equipment in the room is qualified to 120OF and the room is large compared to the amount of equipment located within the room. In addition, the fire (city) water supply can be manually connected to directly supply both the pumps and the room coolers of SAFW. That is, the line from city water goes directly to the pump suction and the room cooler entrance. The licensee considers that the water source and pressure are more than adequate to support both functions.

25. All applicable worksheets. Changed success criteria of “Early Inventory, High Pressure Injection (EIHP)” to “1/3 HPSI pumps in 2 trains” because the 3 pumps of HPSI can start automatically. The success criteria for “High Pressure Recirculation (HPR)” also was updated to “1/3 HPSI pumps in 2 trains with...”

26. All applicable worksheets. Changed credit of “Feed/Bleed (FB)” from “operator action = 1" to “operator action = 2” because the licensee assessed a human error probability (HEP) = 2.62E-2.

27. All applicable worksheets. Changed credit of “High Pressure Recirculation (HPR)” from “operator action = 3" to “operator action = 2” because the licensee assessed a human error probability (HEP) = 1.4E-2.

28. TRANS, SLOCA and SORV worksheets. Changed credit of “Standby AFW or MFW (SAFW/MFW)” from “operator action = 3" to “operator action = 2.” The licensee assessed a human error probability (HEP) for operator failure to align SAFW pump and operator failure to reestablish MFW equal to 2.94E-3 and 4.22E-3, respectively. Since these actions have a common diagnosis, and the time available to implement them is limited by the time before steam generator dryout, we assigned a credit = 2.

29. SLOCA and SORV. The event trees and worksheets were modified so that core damage follows after failure of all Secondary Heat Removal (AFW, SAFW, and MFW). Updated the sequence numbers in the worksheets. Added footnote indicating that the licensee models both small small LOCA and small LOCA. The licensee made analysis showing that secondary heat removal is necessary for the former LOCA, but it is not required for the latter LOCA. In these worksheets we model the most limiting case, requiring secondary heat removal.

30. SLOCA and SORV worksheets. Added 1/2 pressurizer sprays to the function “RCS Cooldown/Depressurization (RCSDEP).”

31. SLOCA worksheet. Changed the credit for the function "Accumulators (ACC)" from "1/1 Accumulator (1 train)" to "1/2 Accumulators (1 multi-train system)" because the break in a small LOCA is not expected to divert significantly the accumulator's flow.

32. SORV. Added new event tree and updated sequence numbers in the worksheet.

33. SORV worksheet. Changed success criteria of PORVs for the function "RCS Cooldown/Depressurization (RCSDEP)" from "1/2 PORVs" to "1/1 PORV" because the stuck-open PORV may be partially open.

34. SORV worksheet. Included specific success criteria of SG ARVs for the function "RCS Cooldown/Depressurization (RCSDEP)": "1/2 SG ARVs."

35. MLOCA worksheet. Changed credit of "Low Pressure Recirculation (LPR)" from "operator action = 3" to "operator action = 2" because the licensee estimated a HEP = 5.25E-3 for this function.

36. LLOCA worksheet. Changed credit of "Low Pressure Recirculation (LPR)" from "operator action = 3" to "operator action = 2" because the licensee estimated a HEP = 1.3E-2 for this function.

37. LOOP worksheet. Added components and their success criteria for steam relief in the function "Turbine-driven AFW pump (TDAFW)": "1/2 ARVs or 1/8 MSSVs."

38. LOOP worksheet. Changed credit of TDAFW from "1 train" to "1 ASD train."

39. LOOP worksheet. Changed success criteria of PORVs for the function "RCS Cooldown/Depressurization (RCSDEP)" from "2/2 PORVs" to "1/2 PORVs" to be consistent with the success criteria used in the SLOCA worksheet for this function.

40. LOOP worksheet. Included specific success criteria of SG ARVs for the function "RCS Cooldown/Depressurization (RCSDEP)": "1/2 SG ARVs."

