February 07, 2002

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SUBJECT: RESULTS OF THE CALVERT CLIFFS UNIT 1 AND 2 SDP PHASE 2 NOTEBOOK BENCHMARKING VISITS

During May, 2001and again in December 2001, NRC staff and a contractor visited the Calvert Cliffs site 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. Since a "complete" level I PRA for both Calvert Cliffs units was available, the benchmark group performed sensitivity analyses to determine the impact of not considering external event initiators and internal flooding in the current revision of the SDP notebook. In addition, the results from analyses using the NRC's draft Revision 3i Standard Plant Analysis Risk (SPAR) model for Calvert Cliffs were also compared with the licensee's risk model. The results of the SPAR model benchmarking effort will be documented in a separate a trip report to be prepared by the Office of Research.

The SDP notebook for Calvert Cliffs was significantly revised after the first site visit prior to the second site visit based on the comments generated by the licensee staff. A total of 43 hypothetical inspection findings were examined during the second site visit. In 39 cases the SDP and the licensee's PSA assigned similar colors reflecting the risk significant of the items under consideration. In two cases, the SDP color reflected a more conservative result than that of the licensee's PSA (by one color). In the remaining two cases the SDP notebook underestimated the risk significance generated by the licensee PSA by one order of magnitude. These two cases were related to the unavailability two vital 120 Vac buses. The impact of these failures could not be adequately captured using the simplified approach in the SDP notebooks.

At Calvert Cliffs, the benchmarking results showed that external event initiators impacted the risk characterization of some of the hypothetical inspection findings. External events accounted for about 70% of the total core damage frequency in Calvert Cliffs PSA (CDF of 3.99E-5 for

internal and 9.0E-5 for external events). The benchmarking group identified seven cases where external initiating events made the hypothetical inspection findings more risk significant than predicted by the phase 2 notebook. The external initiating events in all these cases increased the importance by one color.

Attachment A describes the process and results of the comparison of the Calvert Cliffs SDP Phase 2 Notebook and the licensee's PRA. Attachment A also contains the insights gained from the group's analysis of the impact of not considering external initiators and internal flooding in the current revision of the SDP notebook.

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

Attachments: As stated

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Attachment A describes the process and results of the comparison of the Calvert Cliffs SDP Phase 2 Notebook and the licensee's PRA. Attachment A also contains the insights gained from the group's analysis of the impact of not considering external initiators and internal flooding in the current revision of the SDP notebook.

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# SUMMARY REPORT ON BENCHMARKING TRIP

## to Calvert Cliffs Units 1 and 2 (May 22-23 and December 11, 2001)


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ATTACHMENT A

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# 1. Introduction

A benchmarking meeting took place at the Calvert Cliffs site on May 22-23, 2001. P. Wilson, P. O'Reilly, Eugene Cobey, Ian Chung, and J. Trapp from NRC along with T.L. Chu from BNL participated in this benchmarking exercise. Not all SDP issues and comparisons weren completed during this benchmarking trip. An additional one-day benchmarking trip was necessary to complete the task. The second benchmarking trip took place on December 17, 2001. This benchmarking report documents the overall results and insights from both of the benchmarking trips.

In preparation of the meeting, BNL staff reviewed the SDP notebook for Calvert Cliffs, evaluated the coloring of the Rev 0 SDP worksheets and collected the system diagrams and information. 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) Obtained hard copies of the risk achievement worth (RAW) values for basic events for the internal event model and full model for average maintenance. Received an Excel file containing the RAW information and the associated Delta CDF for the basic events for both internal and full model.

2) Identified a target set for the basic events for the benchmarking exercise.

3) Performed benchmarking of a subset of the target set of basic events using the Rev 0 SDP Notebook with Licensee's staff participating and providing comments on the notebooks.

5) Requested a few runs, e.g., EDG, from the licensee to determine the dominant contributors to the RAW values, to compare with the contributors captured by the notebook.

