



*Seismic PRA Peer Review Findings:
Lessons Learned from F&O Reviews of
Previous Risk-Informed Applications*

CJ Fong, Team Leader
Candace Pfefferkorn, Reliability and Risk Analyst
NRR Division of Risk Assessment/PRA Licensing Branch
Risk Informed Licensing Initiatives Team
October 6, 2016

Background

- Seismic PRAs (SPRAs) will be submitted starting in FY17 in response to the NRC 50.54(f) request for information associated with the Near-Term Task Force (NTTF) Recommendation 2.1: “Seismic”
- The NRC approved guidance for addressing Recommendation 2.1 is the Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1 (ADAMS Accession No. ML12333A170).
- To facilitate streamlined review of forthcoming SPRA submittals NRC is sharing lessons learned from reviews of Facts and Observations (F&Os) associated with previous (non SPRA) risk-informed applications.
 - If the NRC staff cannot conclude, via F&O documentation alone, that a PRA Standard Supporting Requirement (SR) is met, then a Request for Additional Information (RAI) is generally required. Many of these RAIs could be avoided with improved understanding of the level of justification needed to adequately demonstrate a specific SR is met.
 - PRAs used to support risk-informed licensing actions are subject to the PRA Standard as clarified/qualified by NRC Regulatory Guide 1.200, Rev. 2. The SPID provides analogous clarifications/qualifications specifically associated with SPRAs submitted in response to the NTTF Recommendation 2.1.

Common Themes Based on F&O Reviews

Type 1: Description of the Impacts of New/Updated Documentation

- If new/updated documentation is required, both the documentation deficiency as well as the impact of such new information on the results should be addressed. New documentation should be reviewed.

Type 2: Inclusion of the Basis for Expected Outcomes

- If an issue/change is not implemented because it is expected to have no effect and/or a negligible impact, a description of the basis for this conclusion should be included.

Type 3: Inclusion of Clarifications/Qualifications to the PRA Standard

- F&O dispositions should address any additional requirements/clarifications based on the pertinent NRC approved guidance.

Type 4: Delineation between PRA “Upgrade” and “Maintenance”

- Specific discussion of if changes to methodologies/inputs constitute an upgrade and/or maintenance should be included.

Type 5: Explanation of the Effects of Conservative Assumptions

- If acceptance criteria are calculated based on multiple inputs (e.g. change in risk, importance measure, etc.), the effects of using conservative assumptions for baseline inputs should be addressed.

***** The example F&Os used in this presentation have been modified (e.g. summarized, shortened, etc.) for illustrative purposes. The examples may not reflect actual plant-specific F&Os *****

Type 1: Documentation Only

SR	Requirement	Status	F&O	Disposition	Impact
IE-C15	CHARACTERIZE the uncertainty in the initiating event frequencies and PROVIDE mean values for use in the quantification of the PRA results.	Open	Section 123, documents assumptions and sources of uncertainty; however, it does not provide or reference the parametric uncertainty IE data distribution. For example, while the ABC distribution is identified in the model as having an error factor (EF) of 123, no documentation for the EF could be found. Therefore the SR is not met.	Documentation Only: Include EFs and brief discussion about IE frequency uncertainty	This is a documentation issue and IE frequency distribution evaluation. Changes will not impact the licensing action analysis.

This F&O indicates that parametric uncertainty IE data distribution and EF documentation is not available. In addition to addressing the documentation issue, the justification/basis for the EFs should be provided and an assessment of impact discussed. Subsequent review of new information should also be addressed as needed.

Type 1: Documentation Only

SR	Requirement	Status	F&O	Disposition	Impact
IFQ U- B3	DOCUMENT sources of model uncertainty and related assumptions (as identified in QU-E1 and QU-E2) associated with the internal flood accident sequences and quantification.	Open	<p>Section 123, provides a discussion of three areas considered to be major sources of uncertainty in the analysis. This does not constitute an adequate characterization of the sources of uncertainty or a comprehensive discussion of the assumptions that could have an effect on the results.</p> <p>A reasonably thorough investigation of sources of uncertainty is necessary for proper characterization of the analyses and results.</p> <p>A more comprehensive characterization of sources of uncertainty, comparable to that provided for other areas of the PRA, should be developed for this analysis.</p>	Documentation Only: Update the discussion of assumptions and uncertainty to be consistent with the pertinent PRA Standard. Equivalent sections of other PRA technical elements provide an example of the detail that is required. In addition, the discussion of uncertainty and impact of assumptions in the ABC Notebook should be revised to include treatment of pertinent issues (or alternatively, a similar treatment should be provided in the ABC Notebook)	<p>This issue will not affect the analysis. This issue has been partially addressed by the calculation of EFs for the pertinent IEs. These have been added to Table 123.</p> <p>Remaining action is to reference any key sources of uncertainty per pertinent guidance.</p>

While cited against a Documentation SR, this F&O indicates that the uncertainty analysis may be inadequate. The disposition should indicate if a parametric uncertainty analysis on the subject CDF has been completed as well as if uncertainty analysis for any new basic events were considered.

