H. B. ROBINSON

PROBABILISTIC SAFETY ASSESSMENT

PEER REVIEW REPORT

DRAFT REPORT

Prepared for the Westinghouse Owners Group and
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December 31 2001

H.B. Robinson Nuclear Plant Summary of Selected Unique Plant/Procedural Features That May Affect the Risk Profile	
Design Features	**Potential Impact**
Plant predates NRC general design criteria	Less automated systems than newer plants, more reliance on operator actions (e.g., alignment of ECCS recirculation)
DC power batteries nominally rated for 1 hour; DS DG provides overall 8-hour "coping time" to restore power	1-hours battery significantly limits time to restore power (e.g., for SDAFW pump control after SBO)
Dedicated shutdown (DS) diesel generator with manual start, powers one charging pump, one CCW pump, and one SW pump.	Independent source of AC power for blackout coping, credited as a means of providing RCP seal injection during SBO
CVCS contains 3 positive displacement pumps (high head/low flow)	Do not provide ECCS (SI) function
CCW cooling – can be cooled from fire water; no train separation	Lack of train separation has potential impact on loss of all CCW; firewater backup provide alternate cooling source for loss of SW events
DC power battery chargers do not automatically resequence onto ESF buses after loss of power	Manual actions required
System asymmetries (e.g., power supplies to RCS and ECCS equipment trains)	Some asymmetric differences in component/train importances

2.5 Current and Planned PRA Activities

CP&L has used the PSA to support Fire Protection and Appendix R issues. The PSA is also used for the Maintenance Rule Program and for work week management and scheduling. The PSA group plans to use the PSA for Integrated Leak Rate Test deferral and to support License Renewal. CP&L also plans to use the PSA in support of a power uprating and to support responses to regulatory inspections and issues.

SECTION 4

SUMMARY OF RESULTS

4.1 Key Observations and Recommendations

The following is a brief summary of the key results of the H.B. Robinson PSA Peer Review. This is organized in terms of general summary comments, followed by selected PSA strengths noted by the reviewers, and areas where the reviewers made recommendations for improvement. This is intended as a summary only. Additional details of the review results are provided in Section 3 (Technical Element Summary tables) and in Appendix B (Technical Element Review Checklists and notes, and Fact & Observation sheets).

<u>General Summary</u>

All eleven of the technical elements were graded as sufficient to support applications requiring the capabilities defined for grade 2. The H.B. Robinson PSA thus provides an appropriate and sufficiently robust tool to support such activities as initial Maintenance Rule implementation, supported as necessary by deterministic insights and plant expert panel input.

All of the elements were further graded as sufficient to support applications requiring the capabilities defined for grade 3, e.g., risk-informed applications supported by deterministic insights, but in some cases this is contingent upon implementation of recommended enhancements. The general assessment of the peer reviewers was that the H.B. Robinson PSA can be effectively used to support applications involving *risk significance* determinations supported by deterministic analyses, *once the items noted in the element summaries and Fact & Observation sheets are addressed.* Specific suggestions have been provided in this regard, but other options and alternatives that accomplish the same objectives may be available and may be preferable.

As noted in Section 3, even without modifying the PSA to address recommended enhancements the PSA can be used in risk-informed applications, if additional activities are undertaken to compensate for PSA limitations that are pertinent to the application.

The following paragraphs summarize some key strengths and areas for improvement as noted by the reviewers after completing the review of the technical elements.

Some PRA Strengths *[Additional Detail Later]*

- Rigorous HRA with extensive dependency treatment
- Detailed Internal Flooding analysis and ISLOCA analysis
- Good interaction with plant staff / recognition by plant
- Detailed system modeling / fault trees
- Knowledgeable plant staff / opportunities for interaction among PRA staff on PRA issues

Some Recommended Areas for Improvement *[Additional Detail Later]*

- Lack of traceability to bases for PRA assumptions and inputs, especially for unique modeling approaches (e.g., LOCA break size definition)
- AC power recovery / RCP seal LOCA model
- Quantification truncation impact on results
- Lack of current maintenance rule data in the model
- Lack of plant-specific timing for human actions

Documentation

Although documentation is not a separate technical element of the review, it is an important requirement for a quality PRA.

Some specific suggestions have been made within the various technical element summaries and Fact & Observation sheets (and summarized in the preceding discussion) for improvements to make the documentation better able to support future PRA applications. In particular, the reviewers recognize that the Progress Energy philosophy for PSA documentation is to simplify documents, removing information that is available in other plant documentation, and keeping only the minimum set of PSA-specific information required to define and defend the models.

Among this information should be the set of PSA assumptions and groundrules, which the reviewers suggest should be enhanced to more clearly define the analytical and other bases for the PSA models. Completion of Appendix D (success criteria) of the PSA would help in this regard, particularly if calcs such as the base set of MAAP analyses, AC power recovery spreadsheets, and so forth are included in it, along with a cross-reference of sequences to their specific supporting analyses.

In addition, the reviewers recommend maintaining the PSA Summary document that was prepared for the 1997 PSA quantification. This appears to be a key mechanism for communicating PSA results and insights, and should be kept current.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: IE - 01 **/ Element IE / Sub-element 13**

(Related Sub-elements: IE-2)

Older data sources were used for the prior distributions of some initiating events (i.e. NUREG/CR-3862, May, 1985), though it is noted that more recent data sources were reviewed and that more recent data is used for loss of offsite power and for the valve rupture failure rate for determination of the ISLOCA initiating event.

Also, for comparison of steam line break initiating event frequencies, the following plant PRAs are listed:

Oconee (NSAC-60) completed in 1984

Seabrook completed in 1983

Zion completed in 1981

Millstone also old; This reference also includes non-consequential seal LOCA as a separate initiating event but the PRA does not.

LEVEL OF SIGNIFICANCE: B

Use of more recent data could affect the PRA result. Reviewers had trouble reproducing prior distributions from the original (1985) data source used for updating of most IEs.

POSSIBLE RESOLUTION

Use more recent data sources and comparison sources; examine and address the seal LOCA ~~modeling~~initiating event treatment in NUREG/CR-5750.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

A.	Extremely important and necessary to address to ensure the technical adequacy of the PRA, the quality of the PRA, or the quality of the PRA update process. (Contingent Item for Grade Assignment.)
B.	Important & necessary to address, but may be deferred until next PRA update (Contingent Item for Grade Assignment)
C.	Considered desirable to maintain maximum flexibility in PRA Applications and consistency in the Industry, but not likely to significantly affect results or conclusions.
D.	Editonal or Minor Technical Item, left to the discretion of the host utility.
S	Superior treatment, exceeding requirements for anticipated applications & exceeding what would be found in most PRAs.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: IE - 04 / **Element IE** / **Sub-element 2**

(Related Sub-elements:)

The LOCA break size definitions for the PRA are based on different criteria than those for most other PRAs. This is based on plant specific analysis (RELAP and MAAP) to find the upper and lower bounds of each ~~the~~ break size range.