6) Obtained updated HEPs used in the Calvert Cliffs PSA.

7) Obtained descriptions of instrument air and AFW systems that should provide the details of dependencies and interconnection of the systems.

The utility staff provided extensive comments that were resolved and will be incorporated in SDP Rev 1 notebook. .

The SDP notebook for Calvert Cliffs was updated after the first site visit prior to the second site visit based on the comments generated by the licensee staff. A total of 43 hypothetical inspection findings were examined during the second site visit. Table 1 lists these items along with the associated risk significance based on the RAW values from the licensee's PSA and the SDP notebook. In 36 cases the SDP and the licensee's PSA assigned similar colors reflecting the risk significant of the items under considerations. In two cases the SDP color reflected a more conservative result than that of the licensee's PSA (by one color). In remaining five cases the SDP notebook was suspected of underestimating the risk significance generated by the licensee PSA.

In three out of these five cases the differences were not true underestimations and they were caused by the modeling techniques used in the licensee's PSA for common cause failures (CCFs). The CCFs are modeled asymmetrically in the licensee's PSA, and the ordering of the failures would impact the significance determination. Such asymmetric modeling would not impact the bottom line results but can artificially make one train of redundancy more important than the other train depending on how the CCFs are ordered. The true importance would be closer to the average importance rather than the individual importance. The SDP worksheets would then have properly estimated the average importance. We did not consider these cases as underestimates in Table 2, even though they are shown as such in Table 1. The remaining two cases of underestimations are truly considered as the underestimates even though they are shown as not modeled in Table 1. These two cases are related to the unavailability of bus 1Y09 and 1Y10. The failure of these two buses not only impacts the operation of PCS and ADVs but also would potentially impact the instrumentation associated with the level control during HPI. Even though the impact on the PCS and ADV is transparent from the SDP notebook, the effect on the instrumentation can not be easily captured. This is the reason why that these two cases are considered as true underestimates and will be so noted in the Rev 1 SDP notebook.

# 2. Summary Results from Benchmarking

This section provides the results of the benchmarking exercise. The results of benchmarking analyses are summarized in Table 1. Table 1 consists of seven column headings. In the first column, the out-of-service components, human actions, or recovery actions are identified for the case analyses. The second column shows the colors assigned for significance characterization from using the Rev 0 SDP worksheets after being updated per licensee's comments from the first benchmarking visit. The third and fourth columns show the RAW values, the associated colors, and the delta CDF based on the licensee's latest PSA model for the internal events only. The fifth and the sixth columns provide similar information for the external events only based on the licensee's latest PSA model. It should be noted that the delta CDF from internal and external should be added to obtain the total delta CDF contribution. Finally, the last column provides comments for clarification of the SDP evaluation process and the underlying reasons for any differences that might have occurred. A total of 43 cases were analyzed. 36 cases out of the 43 cases analyzed resulted in a consistent risk characterizations. In two cases the SDP worksheet over-estimated the risk importance of the items by one color. Such overestimations were expected due to the conservative approach used for developing and evaluating the SDP notebooks. In remaining five cases the differences between the SDP notebook and the licensee PSA were investigated and the reasons are discussed below:

1. In three out of these five cases (A train of SDC-HX, a train of ECCS room cooling, and a train of Containment Spray) the differences were not true underestimations and they were caused by the modeling techniques used in the licensee's PSA for common cause failures. The CCFs are modeled asymmetrically in the licensee's PSA, and the ordering of the failures would impact the significance determination. Such asymmetric modeling would not impact the bottom line results but can artificially make one train of redundancy more important than the other train depending on how the CCFs are ordered. The true importance is closer to the average importance rather than the individual importance. The SDP worksheets would then have properly estimated the average importance. We did not consider these cases as underestimates in Table 2, even though they are shown as such in Table 1.