Sufficient Justification Provided in Disposition

SR	Requirement	Status	F&O	Disposition	Impact
QU-F3	<p>DOCUMENT the significant contributors (such as initiating events, accident sequences, basic events) to the CDF in the PRA results summary.</p> <p><u>PROVIDE a detailed description of significant accident sequences or functional failure groups.</u></p> <p><i>(Specific to Capability Category (CC) II only)</i></p>	Closed	<p>Significant initiating events and accident sequences have been documented in the Report ABC. A detailed description of significant accident sequences has been documented. However, due to the lack of a single merged cutset files, significant basic events have not been documented.</p>	<p>CC I is acceptable for this application as the actual results are not influenced by not achieving CC II. The contributors at any level can be determined from a review of the cutsets, including the basic events. Importance ranking at the basic event level were not developed. The significant contributors at the sequence level are discussed.</p>	<p>There is no expected impact per the discussion in the F&O disposition.</p>

This F&O requests additional documentation associated with basic events. The disposition includes adequate justification to demonstrate that indeed, basic event information can be derived/evaluated at a level adequate to meet the appropriate SR at the CC I level.

Sufficient Justification Provided in Disposition

SR	Requirement	Status	F&O	Disposition	Impact
QU-D5	REVIEW a sampling of nonsignificant accident cutsets or sequences to determine they are reasonable and have physical meaning.	Closed	Could not find evidence of review of non-significant cutsets to determine if they are reasonable. Documentation is available that shows review of high level cutsets (top 100-200)	This finding has been addressed. No documentation requirement exists in the PRA Standard for this item. It appears that the review team is interpreting that detailed write-ups are required for every detailed step taken in the development of the PRA. The subject review of non-significant cutsets was performed multiple times during draft quantifications of the model, as well as the final documented dominant sequence and cutset discussion in the PRA Summary Notebook. The PRA does not maintain hand mark-ups and corrections in draft quantifications as this is judged to be beyond the intent of this SR. Reviews done by the PRA modelers during development and quantification is deemed adequate for this SR.	The resolution of this F&O did not result in changes to the PRA model and thus the finding has no impact on the use of the ABC internal events PRA in the application.

This F&O addresses the review of non-significant cutsets/accident sequences. The licensee takes exception to the request for additional documentation, but provides sound reasoning. Specifically, it is noted that the PRA standard does not indicate that documentation of the review of non-significant cutsets is required.

Type 2: Justifying Expected Outcomes

SR	Requirement	Status	F&O	Disposition	Impact
DA-C2	COLLECT plant-specific data for the basic event / parameter grouping corresponding to that defined by requirement DA-A1, DA-A3, DA-A4, DA-B1, and DA-B2.	Open	<p>Procedure <i>ABC</i> is the primary data gathering procedure. It is supplemented by <i>ABC</i> data and the <i>ABC</i> report.</p> <p>Some of the generic data is quite dated. More recent generic data should be pursued. Component failures should be defined such that they encompass only those failures that would disable the component over the PRA mission time. It appears that this has not been considered.</p>	The plant-specific equipment failure data is 10 years old. The events, failure modes, and parameters for which data are collected appear to be consistent with those used in the system models, and are collected for groups of components.	<p><u>Minor changes</u> to the random failure rate of the components is <u>not significant</u> in the risk evaluations. There is <u>negligible impact</u> to the application.</p>

This F&O addresses the use of dated data. The basis for “negligible impact” is that “minor changes” to random failure rates are not significant; however, the criteria for what constitutes “minor” and “negligible” are not defined.