The following break size ranges and IE frequencies ~~apply to~~ are provided for Robinson:

S1 = 0.3" to ~ 1.5" . Freq = 5.3E-3

S2 = 1.5" to 3" Freq = 3.5E-5

Medium LOCA = 3" to 13" Freq 3.2E-6

Large LOCA = 13" and greater Freq = 2.2E-5

Because the break ranges do not match with ~~any~~ generally available generic data sources, it was necessary for CP&L to derive a unique way to quantify each break size. The method is based on EPRI-TR-100226. The EPRI pipe sizes were mapped into Robinson pipe sizes, to derive a failure rate per pipe segment. The number of pipe segments in each pipe group category were estimated and multiplied by the pipe rate frequency to get the overall category frequencies.

The observations are the following:

1) The break apportionment ~~is~~ appears to be acceptable and is based on plant specific analysis. (See related observations in element TH.)

2) When calculating pipe break frequencies for the Robinson break sizes, the method was to "map" the EPRI categories to the Robinson sizes and then develop a number of "segments" in each category. The results of this process is that 75% of the EPRI LOCA frequency is not accounted for in the resulting Robinson frequencies. ~~eliminated.~~ This is based on the assumption of pipe segment numbers, as defined in EPRI-TR-100226.

4) The reviewers were unable to reconcile the Robinson IE frequencies for LOCA ~~Considering that these frequencies do not reconcile~~ with ~~neither~~ those from available sources such as NUREG/CR-5750, EPRI-TR-10226, or NUREG/CR-4550, and therefore felt that ~~we have to suspect~~ the method used may not be corrects.

5) The calculation is based completely on pipe leak events, with no contribution from component leaks and random RCP seal LOCA's, as is done in NUREG/CR-5750, for example.

LEVEL OF SIGNIFICANCE: B

This is a significance B because it represents a potential underestimation of LOCA frequencies and neglect of small break IE's that have occurred in the past.

POSSIBLE RESOLUTION

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

***OBSERVATION ID: IE - 04* / Element IE / Sub-element 2**

(Related Sub-elements:)

Review the plant specific LOCA analysis against more recent generic analyses (especially NUREG/CR-5750 frequencies) and either update the frequencies or document the reasons ~~for~~ why differences are appropriate.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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D	Editorial or Minor Technical Item, left to the discretion of the host utility.
S.	Superior treatment, exceeding requirements for anticipated applications & exceeding what would be found in most PRAs.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: AS - 01 / **Element AS** / **Sub-element 7**

(Related Sub-elements: AS-9, AS-18) [ALSO SEE RELATED F&O AS-10]

The event tree for S1 LOCA models core cooling recovery in the event of loss of SI. This is based on MAAP analysis, which also verifies the Westinghouse FRP analysis. The following observations were made concerning the modeling and success criteria for core cooling recovery:

1) The event tree success criteria for depressurization requires 2/3 SG PORV to open. The preceding event for success of AFW only requires AFW to 1/3 SG.

2) The MAAP analysis used to support this analysis had accumulators operable, but accumulators are not modeled in the S1 sequences.

3) The operator error for secondary cooling is "OPER-SD", which is operator fails to align shutdown cooling. It should reflect the actions necessary to comply with FRP C.1.

4) The function "SD", models shutdown RHR cooling, whereas the MAAP analysis shows that RHR is used in the injection mode until 22 hours, whereupon recirc is required. The fault tree does not model recirc.

5) The MAAP analysis used for this sequence allowed the charging system to operate as required. The sequences for T(Seal LOCA) UD do not have the charging system available.

6) The S1 event tree assumes all initiating events can be mitigated by RHR shutdown cooling. Some pipe break LOCA's may occur in a location where continued drainage from the system would preclude close cycle cooling. This eventuality is not discussed.

7) Accumulators are not required for medium LOCA. There is no T/H basis provided for this.

LEVEL OF SIGNIFICANCE: B

The modeling of the S1 LOCA is not ~~conistent~~consistent with a) Westinghouse Owners Group ERG FRP basis, b) other Westinghouse PRA's, c) the MAAP analysis used to support this sequence.

POSSIBLE RESOLUTION

Modify the S1 event tree to reflect the procedural and analytical bases.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: AS - 05 **/ Element AS / Sub-element 12**

(Related Sub-elements:)

Two items were identified regarding the RCP seal LOCA model.

1. The RNP RCP seal LOCA model ~~is based on the NUREG/CR-4550 model from 1989. This model has been shown to have discrepancies in the calculation~~does not include the possibility of the very early (i.e., first-hour), ~~very~~ large seal LOCA that has been included in current generic models (e.g., the "Rhodes" model and related Brookhaven model) to account for expert opinion that such events are possible following a loss of seal injection and cooling. The RNP PRA assumes no seal LOCA until 1.5 hours, which is not consistent with these and other recent ~~latest~~ seal models.

~~The probabilities of the seal failure should also be updated.~~

2. The RNP model currently ~~allows~~credits the dedicated shutdown (DS) diesel to ~~support~~re-establish seal injection flow after a LOSP. ~~However,~~ Based on information provided to the review team, the DS diesel is not expected to be ~~can not be~~ on line until approximately 1/2 hour following the LOSP/SBO, with some possibility that it could be online somewhat earlier. By ~~this~~ the time this occurs, however, the RCP seals will likely have heated up. Although the RNP procedures call for restoration of seal injection, the reviewers were aware of ~~and the~~ Westinghouse guidelines against ~~for~~ such restoration after ~~of seal cooling when~~ the seals have heated up. The current WOG ERG recommendation on restoration of seal cooling is that if seal cooling is lost for more than 15 minutes, thermal barrier cooling is to be re-established prior to restoring seal injection flow. The intent of this WOG recommendation is to prevent shocking of the seal with cold water, which might lead to seal failure. The RNP PRA accepts the RNP procedure and use of the DS diesel. The reviewers were concerned that the basis for success in the resulting RNP PRA model has not been adequately demonstrated. That is, the ability ~~of the DS diesel to support restoration of~~ to restore seal injection flow ~~and/or~~ without prior re-establishment of thermal barrier cooling without possibility of challenging RCP seal integrity ~~be~~is not consistent with ~~reevaluated in light of~~ the current Westinghouse/WOG ~~seal~~ recommendations but the PRA does not provide an analyses or evaluation to demonstrate success.

(There is also a third comment, for non-LOSP events. Failure to trip the RCPs in transient scenarios with loss of seal injection and cooling, or loss of cooling to the RCP motor bearing coolers, can have a significant impact on the resultant seal leakage and timing, and should be included in the model if it is not already.)

The probabilities of the seal failure assumed in the RNP model should also be updated. ***[NOT SURE WHAT THIS SPECIFIC ISSUE IS; NEED INPUT FROM OTHER REVIEWERS]***

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: AS - 05 **/ Element AS / Sub-element 12**

(Related Sub-elements:)

LEVEL OF SIGNIFICANCE: ~~A~~ B [REVIEW TEAM: SIMILAR OBSERVATIONS HAVE BEEN ASSIGNED "B" IN PREVIOUS REVIEWS; IF THERE IS NOT A STRONG BELIEF THAT THESE ISSUES WOULD RADICALLY ALTER THE RISK PROFILE, SUGGEST "B" RATHER THAN "A"]

~~This is a level A significance because the seal LOCA model used by RNP is widely acknowledged to be incorrect. In addition, i~~

If there are situations in which the DS diesel is ineffective in preventing seal LOCA or in restoring seal cooling, the model would have different results, i.e., there would be an additional failure path that is not currently accounted for in the model. Further, by not accounting for first-hour seal failure possibility, the model is inconsistent with current expectations for RCP seal LOCA modeling. It is not clear that revising the model will have a significant impact on results, but the effects should be investigated.