2. In two cases which are related to the unavailability of bus 1Y09 and 1Y10, it appears that the SDP notebook would truly underestimate the risk importance of the events. The failure of these two buses not only impact the operation of PCS and ADVs but also would potentially impact the instrumentations associated with the level control during HPI. Even though the impact on the PCS and ADV is transparent from the SDP notebook (the dependency table), the effect on the instrumentation can not be easily captured. This is the reason why that these two cases are considered as true underestimates and will be so noted in the Rev 1 SDP notebook. These two cases are noted as "not modeled" in the Table 1 here but counted as underestimates in summary table (Table 2).

The SDP notebook as shown in Table 2, therefore, should be capable of capturing 95.5% of the risk significance of the inspection findings (91% matches and 4.5% overestimates). In 4.5% of the cases which appears to deal with the impact of the inspection findings on plant instrumentations and the associated electrical supports, the SDP notebook may underestimate the risk importance.

## Table 1: Summary of Benchmarking Results

**Internal Events' CDF is 3.99E-5, therefore, the RAW thresholds are: W = 1.03, Y = 1.25, and R = 3.5**
**External Events' CDF is 9.0 E-5, therefore, the RAW thresholds are: W = 1.01, Y = 1.11, and R = 2.1**

| Component Out of Service | SDP Worksheet Results (internal only) | Internal RAW[1] | Internal Delta CDF | External RAW | External Delta CDF | Comments |
|---|---|---|---|---|---|---|
| MDAFW Pump 13[(1)] (F7) | Red (M) | 9.07-R | 3.22 E-4 | 4.84-R | 3.5 E-4 | Result of CR of 1Y,3W, and 3G/W, also see note 1 for multi-unit site. |
| HPSI Pump 11 (HA) ( Aux Header) | Red (M) | 3.76-R | 1.1 E-4 | 1.94-Y | 8.5 E-5 | 12 pump is assumed to back up 13 pump only |
| HPSI Pump12 (HW) | Yellow (M) | 1.27-Y | 1.06 E-5 | 1.09-W | 8.1 E-6 | |
| HPSI Pump 13 (HB) (Main header) | Yellow (M) | 1.78-Y | 4.12 E-5 | 1.33-Y | 3 E-5 | |
| TD AFW Pump 11 (TF) | Yellow (M) | 2.26-Y | 5.0 E-5 | 4.84-R | 3.4 E-4 | External Events make it more important |
| TD AFW Pump 12 (TG) | Yellow (M) | 1.48 - Y | 1.9 E-5 | 1.44 - Y | 4. E-5 | The closest Top is OA which for internal only with a RAW of 2.34) The result still would be Yellow. |

| Component Out of Service | SDP Worksheet Results (internal only) | Internal RAW[1] | Internal Delta CDF | External RAW | External Delta CDF | Comments |
|---|---|---|---|---|---|---|
| LPSI Train (LP) | Yellow (O) | 1.04-W | | 1.0-G | 0 | Over due to LLOCA freq. |
| EDG 1A (GE) | Yellow (M) | 2.12-Y | 4.45 E-5 | 3.47-R | 2.21 E-4 | It is more important than other EDGs due to its role in SSSA initiator. External event makes it more important |
| EDG 1B (GG) | White (M) | 1.13-W | 5.1 E-6 | 1.41-Y | 3.7 E-5 | Higher risk significance due to external events. |
| SBO Diesel (GJ) | White (M) | 1.14-W | 5.65E-06 | 1.10-W | 9E-06 | Higher risk significance due to external events based on adding the two delta CDFs. |
| Both MSIVs FTC (MS) | Red (M) | 3.57-R | 1.03 E-4 | 2.79-R | 1.6 E-4 | |
| PZR PORV FTO FB Function (OT) | Yellow (M) | 1.27-Y | 5.3 E-6 | 1.15-Y | 1.35 E-5 | Also Note Top “OT” stands for FB which has RAWs of 1.27. |
| PORV or Block Valve FTC (PV) | Y (M) | 1.95-Y | 3.8 E-5 | 1.54-Y | 4.86 E-5 | The Basic events includes failure of PORV or block valve FTC accounted for by SSSA initiator |
| Safety Valve FTO | White (M) | 1.0 5-W | 2 E-6 | 1.05-W | 2 E-6 | |
| CAC 3/4 fail (WY) | White (M) | 1.12-W | 4.8 E-6 | 1.0-G | 0 | |