41. LOOP worksheet. Changed success criteria and credit of Accumulators from "1/1 Accumulator (1 train)" to "1/2 Accumulators (1 multi-train system)."

42. LOOP event tree. Added sequences after success of the function "Emergency AC Power (EAC)." These sequences were already included in the LOOP's worksheet. Renumbered sequences of event tree in worksheet.

43. SGTR worksheet. Added footnote indicating that the affected SG is credited by procedures and by the licensee's PRA. Accordingly, changed the success criteria for steam relief in the function "Secondary Heat Removal (AFW)" to "1/2 ARVs or 1/8 MSSVs."

44. SGTR worksheet. Added equipment and success criteria for steam relief in the function "Standby AFW (SAFW)": "1/2 ARVs or 1/8 MSSVs."

45. SGTR worksheet. Changed success criteria for the function "Pressure Equalization (EQ)" from "Operator depressurizes RCS using 1/1 SG ARV (on each SG fed by AFW) or RCS

pressurizer PORV (1/2)...” to “Operator depressurizes RCS using 1/1 SG ARV (on each SG fed by AFW) and 1/2 pressurizer PORVs...”

46. SGTR worksheet. Added footnote indicating that the licensee assessed a HEP = 1.6E-2 for the function “Residual Heat Removal (RHR).”

47. ATWS worksheet. Changed credit of the function “Emergency Boration (EMBO)” to 1 because the licensee assessed a HEP = 5.0E-2 for this action.

48. ATWS worksheet. Changed credit of the function “AMSAC (AMSAC)” from “1 multi-train system” to “1 train” to be consistent with the credit assigned to AMSAC in similar plants.

49. ATWS worksheet. Changed the success criteria for the function “Secondary Heat Removal (AFW)” from “2/3 AFW pumps to at least 1/2 SGs plus 8/10 ARVs or MSSVs (1 multi-train system)” to “[2/2 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train)] to 1/2 SGs with 8/10 ARVs or MSSVs” to specify accurately the requirements of AFW for ATWS.

50. MSLB worksheet and event tree. The standard model for MSLB in a Westinghouse PWR is not used for Ginna because the licensee’s analysis shows that a) high-pressure injection is not required to mitigate an MSLB, and b) stopping this injection is not required because the HPSI pumps have a shutoff head of about 1500 psig, so the pumps do not contribute significantly to pressurizing the primary system.

51. MSLB worksheet and event tree. A new plant-specific event tree was developed, including the potential of an MSLB to make the AFW system inoperable.

52. LOIA worksheet. Updated the frequency of total loss of SW to 4.98E-3 per year.

53. LOIA. Added event tree.

54. LSSW worksheet. Updated the frequency of total loss of SW to 5.80E-5 per year. Since this frequency is close to the next category of initiating events, we gave it a credit = 4.

55. LSSW worksheet. Changed the credit of “Lube Oil Cooling for TDAFW (TDLUBE)” from “operator action = 1” to “operator action = 2” because the operator action in the licensee’s PRA has a HEP of 7.46E-3.

56. LSSW worksheet. Changed the credit of “Trip RCP (RCPTP)” from “operator action = 1” to “operator action = 3” because of the use of the generic SDP credit for this action.

57. LCCW worksheet. Updated the frequency of total loss of SW to 8.05E-4 per year. Since this frequency is close to the next category of initiating events, we gave it a credit = 3.

58. LCCW worksheet. Changed the credit of “Trip RCP (RCPTP)” from “operator action = 1” to “operator action = 3” because of the use of the generic SDP credit for this action.

59. LCCW worksheet. The description of the LCCW (footnote 1) was corrected because Turbine building cooling is not lost after a LCCW.

60. LEAC worksheet and event tree. Deleted sequences where PORV successfully re-close.

61. LEAC worksheet. Changed the credit of LPR from “operator action = 3" to “1 train,” and added a footnote indicating that this function has a credit of operator action = 3, limited by hardware failure. The credit of the relevant sequences was updated.