POSSIBLE RESOLUTION

~~Update the seal LOCA model to include a model that is acceptable to the NRC, or at least one that has not been disproved by the NRC.~~

Consider re-evaluating the RCP seal LOCA modeling logic to ensure that the success criteria and failure branching are correct and not overly optimistic (or pessimistic), within the context of available information, considering the above issues. If there is uncertainty in the timing of operation of the DS diesel, consider accounting for the possibility of a first-hour seal LOCA, even upon restoration of injection.

Alternatively, consider performing an evaluation to show that modeling potential inability of the DS diesel to prevent seal LOCA would not have a significant impact on PRA results or insights. Or treat the differences between results obtained using the existing modeling versus the suggested modeling as a source of uncertainty to be considered when using the PRA for risk-informed plant applications.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: AS - 10 / **Element AS** / **Sub-element 9**

(Related Sub-elements:) *[ALSO SEE RELATED F&O AS-1]*

For the S1 LOCA, one of the success paths involves the failure of SI, but RCS depressurization using the SGs to get to conditions where normal RHR can be implemented. While this may be true at the lower end of break size range, the success at the upper end of the break size range (1.5 inch diameter break) is ~~quesitoned~~questioned. No supporting analyses are readily available to justify this success path.

LEVEL OF SIGNIFICANCE: B

Since the loss of SI capability may be a contributor to core damage, the CDF and risk importance may be impacted.

POSSIBLE RESOLUTION

Provide justification for this success path, and demonstrate the consistency of this success path with operator training and full scope simulator predictions.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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D	Editonal or Minor Technical Item, left to the discretion of the host utility.
S	Superior treatment, exceeding requirements for anticipated applications & exceeding what would be found in most PRAs.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 01 / **Element TH** / **Sub-element 4**

(Related Sub-elements:7, IE-13, AS-18)

The LOCA break size definitions for the PRA are based on different criteria than those for most other PRAs. This is acceptable if the underlying analyses provide sufficient basis for the definitions. A substantial number of MAAP analyses (and some RELAP analyses) were performed for the Robinson IPE. Although it is not clear from the information in the HB Robinson PSA Event Tree and Accident Sequence Development notebook (PSA Section 4.0, RSC 96-04) what the analytical bases are (since specific analyses are not referenced in that document), a selective review of some of the available MAAP analyses indicate that there is a basis for the selected definitions.

~~The following is~~Reviewer Note R10 to Table TH in this peer review report provides a comparison of the break size definitions and their bases, with focus on the injection phase, as discerned from the Event Tree Success Criteria notebook~~:~~.

~~PRA S1 (Small LOCA category 1) = breaks that are too large to be accommodated by the normal charging system and too small to provide adequate decay heat removal through the break; range defined as 0.35" to ~ 1.5" diameter breaks.~~

~~PRA S2 (Small LOCA category 2) = breaks that do not depressurize to within the low head injection system capability during injection or recirculation, but are within the capability of the high head injection system, and that are sufficiently large to provide decay heat removal via the break; range defined as ~ 1.5" to 3" diameter breaks.~~

~~"TYPICAL" PRA Small LOCA = breaks that are too large to be accommodated by the normal charging system and too small to depressurize to the high head injection setpoint sufficiently rapidly to avoid the need for decay heat removal; typically 3/8" to 2" diameter breaks.~~

~~PRA Medium LOCA = breaks within the capability of the high head injection system (without need for accumulator injection), with decay heat removal via the break and RCS pressure above LPSI pump shutoff but RCS pressure below the low pressure pump shutoff at the time of switchover to recirculation; range defined as 3" to 13" diameter breaks.~~

~~"TYPICAL" Medium LOCA = breaks that are sufficiently large to depressurize to the high head injection setpoint but for which pressure remains above the RHR pump shutoff head, with decay heat removal via the break; typically 2" to 6" diameter breaks.~~

~~PRA Large LOCA = breaks beyond the capability of the high head injection system, requiring low head injection, with decay heat removal via the break and shutdown reactivity insertion via borated injection; range defined as 13" and greater, up to the design basis LOCA break size.~~

~~"TYPICAL" Large LOCA = breaks that are sufficiently large to depressurize to the RHR pump shutoff head, with decay heat removal via the break and shutdown reactivity insertion via borated injection; typically > 6" diameter breaks.~~

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 01 **/ Element TH / Sub-element 4**

(Related Sub-elements:7, IE-13, AS-18)

Among the implications of the information in note R10 ~~above~~ are the following:

The PRA S1 SLOCA plant response and modeling should be similar to the SLOCA response and modeling for typical plant PRAs, since 0.35" – 1.5" range is similar to typical 0.375 – 2" range.

It is somewhat trickier to compare the PRA S2 SLOCA and the PRA MLOCA plant response and modeling to corresponding typical plant PRA categories, since there is more overlap in the ranges (i.e., 1.5" – 3" compared to the typical 2" – 6" range, and 3"-13" compared to the typical >6" range).

For the Medium LOCA, the Robinson PRA assumes that a single train of high head injection can mitigate this class of LOCAs, whereas typical PRAs do not credit high head injection for breaks at the upper end of this size range (i.e., above 6"). MAAP or other analyses supporting the upper end of the Medium LOCA range were not available during the peer review.

The success criteria for PRA LLOCA plant response and modeling were unclear from the Event Tree notebook; Section 4.7.1 indicates that response to LLOCA requires ECCS injection from one train of LHSI AND 2 accumulators, whereas Section 4.10.4 indicates only that one train of LHSI is required (i.e., accumulators are not mentioned). If accumulators are not required, then this differs from the LLOCA response and modeling for typical plant PRAs.

MAAP analyses were used to support the definition of ECCS requirements for the MLOCA, even at the upper end of the break size range (i.e., 13 inches). In general, MAAP 3.0b is not appropriate for rapid depressurizations as would be occurring for breaks of this size.

LEVEL OF SIGNIFICANCE: B

The definition of LOCA break sizes has become somewhat standardized across plant PRAs since the IPEs. There is no requirement that size range definitions follow any "standard convention," but if they do not, it is important that they be carefully defined and have a sound basis that is supported by realistic analyses. An extensive set of analyses appears to have been performed for the Robinson PSA success criteria. However, portions of the analytical basis for some of the above definitions were either unavailable or seemed inappropriate. While the reviewers believe this is an important observation, it affects mainly the larger LOCAs, which are not dominant contributors to the CDF and LERF results, and so a significance B is appropriate.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 01 / **Element TH / Sub-element 4**

(Related Sub-elements:7, IE-13, AS-18)

POSSIBLE RESOLUTION

Because the break size definitions are central to the LOCA modeling for the Robinson PRA, there should be, in the event tree notebook or appendix, a clear discussion of the bases for the selections, including reference to the spectrum of analyses performed and the specific set of MAAP or other analyses that define the size range for each size break.

Consideration should be given to evaluating and documenting the effect on PSA results and risk insights resulting from using these (as opposed to more "traditional") definitions.