| Component Out of Service | SDP Worksheet Results (internal only) | Internal RAW[1] | Internal Delta CDF | External RAW | External Delta CDF | Comments |
|---|---|---|---|---|---|---|
| SDC HX | G/W (U) | 1.03-W<br>1.01-G | 1.2 E-6 | 1.03-W | 2.7 E-6 | Due to CCF ordering one RAW is higher than the other, average RAW might be more appropriate |
| ECCS Pump RM Cooling (V1&V2) | G/W (U) | 1.03-W<br>1.01-G | 1.03 E-6 | 1.11-Y | 1.1 E-5 | 1 train of CS impacted and the results were reduced by a color to credit recovery action. Again the ordering of CCF makes one W and the other G. External events makes it more important. |
| Salt Water train 11[(2)] (S1) | R (M) | 4.84-R | 1.53E-04 | 1.49-Y | 4.4 E-5 | It is important to do SLOCA and MLOCA with max. credit for CNT to be one train limited by support system<br>See Note2. |
| Salt Water train 12 (S2) | R (O) | 1.66- | 2.64E-5 | 1.23-Y | 4.3 E-5 | This train is more important than train 11 in SDP since it also affects one EDG due to loss of cooling. See also Note 2. |
| Service WTR 12 (S4) | Y (M) | 1.56-Y | 2.24E-05 | 1.15-Y | 1.3 E-5 | EDG-1B needs the SRW12 |
| Service WTR 11 (S3) | W (M) | 1.07-W | 2.69E-06 | 1.44-Y | 4.24 E-05 | EDG1A does not need SRW |
| DC 11 (DA) | R (M) | 175-R | 6.9 E-3 | 71.98-R | 6.3 E-3 | Strong Red from loss of DC |
| DC 21 (DC) | R (M) | 217-R | 8.6 E-3 | 60.52-R | 5.4 E-3 | Strong Red from loss of DC |

| Component Out of Service | SDP Worksheet Results (internal only) | Internal RAW[1] | Internal Delta CDF | External RAW | External Delta CDF | Comments |
|---|---|---|---|---|---|---|
| DC 12 [(3)] (DB) | R (M) | 41-R | 1.6 E-3 | 2.97-R | 1.8 E-4 | Affects 1Y03, therefore if 1Yo4 fails SSSA occurs. The conditional frequency of SSA becomes one train equivalent or credit of 2(see Note 3, new rule) |
| DC 22 [(3)] (DD) | R (M) | 83-R | 3.3 E-3 | 1.67-Y | 6.0 E-5 | Affects 1Y04, similar to DC12 (See Note 3) |
| Bus 1 Y01 (E1) | R (M) | 60-R | 2.3 E-3 | 4.23-R | 2.9 E-4 | 1/2 actuation is lost |
| Bus 1Y02 (E2) | R (M) | 46-R | 1.8 E-3 | 6.67-R | 5.1 E-4 | 1/2 actuation is lost |
| Bus 1Y03 (E3) | R (M) | 44-R | 1.7 E-3 | 1.0-G | 0 | Increase the special initiator see Note-3 for discussion |
| Bus 1Y04 (E4) | R (M) | 85-R | 3.5 E-3 | 1.0-G | 0 | Increase the special initiator see Note-3 for discussion |
| Bus 1Y09 (E5) | Not modeled | 2.43-Y | 5.7 E-5 | 1.07-W | 6.3 E-6 | Affects PCS and ADV but also could cause loss of level control during HPI. Not currently modeled in SDP. |
| Bus 1Y10 (E6) | Not modeled | 1.08-W | 3.2 E-6 | 1.02-W | 1.8 E-6 | Affects PCS and ADV but also could cause loss of level control during HPI. Not currently modeled in SDP. |
| All TDAFW Rm Cooling lost (FC) | Y (M) | 1.31-Y | 1.22 E-5 | 3.10-R | 2.73 E-4 | Both TDAFW failed but reduced by a color for recovery action. External events makes it more important. |