62. LEAC worksheet. Added equipment and success criteria for steam relief in the function “Standby AFW (SAFW)”: “1/2 ARVs or 1/8 MSSVs.”

63. LEAC worksheet. Changed success criteria of PORVs for the function “RCS Cooldown/Depressurization (RCSDEP)” from “1/2 PORVs” to “1/1 PORV” because the stuck-open PORV may be partially open, and hence it cannot be credited for this function.

3.2 Generic Change in IMC 0609 for Guidance to NRC Inspectors

Based on the lessons from this benchmarking, 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 CDF from internal events and external events (flooding and fires) is 3.86E-5 per year, obtained using a truncation value = 1E-10 per year. Out of this total CDF, internal events contribute 1.40E-5 per year, fires (including explosions) contribute 1.18E-5 per year, and floods contribute 1.28E-5 per year. The licensee indicated that the fire events were evaluated by carrying out a fire PRA.

Table 3 gives a summary of benchmarking results for both internal and external events. As seen in this table, in 14 of the 42 hypothetical findings the color due to both internal and external events is higher than the color due to internal events only. Thus, about 33.33% of the total findings increased their color due to consideration of external events. The components and human errors that increased their color are:

Increase in risk-significance by 3 colors:
One charging pump fails (changes from Green to Red (4)).

Increase in risk-significance by 2 colors:
One CCW pump train fails (changes from Yellow to Red (3)),
Operator fails to align fire water to SAFW pump suction during LSSW (changes from Green to Yellow)

Increase in risk-significance by 1 color:
Diesel generator A fails (changes from Yellow to Red (4)),
One MDP AFW fails (changes from Green to White),
TDP AFW fails (changes from Yellow to Red (4)),
One SAFW pump train fails (changes from White to Yellow),
One SI pump fails (changes from White to Yellow)
One primary PORV fails to open (changes from Green to White),
One primary PORV fails to close (changes from White to Yellow),
Operator fails to conduct Feed/Bleed (changes from White to Yellow),
Operator fails to switchover in HPR (changes from White to Yellow),
Operator fails to recover AC power in < 1 hour after a LOOP (changes from White to Yellow),
Operator fails to align fire water for TDAFW lube cooling in LSSW (changes from White to Yellow).

Table 3 Summary of Benchmarking Results for Ginna - Internal and External Events
Internal and External Events CDF is 3.86E-5 per year (Revision 4.3 of PRA)
RAW Thresholds are White = 1.03, Yellow = 1.26, and Red = 3.59

No.	Component Out of Service or Failed Operator Action	Plant Internal Color (2)	Internal and External RAW	Plant Internal and External Color (2)	SDP Worksheet Results (After - Internal only) (1)	Comments
	Component					
1	480 VAC Emergency Bus 16 fails	Red (4)	37.17	Red (4)	Red (4)	
2	Diesel generator A fails	Yellow	7.86	Red (4)	Yellow	Changes from Yellow to Red (4).
3	One MDP AFW fails	Green	1.16	White	White	Changes from Green to White.
4	TDP AFW fails	Yellow	6.27	Red (4)	Yellow	Changes from Yellow to Red (4).
5	One CCW pump train fails	Yellow	29.62	Red (3)	Yellow	Changes from Yellow to Red (3).
6	One SW pump train fails	Green	1	Green	Yellow	
7	One IA compressor fails	Green	1	Green	Green	
8	One service air compressor fails	Green	1	Green	Green	
9	Loss of IA	White	1.12	White	White	
10	One CS pump train fails	Green	1	Green	Green	
11	One SAFW pump train fails	White	1.53	Yellow	White	Changes from White to Yellow.
12	One SI pump fails	White	1.34	Yellow	White	Changes from White to Yellow.
13	One SI train fails	Yellow	2.86	Yellow	Yellow	
14	One charging pump fails	Green	5.90	Red (4)	Green	Changes from Green to Red (4).
15	One RHR pump fails	Yellow	1.70	Yellow	Yellow	
16	One CRFC fails	Green	1	Green	Green	
17	One Accumulator fails	Green	1	Green	Yellow	