Confirm that all definitions are based on analyses performed using appropriate codes and modeling assumptions, especially for the larger break size definitions (i.e., those in the range of 3" and above). Consider confirming the results of key earlier MAAP 3.0b analyses against results obtained using currently available versions of MAAP, which have improved capabilities for modeling depressurization and other T/H phenomena.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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D.	Editorial or Minor Technical Item, left to the discretion of the host utility.
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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 02 **/ Element TH / Sub-element 1**

(Related Sub-elements: TH-3, TH-9, AS-17, AS-24)

The Event Tree and Accident Sequence Development notebook (PSA Section 4.0, RSC 96-04) and the PSA Groundrules and Assumptions Document (RSC 96-02) provide some perspective on the rationale and approach used to define the success criteria. Further, Section 4.1 of the Groundrules document states that front-line system success criteria are to be best-estimate using acceptable T/H codes (specifically listing MAAP, RELAP, and RETRAN) or documented hand calculation.

However, it is not possible to determine, from the PSA notebooks, which codes or methods of analysis are used for specific success criteria determination, or why these methods are appropriate. For example, applications of the MAAP code, particularly the IPE-vintage 3b version, may require some justification or check for applicability (e.g., avoiding use of MAAP 3.0b for rapid RCS depressurization scenarios, which typically require capabilities beyond what was available in that particular version of the code).

Further, it is difficult to determine the specific analytical bases for specific success criteria used in the model. No success criteria summary was found. The IPE and the current event tree notebook success criteria provide general discussions of equipment and systems required for sequence success, but do not provide references to the bases or analyses for these.

LEVEL OF SIGNIFICANCE: B

Clearer guidance should be provided to preclude potential mis-application of T/H codes and assumptions.

The analytical bases for the success criteria should be clear.

POSSIBLE RESOLUTION

Provide clearer traceability of success criteria to analytical bases, at least for "non-obvious" criteria (e.g., other than FSAR).

Consider developing a clear set of guidelines establishing the acceptable range of applications of various types of codes and calcs.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 02 / **Element TH** / **Sub-element 1**

(Related Sub-elements: TH-3, TH-9, AS-17, AS-24)

PLANT RESPONSE OR RESOLUTION

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 04 / **Element TH / Sub-element 2**

(Related Sub-elements:)

Section 2.4 of the PSA Groundrules document (RSC 96-02) defines core damage as: "Core Damage will be assumed to occur if both of the following conditions occur:

- The collapsed water level has decreased such that the core has been uncovered.

- A temperature in excess of 2200 degrees Fahrenheit is reached in an node of the core as defined by a best-estimate thermal-hydraulic calculation."

This definition is reasonable, but the following observations are noted.

The 2200 degF criterion can be considered to be a function of the accuracy of the code and model being used to calculate it. For example, supporting requirement SC-A2 of Rev. 14 of the ASME PRA Standard provides example measure of core damage that indicate that 2200 degF would be appropriate using a code with "detailed core modeling" whereas a temperature of 1800 degF would be appropriate using a code with "simplified (e.g., single node core model, lumped parameter) core modeling". The idea is to provide sufficient margin between actual and code-calculated values to allow for limitations in codes and models, and uncertainties in inputs and calculations.

The Rationale provided in Section 2.4 implies that the 2200 degF value is based on "existing licensing basis for emergency core cooling systems." This implies that the analytical bases for the PSA success criteria are the licensing basis analyses. However, this is not always the case, e.g., the MAAP code has been used to define success criteria for some sequences. Thus, when MAAP (or other codes / models with more simplified modeling detail than the licensing basis codes) is used, selection of a lower predicted temperature may be more appropriate.

LEVEL OF SIGNIFICANCE: B

The core damage temperature criterion should be selected consistent with the capabilities of the analysis codes and models used. Significance B is assigned assuming that there is a potential that existing results/conclusions might be affected by using a lower temperature.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 04 / **Element TH** / **Sub-element 2**

(Related Sub-elements:)

POSSIBLE RESOLUTION

Revise the discussion of core damage conditions and rationale to address the capabilities of the codes and models used.

Check to see that the results/conclusions from prior MAAP analyses would not change significantly if additional margin for uncertainty were allowed in the definition of core damage.

Address the effects of any such significant changes in the PSA.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: TH - 05 / **Element TH** / **Sub-element 5**

(Related Sub-elements:)

[ALSO SEE F&O AS-8]

The small LOCA (S1) event tree sequence with failure of high head safety injection but success of secondary side heat removal (AFW) credits successful long-term closed-loop RHR cooling (i.e., no ECCS injection or recirculation required) as a success path. Although this modeling reflects guidance in the emergency operating procedures, few PRAs credit this, in part because plant response is dependent on break size and location, and analyses must be performed to demonstrate success.

For the Robinson IPE, a MAAP case (SDC001) was run to confirm success for this scenario. However, review of this analysis indicated that credit was taken for accumulator injection in the MAAP run, whereas the event sequence modeling for the PRA does not include requirement for accumulators. A related MAAP case for S1 with failure of HHSI and successful AFW (case SLC001) was also located, and that analysis also credits accumulator injection, as well as and low head ECCS injection and recirculation.

LEVEL OF SIGNIFICANCE: B

The analytical basis for sequence success paths must match the conditions modeled in the sequence.

POSSIBLE RESOLUTION

Either perform a T/H analysis that demonstrates success for the scenario modeled in the fault tree, or revise the fault tree to include the accumulators.

(But also see F&O AS-8, which questions the validity of crediting closed loop RHR cooling in this scenario for other reasons.0

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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B.	Important & necessary to address, but may be deferred until next PRA update (Contingent Item for Grade Assignment)
C.	Considered desirable to maintain maximum flexibility in PRA Applications and consistency in the Industry, but not likely to significantly affect results or conclusions
D.	Editonal or Minor Technical Item, left to the discretion of the host utility.
S	Superior treatment, exceeding requirements for anticipated applications & exceeding what would be found in most PRAs.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: SY - 05 / **Element SY** / **Sub-element 5**

(Related Sub-elements:)

The model was incorporated into a calculation without review in 1997. CP&L PRA engineers indicated that there was a review of the system notebooks by Plant Personnel (i.e. system ~~engineer~~engineer, design engineers, operations) for the IPE, and that some of the systems modeling information was reviewed by plant personnel for the previous update. But it was not clear to the (peer) reviewers that it is standard practice to confirm that assumptions regarding modifications implemented in the model are similarly confirmed by plant personnel to confirm that the model reflects the actual configuration of the plant.

LEVEL OF SIGNIFICANCE: B

If the model does not accurately reflect the actual configuration of the plant then any analysis done may not adequately reflect plant risk. However, CP&L indicated that they already have a plan to adopt a process of formally requesting system engineer reviews for model changes.

POSSIBLE RESOLUTION

Implement the planned system engineer reviews to confirm that the model actually reflects the current plant configuration.

Consider having such confirmations on an application-specific basis to address configurations that may arise in between PRA updates as a result of emergent or other specific issues but are not reflected in the model.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: SY - 09 / **Element SY** / **Sub-element 26**

(Related Sub-elements:)

There is no evidence of a~~n independent~~ verification review of the applicability of the documentation used to develop the system models, or of a review of the fault trees and associated system notebooks. ~~There is also no evidence of an independent review of the fault trees and the system notebooks.~~ So it was not clear to the reviewers how potential ~~a~~ mistakes by ~~the~~an author of these documents would be ~~may not have been reviewed,~~ identified~~,~~ and corrected, which is the intent of the criteria in ~~. This is in direct violation of~~ sub-element SY-26.