| Component Out of Service | SDP Worksheet Results (internal only) | Internal RAW[1] | Internal Delta CDF | External RAW | External Delta CDF | Comments |
|---|---|---|---|---|---|---|
| One ADV FTO (DW) | G (M) | 1.01-G | 4 E-7 | 1.0-G | 0 | |
| ADV FTC or modulate (DV) also MSSV FTC | Y (M) | 1.25-Y | 9.8 E-6 | 1.01-W | 1.42 E-6 | Two effects 1) loss of PCS during all initiators due to MSIV closure and 2) potential for induced SGTR. The latter is not included in SDP. However the SDP assumes the affected SG will not be fed. That is the AFW function would be reduced to 1 multi-train system. This will be footnoted in Table 2 of SDP. |
| CS header 11 (CS)<br>CS header 12 (CT) | G/W (M)<br>G/W (U) | 1.01-G<br>1.03-W | 4.0 E-7<br>1.2 E-6 | 1.01-W<br>1.03-W | 1.4 E-6 | The difference caused by ordering of CCF. External events makes it more important. |
| CCW train 12, standby (KN) | W (M) | 1.12-W | 4.8 E-6 | 1.0-G | 0 | |
| CCW pump 12 or 13, standby (KY, KZ) | G (M) | 1.02-G | 7.6 E-7 | 1.0-G | 0 | |
| SWAC Header 11 (I1) | W (M) | 1.0-G | 0 | 1.0-G | 0 | Manual feed water control is possible without SWAC in Loss of 4KV11 . |

| Component Out of Service | SDP Worksheet Results (internal only) | Internal RAW[1] | Internal Delta CDF | External RAW | External Delta CDF | Comments |
|---|---|---|---|---|---|---|
| SWAC Header 12 (I2) | W (M) | 1.07-W | 2.8 E-6 | 1.11-Y | 1. E-5 | Manual feed water control is possible without SWAC in Loss of 4KV11 . External events makes it more important. |
| MFW fails to provide flow after trip (MN) | W(M) | 1.03 -W | 1.2 E-6 | 1.01-W | 1.4 E-6 | TPCS was set to zero |
| Isolate feed to the non-isolated SG in MSLB (BK) | R (M) | 12.22-R | 4.4 E-4 | None Found | None Found | |
| Op. Align N2 or start SWAC supply to AFW control valves (FN) | W (M) | 1.11-W | 2.2 E-6 | 1.07-W | 6.3 E-6 | Manual feed water control is possible without SWAC . Results in 2 W. |
| Op. Depressurize using ADV following SGTR (LD) | W (M) | 1.2-W | 8 E-6 | None Found | None Found | Use ISO in SGTR |

**Notes:**

1. Reminder of potential SDP rule. In many dual unit sites, the PSA credits a train of the system in one unit as a potential for cross connection to the other unit. The importance of such an equipment therefore first should be evaluated for the dedicated unit and then for the other unit. The resulting color is determined based on both results. The case in point in the MDAFW in Calvert Cliffs.

The dual unit issue was not addressed in the SDP benchmark since the licensee's RAW values is for one unit only. However, in actual inspection finding the total risk from the impact on both units should be considered.

2. Reminder of an existing SDP rule. According to the SDP rule, the credit for a front line function is limited by the minimum of the credit for its common support system, operator action, or the front line function itself. Therefore, if two trains of a system of a front line function is supported by one remaining train of a support system, the credit would be always limited to 2 (1 train).