Type 2: Justifying Expected Outcomes

SR	Requirement	Status	F&O	Disposition	Impact
IFS N- A16	<p>USE potential human mitigative actions as additional criteria for screening out flood sources if all the following can be shown:</p> <p>(a) Flood indication is available in the control room</p> <p>(b) The flood source can be isolated</p> <p>(c) The mitigative action can be performed with high reliability...</p>	Open	<p>Only one flood appears to have been screened based on qualitative consideration of potential human action; for that action (123 gpm break in ABC) there doesn't appear to be any justification for the time identified (123 min). Nothing other than time available is cited as rationale for screening the event.</p> <p>To meet CC II, it is necessary to characterize potential human actions that could terminate flooding more explicitly than was done in this case.</p> <p>Address the required aspects for this and any other human actions used in justifying screening out flood scenarios.</p>	Characterize in greater detail those potential human actions that could terminate the event and develop an estimate of the likelihood of failing to mitigate the pipe break using accepted HRA methods.	The screened flood will be added to the flood model. However, the impact is <u>expected to be minimal</u> , and is <u>not expected to have any impact</u> of the associated program.

This F&O addresses the consideration of potential human actions with regards to screening of flood scenarios. The disposition addresses the consideration of potential human actions; however, a description of why the impact of this additional analysis is “expected” to be minimal/ “is not expected” to impact the pertinent program is not addressed.

Sufficient Justification Provided in Disposition

SR	Requirement	Status	F&O	Disposition	Impact
IE-A9	REVIEW plant-specific operating experience for initiating event precursors, for identifying additional initiating events. For example, plant specific experience with intake structure clogging might indicate that loss of intake structures should be identified as a potential initiating event.	Closed	Capability Category I met. There is no evidence in the notebook that a precursor review was performed. In response to the question, a review of Table 123 and LERs was performed. The items in the table were all plant scrams. The LER review would contain non-scram precursors. However, a question was asked to the licensee team and the response pointed back to the support system initiator development, which is covered by another SR. This SR of Category I (no requirement for precursor review).	<p>This finding has been addressed. There was an extensive plant-specific review of operational experience to identify precursors.</p> <p>The systematic search for plant-unique and plant-specific support system initiators is document in Section 123 of the IE notebook. The search for precursors included the interview of the system managers, operators, and a review of LERs. The IE notebook provides a detailed review of plant-specific design and the identification of IE precursors; see Section 123 of the PSA. Each plant-specific system / subsystem) potential IE impact is discussed; for example....</p> <p>In addition, the PRA industry has exhaustively identified IE categories in countless IE studies over the past 30 years. Further, other SRs (e.g. IE-B3) are already require individual support systems to be reviewed as potential IEs. This is documented in Section 123.</p> <p>In addition, the loss of intake IE was extensively studied. See Section 123.</p>	<p>The resolution of the F&O validated adequacy of the IE analysis and did not result in changes to the PRA model.</p> <p>Therefore, the F&O has no impact on the use of the PRA in the application.</p>

This F&O questions the adequacy of IE precursor review. The disposition thoroughly discusses the concern and specifically addresses the example from the SR (the loss of intake structures).

Type 3: Discussion of Additional Guidance

SR	Requirement	Status	F&O	Disposition	Impact
SY-B14	<p>IDENTIFY SSCs that may be required to operate in conditions beyond their environmental qualifications. INCLUDE dependent failures of multiple SSCs that result from operation in these adverse conditions. Examples of degraded environments include (a) – (g)</p> <p><i>(h) Added via RG 1.200, Rev 2</i></p>	Open	There was no evaluation of the ability of non-qualified equipment to survive in a degraded environment following an accident such as a steam line or feed water break outside of containment.	This F&O is open because an evaluation of potential adverse effects on equipment operation due to degraded environmental conditions resulting from accidents in the PRA model has not been performed for events like steam line break and feed line breaks. The fire PRA considers the impact of fire on the environment in the analysis. High energy line breaks are not relevant to the fire PRA.	The fire PRA considers the impact of fire on the environment in the analysis. High-energy line breaks (e.g. steam line breaks and feed line breaks) are addressed in the internal flood PRA. This is considered resolved. There is no impact on the application.

This F&O regarding an evaluation of non-qualified coatings in degraded environments is adequately dispositioned. However, RG-1.200, Rev. 2 adds another example degraded condition to the SR. Consideration of this additional example with regards to the impact on the application should be included.