LEVEL OF SIGNIFICANCE: B

~~This may have a major impact on CDF and/or LERF.~~ Since the PRA is used to support decisions affecting the plant, it is important to have a verification process in place for the PRA inputs and results.

POSSIBLE RESOLUTION

Implement an appropriate process ~~Have the~~for review of PRA models, inputs (e.g., referenced documents), and outputs ~~independently reviewed~~, and for resolution of ~~. Address all~~review comments.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: SY - 10 / **Element SY** / **Sub-element 27**

(Related Sub-elements: QU-27)

There are assumptions made in each notebook. The supporting basis for each assumption ~~documentation~~ is frequently not specified. Therefore it is difficult to establish ~~a review of~~ ~~whether~~that the assumption is valid~~acceptable is hard to determine~~. This ~~is a problem which~~ has been noted in ~~previous~~other Fact/Observation forms.

Several examples are:

1. AFW notebook Section A.5.5 Item 1 states that since the flow recirculation lines contain normally open valves they are not flow diversions.

2. AFW notebook Section A.5.5 Item 10 states that operator action to open doors to the AFW motor-driven pump room to allow for adequate cooling is inherent in the model.

3. RHR notebook Section A.2.5 Item 6 states that the probability of sump blockage is assumed to be probablistically insignificant.

4. RHR notebook Section A.2.5 Item 8 states that no misposition faults are assumed for this line since it is likely the operator will realize that the CVCS is isolated from the RHR when the reactor is taken up in pressure.

More examples can be found in the notebooks.

LEVEL OF SIGNIFICANCE: B

This lack of references is seen ~~in many~~ across various system notebooks and the reviewer can not ~~verify~~determine that the assumptions have adequate basis. Some assumptions may be important to ~~This could cause an impact on~~ the CDF and LERF values.

POSSIBLE RESOLUTION

System modeling ~~The~~ assumptions should be reviewed and technical bases established and documented. Where there are no technical bases, consideration should be given to evaluating the impacts of the assumptions on results and applications. ~~references verified before using the system/components in a risk application.~~

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: SY - 10 / **Element SY** / **Sub-element 27**

(Related Sub-elements: QU-27)

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: SY - 11 / **Element SY** / **Sub-element 13**

(Related Sub-elements:)

RWST refill is modeled for SGTR and some small LOCA's. The event is represented by an operator action. There is no assessment of the capability to provide 150 gpm of borated water for a 12-24 hour period, which would be needed in the event of RWST refill.

There are actually 2 HEPs involved - a basic error probability and a 0.1 recovery factor. This results in an overall HEP of 3.5E-3, with no equipment modeled at all.

LEVEL OF SIGNIFICANCE: B

This is level B. The modeling of recovery such as RWST refill, which can be very important to the mitigation of small LOCA sequences, should have a basis the for ability to refill the RWST. Where the failure probability, based on the human actions only, is small (as it is here), the effects of potential equipment failures should also be accounted for. Further, the model should be reviewed to determine that simply refilling the RWST results in a stable end state consistent with the rest of the PRA model (e.g., does aligning for refill achieve a stable state within the PRA mission time, or do extended mission times for other systems, or additional actions or equipment, need to be considered?)

POSSIBLE RESOLUTION

Verify the capability to provide 150 gpm of borated water in the available timeframe.

~~Model~~Address the potential impact of system failures as well as operator actions for RWST refill.

Ensure that credit is only taken where it is consistent with plant procedures and PRA assumptions and mission times.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: SY - 12 / **Element SY** / **Sub-element 24**

(Related Sub-elements:)

The PRA provides a recovery of failed MOV's with a recovery factor of 0.05.

In the case of SI MOV 862A and B, the modeled probability of failure of the valve to close is 0.046. The fault tree automatically includes a recovery factor of 0.05. There is no basis for this recovery factor and there is no substantiation that this valve can (or will) be closed locally in the recirculation switchover. If the recovery factor is not modeled, ~~this~~the frequency of the core damage cutset including this failure jumps from 5E-7 to 1E-5.

LEVEL OF SIGNIFICANCE: B

This is level B. Considering the magnitude of reduction in CDF without any substantiation of the basis for the recovery factor, this could have a significant impact on CDF.

POSSIBLE RESOLUTION

Document the basis for the recovery action (e.g., the procedural guidance), and the basis for the recovery probability used.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 01 / **Element DA** / **Sub-element 2**

(Related Sub-elements:)

The data analysis was developed for the IPE with an update for selected components in 1996. Most of the references for the data analysis are well over 10 years old. While the documentation basically describes the process used, industry information developed during the last decade would obviate the need for some of the effort required to develop generic priors. Hence, the documentation of the data analysis does not act as guidance for future updates and revisions.

The data documentation does not provide guidance in the assignment of the proper error factor to assign for particular component failure rates when the error factors are not provided in the reference.

Guidance on the development of the disallowed maintenance or mutually exclusive maintenance file was not located.

LEVEL OF SIGNIFICANCE: C

~~The document should provide g~~Guidance should be provided on the use of plant specific data, common cause data and methods, and the selection of generic data from industry sources. While the documentation describes what was used, the references are out of date and there is no general guidance.

POSSIBLE RESOLUTION

Add such guidance as the data analysis is revised.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 02 / **Element DA / Sub-element 2**

(Related Sub-elements:)

The method used to perform Bayesian updates is often described as moment matching. In this method, a lognormal distribution is mapped into a Beta function (for demand failures) or a Gamma function (for operating failures). The Beta and Gamma functions have a property that, when updated, produces a Beta or Gamma function whose parameters are completely described by the prior and the evidence (they are natural conjugate priors). Once the posterior Beta or Gamma functions are described, then they are mapped back into a lognormal distribution. This process is capable of producing erroneous results.

NUREG/CR-4350, Volume 6, is the data development part of a PRA Course Documentation prepared for the NRC. On page 6-17 it states "The disadvantages of natural conjugate priors include the fact that they cannot be used if the form of the prior is specified in the generic data source. If a prior is specified, using natural conjugates is prohibited. Another disadvantage involves the sensitivity to the choice of the prior, which may be important. In such cases, choosing a natural conjugate prior for convenience may lead to answers that are a little leading." The NUREG goes on to point out that, for lognormal distributions, discretization or numerical integration must be used.

<u>The Bayesian updating performed for the HB Robinson PRA has not addressed this issue.</u> In addition, there is no <u>specific</u> guidance ~~document~~<u>provided</u> on the use of Bayesian updating.

LEVEL OF SIGNIFICANCE: B

The blind use of Bayesian updating can lead to erroneous results. The use of moment matching produces optimistic results when there are zero failures involved. This is the case for some initiators and components.

POSSIBLE RESOLUTION

Add guidance for performing Bayesian analysis that includes cautions and limitations <u>for situations such as that described above</u>.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 02 / Element DA / Sub-element 2

(Related Sub-elements:)

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 03 / **Element DA** / **Sub-element 4**

(Related Sub-elements:) *[ALSO SEE RELATED F&O DA-05]*

The failure data is a collection of 1992 data and a 1996 update. The 1992 failure data package has no plant specific data at all. The 1996 data update is based on plant specific data, but is only done for about 20 components. Thus, the current status of the data base is that all the data is from "pre-Maintenance Rule" data collection. The failure data is not "representative" of the current plant operating experience.