3. Loss of both 1Y03 and 1Y04 is a special initiator called SSSA with a frequency of 7.29E-5. This event could occur if one train fails and is under maintenance and prior its restoration the other train fails. Such events are dominated by CCFs. Therefore, the conditional probability of one train failure in a short period on the inspection finding that deals with the failure of the other train would be in the order of 1.0E-2. It is proposed that for SDP evaluation, a maximum credit of 2 to be assigned to those cases where the failure of one train could result in a special initiator. This is important for the electrical and I&C support system initiators. The case in point is the special initiator SSSA in Calvert Cliffs as denoted in the table.

## Table 2: Comparative Summary of the Benchmarking Results

| Total Number of Cases Compared = 43 | SDP Notebook | |
|---|---|---|
| | **Number of Cases** | **Percentage** |
| SDP: Less Conservative | 2 | 4.5% |
| SDP: More Conservative | 2 | 4.5% |
| SDP: Matched | 39 | 91%. |

# 3. Proposed Revisions 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, allowance for additional recovery actions, revised Human Error Probabilities (HEPs), modified initiator frequencies, and the results of benchmarking.

## 3.1 Specific Changes to the Rev 0 SDP Notebook for Calvert Cliffs

The earlier version of the notebook was reviewed by the utility on May 26-27, 2000. The resolution of the comments is included in the notebook. Additional comments were received during the first site visit. These comments were reviewed and incorporated into the SDP notebook to the extent possible. The following items list major comments that were incorporated.

1. Table 2: Deleted MSLB from the last column of HPSI.

2. Table 2: Added SSSA to the last column of EDG.

3. Generic modification of feed and bleed success criteria: 2/3 HPSI pumps (instead of 1/2 trains (3 pumps)) and 2/3 charging pumps (1 train). For small LOCA and SORV, keep the current criteria. Add a footnote describing when a more relaxed success criteria may be used.

4. Generic modification: Those EIHP top events with "1 train" for mini-flow valves, change the criteria to "1 multi-train system", because the valves are electronically locked open.

5. Lowered LOOP and LOOP1EDG by one row in Table 1, based on the new utility provided frequency of 1.23E-2 for LOOP of 1 hour. In the LOOP event tree, give 0 credit to REC1. Provided an explanation in a foot note. Furthermore, the initiating event of LOOP1EDG were removed since a loss of one division AC by itself is an initiator and the probability of PORVs to be demanded is small.

6. Loss of service water and loss of salt water: Loss of service water only affects unit 1 instrument air which is normally backed by the unit 2 plant air (which is cooled by unit 2 service water) and can be manually cross tied to the safety related salt water air compressors. Added a top event to model the alternative air supply and developed the rest of the event trees accordingly. The old AFW is changed to AFW2 and used to model the case with no air. The nominal AFW is used in those sequences with air available.

7. MDAFW pumps do not need air. However, there is a possibility that operator over feeds and thereby overflows the SGs. A credit of 2 was given for use of MDAFW without air and another credit of 2 for operator action to restore air. Over filling SGs also should help with the feed and bleed success criteria.

8. Loss of 4KV bus 11 has the same effect of failing non-safety related service water and instrument air. Therefore, in order to credit the TDAFW pumps, operator action is needed. Operator can manually control AFW and use SWAC. Furthermore, loss of 4KV bus 14 does not lead to a trip. It fails 1 HPSI train but no impact on AFW.
9. SSSA: One of the unit 1 EDG is air cooled. Without it, the PORVs should close on loss of AC. If it is available, the operator can close the block valve with power and the other block valve by cross tying the MCCs. A credit of 2 is used for operator closing the block valves. The AFW top event is changed to AFW2 for the case the EDG is not available, and the nominal AFW is used with the EDG available.