No.	Component Out of Service or Failed Operator Action	Plant Internal Color [(2)]	Internal and External RAW	Plant Internal and External Color [(2)]	SDP Worksheet Results (After - Internal only) [(1)]	Comments
18	Loss of PCS as initiator	White	1.03	White	Green	
19	Loss of FW/PCS as mitigation and initiator	White	1.03	White	Green	
20	Failure of an ARV to open	Yellow	1.71	Yellow	Yellow	
21	Failure of a containment sump valve for recirculation	Green	1	Green	Yellow	
22	One MSIV fails to close	Green	1	Green	Yellow	
23	One primary PORV fails to open	Green	1.03	White	White	
24	One primary PORV fails to close	White	1.73	Yellow	Yellow	Changes from White to Yellow.
25	One primary block valve fails to close	Green	1.02	Green	White	
26	One primary safety valve fails to open	White	1.08	White	White	
27	Loss of Battery A (BTRYA)	White	To be provided by licensee		Yellow	
28	Loss of Battery B (BTRYB)	White	To be provided by licensee		Yellow	
29	Loss of DC bus A or B	Red (3)	31.68	Red (3)	Red (3)	
30	Loss of 1A or 1B battery charger	Green	1	Green	Red (4)	
	Operator Actions					

No.	Component Out of Service or Failed Operator Action	Plant Internal Color (2)	Internal and External RAW	Plant Internal and External Color (2)	SDP Worksheet Results (After - Internal only) (1)	Comments
31	Operator fails to conduct Feed/Bleed	White	1.66	Yellow	White	Changes from White to Yellow.
32	Operator fails to switchover in HPR	White	1.73	Yellow	Yellow	Changes from White to Yellow.
33	Operator fails to switchover in LPR	Red (4)	5.22	Red (4)	Red (3)	
34	Operator fails to recover AC power in < 1 hour after a LOOP	White	1.42	Yellow	White	Changes from White to Yellow.
35	Operator fails to recover AC power in < 3 hours after a LOOP	White	1.06	White	Yellow	
36	Operator fails to depressurize RCS and perform rapid cool down	Yellow	1.54	Yellow	Red (4)	
37	Operator fails to isolate the ruptured SG	Yellow	2.23	Yellow	Yellow	
38	Operator fails to equalize in SGTR	Yellow	3.57	Yellow	Yellow	
39	Operator fails to align RHR/SDC	Yellow	1.40	Yellow	Yellow	
40	Operator fails to align fire water for TDAFW lube cooling in LSSW	White	2.40	Yellow	Yellow	Changes from White to Yellow.
41	Operator fails to conduct emergency boration after ATWS	White	1.06	White	White	
42	Operator fails to align fire water to SAFW pump suction during LSSW	Green	1.49	Yellow	Yellow	Changes from Green to Yellow.

Notes:

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

2. When the color corresponding to the plant's CDF is red, the number in parentheses 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).

5. LIST OF PARTICIPANTS

Ogbana Hopkins	Nuclear Regulatory Commission/Office of Nuclear Reactor Regulation
Richard Rasmussen	Nuclear Regulatory Commission/Office of Nuclear Reactor Regulation
Mark D. Flaherty	Rochester Gas and Electric Corporation
Raymond H. V. Gallucci	Rochester Gas and Electric Corporation
Stephen C. Kimbrough	Rochester Gas and Electric Corporation
John A. Schroeder	Idaho National Engineering and Environmental Laboratory
Gerardo Martinez-Guridi	Brookhaven National Laboratory