The 1996 data update is based on Cycle 10 -17. The plant is now on cycle 21.

LEVEL OF SIGNIFICANCE: B

This is given a ~~signficance~~significance level of B because the PRA data is ~~has~~ 5 years old, and should be more current ~~data~~.

POSSIBLE RESOLUTION

One possible resolution is to use Maintenance Rule data in the next data update.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 04 / **Element DA** / **Sub-element 6**

(Related Sub-elements:)

The test interval for MOV SI 862 is stated as 18 months. These valves appear to be tested every time an RHR pump is tested. It is not clear why the test interval is not 3 months, or 1.5 months if the pumps are staggered test.

The groundrules indicate that components tested every 3 months or less were modeled with a time dependent failure rate, whereas if the test interval is 3 months or greater the time dependent failure model is used. The demand rate for open and close is 3E-3/d. Rates for fail to transfer are typically 7.4E-6/hr and 1.88E-6/hr.

The observations are the following:

1) Although the groundrules say the breakpoint is 3 months, some 3 month components in the PRA use ~~are~~ time dependent models, while some others use ~~are~~ demand related models

2) The rates for "valve fails to change" indicate that the probabilities for FTO and FTC evaluated for a 3 month test interval equal 8E-3 and 2E-3, not 3E-3.

3) By arbitrarily assigning long test intervals, the failure probabilities of certain valves are artificially made higher or lower.

LEVEL OF SIGNIFICANCE: B

This is a B Level of Significance because it shows an inconsistent application of failure probability models, with possible aeffects on the numerical results.

POSSIBLE RESOLUTION

1) Develop a basis for use of time dependent and demand related models

2) Coordinate the failure rates so that the failure probabilities at the cross-over point are the same.

3) Consistently implement the resolution of this F&O.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 04 / **Element DA** / **Sub-element 6**

(Related Sub-elements:)

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 05 **/ Element DA / Sub-element 7**

(Related Sub-elements: ***) [ALSO SEE RELATED F&O DA-3]***

Plant specific data is used for several components for Test and Maintenance. This data was collected from cycle 10 to cycle 17. This represents a time period from about 1984 to 1994. This data represents "pre-Maintenance Rule" data collection quality.

Some of the plant specific OOS hours are so low as to be suspect. For example, the total time OOS for all four SW pumps in 10 years is 123 hours, which is 4 hours/year per pump. The RHR pumps show a ~~c~~ total of 46 hours per 10 years. This is 2.3 hours per year per pump.

LEVEL OF SIGNIFICANCE: B

This is a significance Level B. The plant specific T&M frequencies for some components are very low and are from pre-MR data collection efforts. A change in some T&M probabilities will have a significant ~~a~~effect on results.

POSSIBLE RESOLUTION

Update data with current data.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 06 **/ Element DA / Sub-element 8**

(Related Sub-elements: DA-9)

The documentation indicates that the common cause factors are taken from a draft EPRI report. The report is not referenced, but the reviewers believe that ~~. T~~this report cannot be more recent than 1992. In general, the common cause factors do not ~~not~~ agree with more recent accepted sources, such as the INEEL database.

LEVEL OF SIGNIFICANCE: B

Given the importance of common cause basic events to the overall results, a reliance on an outdated source could have a significant affect on CDF and LERF.

POSSIBLE RESOLUTION

Use a contemporary, accepted source for CCF data.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 08 **/ Element DA / Sub-element 18**

(Related Sub-elements:)

The only documentation for the data update is a spreadsheet. There is no evidence of an associated calc and ~~independent~~ review.

LEVEL OF SIGNIFICANCE: B

Errors could have ebeen made and not detected that could affect the results.

POSSIBLE RESOLUTION

Provide more (detailed) documentation for data updates and perform an ~~independent~~ verification review of that documentation.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 09 / **Element —— DA / Sub-element 2**

(Related Sub-elements:)

The derivation of prior distributions that reflect a combination of data from plants where the plant failure history is unknown with data from plants with known failure counts is not consistent with industry guidance. The method employed (geometric averaging) is generally similar to a method prescribed in NUREG-2300 for combining multiple sources. One concern with the method as implemented is that it allows the failure history at a single plant to be equally weighted with distributions from a number of plants. There is no discussion provided justifying this. Thus, there is the potential to skew the mean.

It was not clear to the reviewers that the method for determining the confidence interval is consistent with the discussion in NUREG-2300. The priors are taken to be lognormal distributions. The method used may tend to underestimate the tails of the lognormal distributions, which can have an effect on the variance.

LEVEL OF SIGNIFICANCE: B

Inappropriate prior distributions may not matter given sufficient plant specific evidence. However, questions have been raised concerning the applicability of plant evidence and the Bayesian updating process.

POSSIBLE RESOLUTION

Use industry guidance or ensure that the results are equivalent with what would be obtained using such guidance. ***[SHAWN, PLEASE PROVIDE A MORE SPECIFIC REFERENCE FOR "INDUSTRY GUIDANCE"]***

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: DA - 10 **/ Element DA / Sub-element 15**

(Related Sub-elements:)

The possibility of blocking a pressurizer PORV or a steam generator PORV is not modeled.

LEVEL OF SIGNIFICANCE: B

A blocked pressurizer PORV can have an impact on the ATWS (pressure relief), Bleed and Feed, and response to pressurizer challenges. A blocked SG PORV would affect cooldown and depressurization.

POSSIBLE RESOLUTION

Add logic to account for blocked PORVs to the fault tree modeling and reassess impact on aforementioned events.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: HR - 03 **/ Element HR / Sub-element 6**

(Related Sub-elements:)

The PRA was searched for ~~and~~ postulated pre-initiator human actions. Actions are included for miscalibration and restoration where appropriate.

The HEP for miscalibration are particularly high (0.01- 0.001), although the method is not a screening method. The miscalibration HEP was calculated for one channel of instruments and then applied to all 3 channels, so in effect it is a common cause miscalibration.

The HEP for manual actuation is quantified ~~however,~~ disregarding the miscalibrated channel sensors. Also, in the quantification rule file, the HEP for AFW action do not include consideration of the miscalibrated water level sensors in the determination of the HEP.

LEVEL OF SIGNIFICANCE: B

This problem is masked in the analysis. It is important to model conditions in the HEP evaluation that correspond to the scenario being addressed. ~~but resulted in a grade of 1 on sub element 6 based on the subtier criteria.~~

POSSIBLE RESOLUTION

Check the analysis, ~~and~~ remove ~~any~~ screening values used for risk-significant HEPs, and check that the HEP calculations reflect the conditions applicable to the scenarios being addressed.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 02 / **Element QU** / **Sub-element**

(Related Sub-elements:)

The AC power recovery factors do not consider the need to apply a unique recovery factor to sequences involving stuck open PORVs~~ as an individual sequence with a unique recovery factor~~.

The stuck open PORV cutsets are recovered by the same recovery factor as seal LOCA cutsets (using recovery factor X-ACP1). The stuck open PORV leak rate is greater than that for a seal LOCA and starts at time=0. The PORV LOCA will lead to core uncovery in shorter time than a seal LOCA, resulting in the need to apply a higher non-recovery probability. ~~about 2 hours.~~ ~~T~~For example, if the PORV LOCA leads to core uncovery in about 2 hours, the non-recovery of AC power probability for 2 hours is 0.215, not 0.156, which ~~as~~ is the value of X-ACP1 used in the recovery rule.