10. Create a separate row for MSIV in the last column of Table 2.

11. Modify the SGTR event tree and remove the need for RWT make up. RWT can last 72 hours for single SGTR.

12. LOOP event tree top sequence add a seal LOCA question.

13. Similar to other CE plants credit the SG refill after it has dried out.

14. Loss of a DC bus 11: An overall credit of 2 has to be assigned to AFW top event. Use a foot note to specify the differences between DC buses 11 or 21. Bus 21 fails PORVs at both units and MDAFW pump 23. Bus 11 only fails MDAFW pump 12.

15. MSLB frequency is based on NRC generic assignment. Calvert Cliffs' frequency is 9.2E-4 per year for a Leak outside the containment (no change to SDP at this time).

16. Loss of dc bus should be lowered based on the new frequency of 8.72E-4 per year.

17. The licensee's PSA credits a 0.6 success probability for using TDAFW after battery depletion in a SBO. No credit will be given in the SDP worksheets.

18. For loss of 4 KV bus change the initiators to "All" in Table 2 in the SDP notebook.

19. In ATWS, do not mitigate the ARVR scenarios.

20. LCCW: Change the description of RCPTRIP to include seal failure due to loss of CCW. Give it a total credit of 3 for both possibilities.

21. Update the footnotes with updated HEPs and change credits for operator actions accordingly.

22. Remove the credit for turbine bypass valves in work sheets with SI signal is actuated or LOOP.

23. In TPCS and LOOP indicate that; if TDAFW (or any train of secondary heat removal function) operates for at least one hour and then fails, feed and bleed function would be satisfied by only 1 HPSI pump and 1 PORV. Foot note in Table 2 .

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

### 3.3 Generic Changes to the SDP Notebook

Three generic insights were obtained from this benchmarking trip that could have generic implications for the SDP notebooks and SDP evaluations. Due to importance of these items, each of these items are discussed individually. Two of these items deals with the SDP evaluation process and one item deals with the generic SDP assumptions for CE plants.

#### 3.3.1 Generic Insights for SDP Evaluation Process

**Adjustment of the special initiator frequency for I&C and electrical support system**

The following guide is currently used for evaluating the inspection findings associated with a split system where the failure of the whole system is an initiator.

"For inspection findings that involve the unavailability of a normally running component of a split train support system that increases the likelihood of an initiating event caused by a total loss of system, increase the Initiating Event Likelihood by one order of magnitude for the associated special initiator. For inspection findings that involve the unavailability of a normally standby component of a split train support system that increases the likelihood of an initiating event, increase the Initiating Event Likelihood by two orders of magnitude for the associated special initiator. In addition, determine the impact on front line mitigation capability and evaluate each of the worksheets directed by Table 2, "Initiators and System Dependency," for the unavailability of the affected front line systems."

The above SDP rule were generally developed for fluid/mechanical systems, and have so far been benchmarked properly with the licensee's detailed PSA models. The applicability of this rule was questioned during Calvert Cliffs' visit when dealing with the instrument buses 1Y03 and 1Y04. Loss of both 1Y03 and 1Y04 is a special initiator called SSSA with a frequency of 7.29E-5. This event could occur if one train fails and is under maintenance and prior its restoration the other train fails. Such events are dominated by CCFs. Therefore, the conditional probability of one train failure in a short period for an inspection finding that deals with the failure of the other train would be in the order of 1.0E-2.

The issue of CCFs is an important issue and may need to received further attention in the oversight program. To account for CCFs it would be necessary to characterize the inspection finding not only in terms of component downtime but also the susceptibility of its root cause to CCF potential. The initiator frequency under degraded condition of the inspection finding should be determined based on the degree of susceptibility to CCF.

Under current process, it is proposed that for SDP evaluation of Calvert Cliffs, a maximum credit of 2 to be assigned to those cases involving inspection finding associated with 1Y03 or 1Y04. This will be explicitly noted as a footnote in Table 2 of the Rev 1 SDP notebook.

**Limiting the credit for front line function by its support**

The SDP guide currently contains the following evaluation rule:

"When evaluating inspection findings that impact safety functions involving mitigating equipment and operator action, the remaining mitigation credit should correspond to the equipment or operator action credit, whichever is most limiting."