Type 3: Discussion of Additional Guidance

SR	Requirement	Status	F&O	Disposition	Impact
FSS -A2	GROUP all risk-relevant damage targets in each unscreened physical analysis unit within the global analysis boundary into one or more damage target sets and for each target set, SPECIFY the equipment and cable failures, including specification of the failure modes, including spurious operation. <i>(Added via RG 1.200, Rev 2)</i>	Closed	Target sets and related failure modes are not listed in an comprehensive and organized fashion, and then linked to pertinent sources. Additional identification of objects may be needed. SR judged to be met.	As described in a pertinent report, only certain targets are identified for a given scenario. It was not considered practical to group target sets and then link to pertinent sources. However, a list of scenarios where a specific target was impacted can be derived using ABC database.	Since the F&O has been met, there is a negligible impact to the application.

This F&O has been dispositioned, but it is not clear whether a clarification from RG 1.200, Rev. 2 was addressed. Specifically, the clarification adds “including spurious operation” to the requirement to specify failure modes for equipment and cables in the target sets.

Sufficient Justification Provided in Disposition

SR	Requirement	Status	F&O	Disposition	Impact
SC-B3	When defining success criteria, USE thermal / hydraulic, structural, or other analyses / evaluations appropriate to the event being analyzed, and accounting for a level of detail consistent with the initiating event grouping (HLR-IE-B) and accident sequence modeling (HLR-AS-A and HLR-AS-B).	Closed	<p>CC I/II/III met. Document 123 dismisses the need for long term core spray in large LOCA scenarios based on MAAP calculations. While consistent with existing PRAs, this needs to be addressed further.</p> <p>MAAP does not treat steaming in the low power bundles precisely. It is OK if recovery is imminent or if the core is going to a melt state, however for long term steady state at low water level it will over-predict the two phase level in the low power bundles.</p> <p>MAAP calculates an overall steaming rate and applies it evenly across all bundles. This provides an adequate collapsed level in each bundle, but the two-phase will be too high in the low power bundles. MAAP also does not behave as expected when calculating the individual node core power. Due to the way it handles the uranium group, the power shape calculated is flatter than expected. This could affect the two phase level as well.</p>	<p>This finding has been addressed. ABC calculations are the basis for the success criteria (e.g. not relying solely on MAAP calculations).</p> <p>The success criteria that do not require core spray for large LOCA mitigation are based primarily upon ABC calculations.</p> <p>The Success Criteria Notebook identifies that the pertinent calculations by ABC do not show fuel or clad melting for the identified cases in question. Rather, the ABC design calculations show that 10 CFR 50 App. K requirements for clad oxidation cannot be assured. However, this is not a criterion for core damage as specified in the ASME PRA Standard or in the plant-specific PRA. Therefore, these criteria do not need to be satisfied to allow success in the Level 1 PRA.</p> <p>The plant-specific success criteria are consistent with all pertinent PRAs reviewed against ABC certification and NRC guidance.</p>	<p>The resolution of the F&O identified that both MAAP and ABC analysis were used in development of the success criteria.</p> <p>No changes to the PRA model were required, and the finding has no impact on use of the PRA in the application</p>

This F&O addresses a potential over-dependence on one analysis method. The disposition clarifies that, in fact, multiple analysis methods were used, and specifically specifies the bases for the conclusion regarding the dismissal of core spray in large LOCA scenarios.

Type 4: PRA “Upgrade” vs. “Maintenance”

SR	Requirement	Status	F&O	Disposition	Impact
IFQ U- A5	If additional human failure events are required to support quantification of flood scenarios, PERFORM any human reliability analysis in accordance with the applicable requirements described in 2-2.5.	Closed	It was not clear that the requirements were met in all cases. For example, interviews to establish response times were performed, but the HRA was dramatically changed and the new interviews/changes were not incorporated nor were any inputs obtained from the HRA performed. It is necessary to perform the assessment of HFES associated with internal flooding in the same manner as for other HFES. The requirements to confirm procedure paths, timing, etc. via interviews with operators were not met for a number of events. Re-examine the HFES associated with internal flooding, and either perform needed operator interviews or identify and document existing inputs.	Required operator interviews should comprise the following: (1) – (4)... Estimate and document pertinent HFES using the same approach as was used for other HFES in the PRA. Recalculate scenario frequencies based on the new HFES.	There is no impact to the application. The HRA documents the pertinent recovery actions. The information and HRA values were verified to be consistent with the HRA actions used. No additional interviews were identified as being necessary.

This F&O addresses HRA methodology as it relates to internal flooding. The disposition should indicate if the same HRA methodology was used for the internal flooding and internal events. If the methodology was “upgraded” for internal flooding, the disposition should indicate if a focused-scope peer review was performed to evaluate technical adequacy.