LEVEL OF SIGNIFICANCE: B

This is significance level B because incorrect values are being used, which may have an impact on results.

POSSIBLE RESOLUTION

Apply a separate recovery factor to the stuck open PORVs.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

A.	Extremely important and necessary to address to ensure the technical adequacy of the PRA, the quality of the PRA, or the quality of the PRA update process. (Contingent Item for Grade Assignment.)
B	Important & necessary to address, but may be deferred until next PRA update (Contingent Item for Grade Assignment.)
C.	Considered desirable to maintain maximum flexibility in PRA Applications and consistency in the Industry, but not likely to significantly affect results or conclusions.
D.	Editonal or Minor Technical Item, left to the discretion of the host utility.
S.	Superior treatment, exceeding requirements for anticipated applications & exceeding what would be found in most PRAs.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 03 **/ Element QU / Sub-element 8**

(Related Sub-elements: AS-13)

It is not clear the AC power recovery factors were calculated correctly.

The PRA ~~uses~~applies recovery factors to ~~for~~ LOSP sequences ~~for~~ cutsets with "fail to run" events, to ~~accommodate~~account for the time dependence of the failures. The details of the method used for this calculation ~~was~~were not available ~~for~~during the peer review.

The method of time-phased recovery should calculate the average probability of non-recovery for the time interval of interest (i.e., 24 hours). It appears the method used for Robinson uses the probability of non-recovery at the average failure time (i.e., 12 hours). If the recovery curve for AC power ~~is~~were linear, these two mathematical quantities would be the same. However, the AC power non-recovery curve is ~~expontential~~exponential, so that ~~. T~~the recovery factors applied to the 24 hour fail to run sequences appear too low to be compatible with the ~~OSP~~offsite power recovery curve being used for the project.

The value of recovery factor ACP8 ~~-~~(~~SSHR~~secondary side heat removal loss at 12 hours) is 0.0174. The average non-recovery of AC power probability over the first 24 hours~~,~~ is 0.0924.

LEVEL OF SIGNIFICANCE: B

This is an B significance because the difference in the recovery factor ~~it~~ is very important to core damage frequency results.

POSSIBLE RESOLUTION

Verify the method for calculation of AC power recovery factors. Correct the factors if necessary. If the method used is believed to be correct, provide more detailed documentation of the approach and bases.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 04 **/ Element QU / Sub-element 8**

(Related Sub-elements:)

The recovery data for Offsite power is not consistent between the ~~system~~ Initiating Events notebook and the recovery factor calculation sheets. The IE notebook has an appendix which provides non-recovery AC curves. The spreadsheet "RCPL15.xls" provides recovery values which are not consistent with the curves in the IE notebook Appendix.

LEVEL OF SIGNIFICANCE: B

This is a B Level of Significance because a consistent recovery model is important to ~~provide for~~ the LOSP model.

POSSIBLE RESOLUTION

Verify the correct usage of the most current OSP non-recovery curve for the recovery factor calculations. Correct inconsistencies across PRA work packages as necessary.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 05 **/ Element QU / Sub-element 27**

(Related Sub-elements: 28,29,30)

-It is not apparent that a search for ~~modeling~~sources of uncertainty in the PRA results has ~~ever~~ been performed. The ~~Certification~~Peer Review Team ~~found that the following~~identified several potential sources of uncertainty in the PRA results, the impacts of which did not appear to have been evaluated, e.g.:

a) assumptions associated with the RCP seal LOCA model

b) basis for the time lines used for HEP dependency evaluation

c) groundrules which ~~delete~~eliminate many items from consideration in the PRA based on being "probabilistically insignificant"

d) the inability to show convergence~~-~~ in quantification results / quantify to a sufficiently low cutoff frequency

e) the ~~variation~~ differences in LOCA category definitions and resulting frequencies~~y~~ between Robinson and other PWR PRAs.

Rigorous quantification of the impacts of such sources of uncertainty is not expected. But it is important to have an understanding of what potential uncertainties exist in the model, and at least a qualitative evaluation of how they may affect risk-informed decisions using the PRA.

A calculation of data uncertainties was performed for the 1997 results. This has not been performed for the 1999 model of record (MOR).

LEVEL OF SIGNIFICANCE: B

This is significance B as a systematic search for, and understanding of the impacts of, sources of uncertainty in the PRA is important~~(and required for a grade of 3)~~.

POSSIBLE RESOLUTION

Identify and evaluate the effects of ~~Address~~ sources of uncertainty in the PRA. Once sources are identified, ~~area through either~~ qualitative methods and systematic sensitivity analyses and/or ~~with~~ a formal quantitative ~~model~~approach could be taken to gain insights into their effects.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 05 / **Element QU** / **Sub-element 27**   ***(Related Sub-elements: 28,29,30)***
PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 06 **/ Element QU / Sub-element 24**

(Related Sub-elements: QU-6, QU-23)

The core damage frequency model is presently quantified at a cutoff of 4.00E-09. Many PRAs are quantified using a much lower cutoff, with identical PRA software.

Several quantifications were made during the review by the ~~Cert~~peer review team to investigate the impact of this relatively high cutoff, using the 16-bit CAFTA, FORTE and NURELMCS software. The review team found the following:

1) The current RNP process for quantification, using the screening HEP values, produces a large number of cutsets. Quantification below 4E-09 results in too many cutsets for the 16 bit version of CAFTA.

~~1~~2) ~~w~~When the RNP model was quantified using the nominal independent HEP's and a cutoff of 4E-09, ~~in the first quantification~~ the CDF was 3.9E-05 (~~using a cutoff of 4E-09~~).

~~2~~3) When the RNP model was quantified using the nominal independent HEP's and a cutoff of 8E-10, ~~in the first quantification~~ the CDF increased to about 5E-05 (~~using a cutoff of 8E-10~~). This is an increase of ~25%, which is significant.

~~3~~4) When the RNP model was quantified using the RNP method of "recovering" the dependent HEPs (i.e., post-cutset-quantification replacement of the nominal values of dependent HEPs in cutsets with combined dependent values), but including all the recovered cutsets ***[ADD SOME WORDS HERE TO CLARIFY WHAT WAS DONE ???]***, the CDF increased from 3.9E-05 to 4.7E-05. This is an increase of ~10%. ***[WHAT CUTOFF WAS USED FOR THIS CASE ??? WAS THIS A 32-BIT CAFTA CASE ???]***

~~The current RNP process for quantification, using the screening HEP values, produces a large number of cutsets. Quantification below 4E-09 will result in too many cutsets for the 16 bit version of CAFTA.~~

The sensitivity studies performed by the review team indicate there may be a substantial CDF frequency truncated away because of the ~~choice of~~ cut off value dictated by the combined model requirements and software version limitations.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 06 / **Element QU** / **Sub-element 24**

(Related Sub-elements: QU-6, QU-23)

LEVEL OF SIGNIFICANCE: A

This was assigned ~~is~~ significance A because it appears that there may be a significant fraction of the total core damage frequency that is not accounted for in the results. REG Guide 1.174 ~~states~~suggests that the CDF used for applications ~~must~~should be 95% of the total represented by the PRA model. At present this level of convergence is not assured.