This guidance could be extended such that it covers the remaining support trains for the front line mitigation trains when and if the credit is limited by the availability of the support trains. As an example; for an inspection finding on one train of CCW, the High Pressure Recirculation Function could be satisfied by 1/2 HPI pump manually switched over. The hardware credit for HPI is 3 (1 multi-train system), and the credit for operator action for switch over is also 3. The CCW is composed of two split trains. The failure of one train would not reduce the credit for hardware since two trains would be remained. However, the two HPI pumps could fail if the remaining CCW train fails. Therefore, the hardware credit is limited by the remaining train of CCW which is a credit of 2. It should be noted that in most cases loss of total CCW as an initiator may be a dominating contributor, however, in some cases the benchmarking exercise have shown that the contributions from other initiators such as SLOCA may be more important when a train of the support system is down. Table 2 in the SDP worksheet will specifically identify the worksheets that need to be re-analyzed (All vs. LCCW).

The above rule even though intuitive, have been the subject of several mis-interpretation. Use of the above instruction for proper evaluation of the SDP inspection finding should be emphasized during the training sessions.

### 3.3.2 Generic Insights for CE plants

The Rev 0 SDP worksheets for CE plants were originally developed based on a series of generic assumptions. The recent benchmarking of the four CE plants have confirmed some of these assumptions and resulted in modification of others. The current set of assumptions for CE plants supported through benchmarking of the latest licensee's PSA are as follow:

1. CE plants could feed a dried out SG with little concern for tube rupture.

2. For those CE plants the PORVs are less demanded during transients than other PWRs. Therefore, the frequency of SORV should be dropped by one order of magnitude to 1.0E-3.

3. In LOOP and LOOP1EDG initiators, PORVs most probably will not be demanded. A probability of 0.1 should be used for PORV to be demanded and a probability of 0.01 for PORV fail to re-close. This is one order of magnitude lower than other PWR types. In some plants such scenarios are so insignificant that they may not have been modeled in licensee's PSA.

4. The Byron Jackson pumps used in CE plants are typically less susceptible to seal LOCA as a result of loss of cooling. The current assumption is a credit of 3 if the operator does not close the bleed off line, and a credit of 4 if he does.

5. Containment heat removal is required in CE plants after LOCAs.

6. In PWRs in general and CE plants in specific, the failure of ADVs or MSSV to close would cause closure of MSIV as expected. However, in CE plants there are generally two more

assumptions in the licensee's PSA that were not observed in other PWRs. The licensee's PSA model typically assumes that the affected SG will not be fed, and there is a potential for induced SG tube rupture. In the SDP notebook and as a part of evaluation process, the affected SG should not be credited. However, the SDP notebooks do not address the concern for the SG tube rupture.

# 4. Discussion on External Events

The external events accounts for about 70% of the total core damage frequency in Calvert Cliffs PSA (CDF of 3.99E-5 for internal and 9.0E-5 for external events). The integrated licensee PSA for Calvert Cliffs is quite comprehensive and accounts for all possible system interactions including the I&C functions. From limited comparisons of RAW values for internal and external events, seven cases were identified and denoted in Table 1 that the external event made the component more important. These cases included, the AFW system specifically the TDAFW pumps and associated support systems, the EDGs, ECCS room cooling, SWAC headers, and CS headers. The external events in all these cases increased the importance by one color. As an example the TDAFW pump is "yellow" based on internal events and "Red" when considering the external events. Other areas that highlights the importance of external events is the room cooling requirements. As an example the ECCS pump room cooling will be elevated to "Yellow" from "Green" when considering the external events. EDG1A similarly moved from Yellow to Red when external events were considered. Generally the external events increases the importance of many systems, therefore, proper identification of the dominating scenarios would be important in characterizing the risk of inspection findings.

# Attachment 1

## List of Participants

| | |
|---|---|
| Robert Cavedo | (Calvert Cliffs) |
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