Type 4: PRA “Upgrade” vs. “Maintenance”

SR	Requirement	Status	F&O	Disposition	Impact
DA-D5	<p>Use one of the following models for estimating CCF parameters for significant CCF basic events:</p> <ul style="list-style-type: none"> (a) Alpha Factor Model (b) Basic Parameter Model (c) Multiple Greek Letter Model (d) Binomial Failure Rate Model <p>Justify the use of alternative methods (i.e., provide evidence of peer review or verification of the method that demonstrates its acceptability).</p>	Open	None	<p>The CC II requirements for DA-D5 were partially evaluated in a previous peer review.</p> <p>The PRA model uses a “modified” MGL method ... The approach appears reasonable. Generic estimates for EFs are used for the common cause event. However, the documentation for the selection of specific EFs used is not included in the CCF analysis.</p>	<p>The PRA uses a “modified” MGL method. This is a documentation issue that does not impact the PRA model. There is negligible impact to the application.</p>

While no F&O is cited here, a action associated with DA-D5 remains Open. The action addresses the use of a “modified” MGL method for CCF analysis. The disposition should address if the modified MGL method constitutes an upgrade. If the modified treatment constitutes a PRA upgrade, a sensitivity evaluation of its effect could be provided until a focused-scope peer review could be completed.

Type 5: Use of Conservative Assumptions

SR	Requirement	Status	F&O	Disposition	Impact
LE-C13	Perform a containment bypass analysis in a realistic manner. Justify any credit taken for scrubbing (i.e. provide an engineering basis for the decontamination factor used).	Closed	Credit for scrubbing was not taken. A sensitivity for the impact of scrubbing was performed and it was determined that the impact of considering scrubbing is negligible. This is a requirement of the standard to move from CC I to II.	Review the possible credit for release scrubbing to reduce LERF.	There is no impact to the application. A sensitivity for impact of scrubbing was performed and it was determined that the impact of not considering scrubbing is negligible.

The F&O questions the impact of not crediting scrubbing. While it was determined via sensitivity analysis that the impact of scrubbing was negligible, a similar analysis should confirm that the impact is also negligible with respect to the “before” vs. “after” risk calculation.

Type 5: Use of Conservative Assumptions

SR	Requirement	Status	F&O	Disposition	Impact
IFE V- A8	<p>SCREEN OUT flood scenario groups if</p> <p>(a) the quantitative screening criteria in IFSN-A10, as applied to the flood scenario groups, are met, OR</p> <p>(b) the internal flood event affects only components in a single system, AND...</p> <p>If the flood impacts multiple systems, DO NOT screen on this basis.</p>	Closed	<p>Quantitative screening of some scenarios was performed, but it is not clear what criteria were applied in doing so. The criteria should be defined and applied in a clear and consistent manner.</p> <p>SRs IF-D7 and IF-E3a provide explicit criteria for performing quantitative screening of flood scenarios. The IF Notebook documents that some scenarios were screened on low frequency, but does not invoke any particular criteria in doing so.</p> <p>Provide a clear set of criteria for performing quantitative screening of flood scenarios and apply the criteria in a clear and consistent manner.</p>	Update the internal flooding study to describe the criteria used to screen flood scenarios. If current screening criteria are not well defined, develop such criteria and apply them to scenarios addressed in the analysis.	There is no impact to the application. Notebook Section 123 was updated to document the screening criteria used. A figure was added to show the screening criteria and a table was edited.

This F&O addresses flood scenario screening. It is stated that there is “no impact” to the application based on the criteria used. The disposition should confirm that any scenarios previously screened-out remain so after applying the criteria to ensure that the “no impact” conclusion is still applicable when assessing “before” vs. “after” risk.

Summary

- NRC review of F&Os enables staff to focus efforts on key assumptions and areas identified by peer reviewers as being of concern and relevant to the submittal.
- Historically, many F&O dispositions do enable NRC staff to conclude that pertinent SRs are met. However, continued communication regarding the expectations associated with F&O dispositions may facilitate further reductions in RAIs in the future.
- SPRAs submitted per NNTF Recommendation 2.1 are subject to specific NRC guidance (SPID). However, implementing general lessons learned from previous non SPRA F&Os can help streamline SPRA F&Os reviews.
 - Type 1: Description of Impacts of New/Updated Documentation
 - Type 2: Inclusion of the Basis for Expected Outcomes
 - Type 3: Inclusion of Clarifications/Qualifications to the PRA Standard
 - Type 4: Delineation between PRA “Upgrade” and “Maintenance”
 - Type 5: Explanation of the Effects of Conservative Assumptions