The CP&L PRA team has provided additional information that they feel justifies the use of the current process (see attachment following this observation). The review team is considering this in its review of the draft report.

POSSIBLE RESOLUTION

Take the necessary steps to either a) change the model so that the current PRA software can be used to capture a larger percentage of the total modeled CDF, b) change the quantification process, or c) use an enhanced system of computers and ~~codes~~software to allow quantification at a much lower cutoff.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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[SEE NEXT PAGE FOR ADDITIONAL INFORMATION FROM CP&L REGARDING THE ISSUES IN F&O QU-06]

[ADDITIONAL INFORMATION FROM CP&L REGARDING ISSUES IN F&O QU-06]

From: Sloane, Barry D.

Sent: Tuesday, December 04, 2001 10:08 PM

To: Bertucio, Robert'; KACHNIK, LEO J; 'Lichtenstein, B.'; Lutz, Bob; Rodgers, Shawn'

Cc: Sloane, Barry D.; Lockridge, DeLeah V

Subject: CPL Response to Peer Review Item

Importance: High

Team,

The following information was provided by CP&L (as an attachment to a letter to me) in response to the open item for QU.

This response appears to focus on the aspect of the numerical truncation limit, measured against the PSA Applications Guide criteria; but the use of compensatory actions for applications would seem to have the potential to at least partially address the real issue. In any case, it appears they are already taking action to evaluate the issue (see last paragraph of the attachment).

I believe they likely will not have additional information on this item prior to the draft report going out. So please consider this information relative to the discussion we had regarding the issues affecting the QU grade. Then please email any perspectives you have to the team, so we can all have the benefit of each others opinions on this.

I would like to resolve this by Thursday if at all possible, since I'll be tied up with the Vogtle review next week.

Thanks for your help with this.

Regards,

Barry

[ADDITIONAL INFORMATION FROM CP&L REGARDING THE ISSUES IN F&O QU-06 (Continued)]

Attachment from CP&L

CP&L recognizes that the current truncation limit of 4.0E-9 may be high relative to some other plant PSA models; however, our basis for applying this truncation limit to our baseline quantification is that it is four orders of magnitude below the resulting CDF, ensuring that any new cutsets are very small compared to overall CDF. This is consistent with the EPRI PSA Applications Guide (TR-105396).

Recognizing that this truncation limit may not be appropriate for all situations, our practice is to compensate for applications sensitive to the truncation limit. For example,

1. AOV and MOV risk ranking studies were evaluated with associated failure probabilities increased to compensate for the truncation limit
2. Maintenance Rule Performance Criteria were evaluated with increased failure probabilities and requantified
3. EOOS is requantified, rather than using pre-solved cutsets

Use of the EPRI Applications Guide truncation limit alone should be the basis for a sub-element score of "2". In light of the underlying quality of the PSA and the compensatory measures used for risk applications, we feel that the existing RNP PSA model at the current truncation limit is deserving of an adequate rating. Our interpretation of the guidelines would suggest a rating of "Conditional 3".

As a result of this "A" level finding, we are reviewing the behavior of the RNP PSA model at lower truncation levels. We may also adopt the 32-bit CAFTA, PRAQUANT and FORTE software, to remove the current technological barrier.

FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: QU - 09 **/ Element QU / Sub-element 17**

(Related Sub-elements: HR-18, HR-19, HR-20)

Calculation of dependencies between human actions requires assessment of sequence timing and the amount of time between events. The CP&L team stated that time lines for sequences had been ~~were supposedly~~ developed, but ~~were~~the time lines were not available for review. As a result, it was not possible to ~~The ability~~ to trace the timing considerations to plant specific analysis ~~was not present~~.

LEVEL OF SIGNIFICANCE: B

This was assigned a ~~is~~ level B significance. A large percentage (~50%) of the Base Case CDF ~~is due to~~involves operator errors. Many of these are calculated considering the impacts of ~~in a~~ human action dependencies~~t fashion, which~~. However, an accurate dependency evaluation requires knowledge of ~~the~~ timing (among other factors) to discern the level of dependence. Discrepancies in the relation of the time frames to Robinson specific analysis could have a large effect ~~of~~on the results.

POSSIBLE RESOLUTION

Provide the basis (e.g. the event timing) for the choice of high, medium, low and zero dependence between human actions; and complete the evaluation of dependence among HRA events. ***[WAS THERE A COMPLETENESS ISSUE ??? THE F&O TEXT DOESN'T SEEM TO ADDRESS THAT]***

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

OBSERVATION ID: L2 - 03 / **Element L2 / Sub-element 8**

(Related Sub-elements: L2-6, L2-19)

~~Small~~The probabilities of early containment failure are developed through detailed assessments of various phenomena that can occur in HB Robinson containment following reactor vessel failure, including DCH, Steam Explosions, Hydrogen burns, and Hydrogen Explosions. The assessments were developed based on information available in early 1990's as summarized in NUREG-1150 and supporting documents such as NUREG/CR-4551. The Robinson PRA retains estimated (small but non-zero) probabilities for these events.

More recent information on DCH, Hydrogen Detonations and Steam Explosions has concluded that the contributions to early containment failures are much smaller than estimated in NUREG-1150 and may be nearly zero at many plants.

LEVEL OF SIGNIFICANCE: B

Since ~~none of~~ these phenomena (e.g., DCH and Steam Explosions) are no longer viewed as contributors~~e~~ to LERF ~~value~~, ~~they~~the continued use of the IPE-era probabilities should be re-examined. It is important that the LERF value not be inflated by conservative assumptions that will result in incorrect risk significance assessments in applications. For example, if the LERF is inflated by conservative assumptions, the risk significance of more realistic contributors will be understated.

POSSIBLE RESOLUTION

Re-assess the likelihood of phenomena that contribute to early containment failures using a current knowledge base. Retain the capability to address such phenomena using the model if required for future applications, but replace the probabilities for the base LERF determination so that such phenomena do not incorrectly affect the LERF results.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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FACT/OBSERVATION REGARDING PRA TECHNICAL ELEMENTS

***OBSERVATION ID: L2 - 08 /* Element L2 / Sub-element 22**

(Related Sub-elements: L2-1, L2-23)

The was no guidance for the LERF model. The definition of LERF is not provided, although it is obvious that the LERF definition ~~contains~~includes releases resulting from ISLOCA, SGTR, and failure of containment isolation. The LERF results indicate that all SGTR are assumed to contribute ~~go~~ to LERF, which is conservative compared to assumptions made in other Westinghouse plant PRAs. The SGTR event contributes about 3E-06 to LERF, which is high compared to ~~most~~ other plants.

If formal guidance were~~was~~ available to define LERF and provide guidance for discerning early from late failures, it ~~may~~might be possible to reduce ~~that~~ LERF conservatisms ~~would be reduced~~.

LEVEL OF SIGNIFICANCE: B

This is a significance B, because t~~. T~~he basis of the LERF model is not apparent and the LERF appears conservative.

POSSIBLE RESOLUTION

Provide a definition of LERF, and guidance indicating which ~~to~~ include early and late failures and EAL's are to be considered.

PLANT RESPONSE OR RESOLUTION

LEVELS OF SIGNIFICANCE FOR FACTS AND OBSERVATIONS

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