NRR-PMDAPEm Resource

From: Purnell, Blake
Sent: Wednesday, August 31, 2016 11:16 AM
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Subject: Davis-Besse NFPA 805 LAR - DRAFT RAI for PRA
Attachments: MF7190 DB NFPA 805 RAI APLA.docx

Phil,

Attached is the draft request for additional information (RAI) from the NRR PRA Licensing Branch regarding the Davis-Besse NFPA 805 application. A separate draft RAI from the NRR Radiation Protection and Consequences Branch will be provided later. The NRC staff will use this draft RAI during its upcoming onsite audit. The final RAI will be issued after the audit and the questions may be revised based upon the audit findings.

Please let me know if you would like to have a clarification call regarding this draft RAI in advance of the audit.

Thanks,

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REQUEST FOR ADDITIONAL INFORMATION

LICENSE AMENDMENT REQUEST TO ADOPT

NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805

FIRSTENERGY NUCLEAR OPERATING COMPANY

DAVIS-BESSE NUCLEAR POWER STATION, UNIT NO. 1

DOCKET NO. 50-346

PRA RAI 01 – Internal Events PRA Gap Findings and Facts and Observations

Attachment U, "Internal Events PRA Quality," of the LAR provides information regarding the peer review of the DBNPS internal events PRA. The following questions relate to disposition of the internal events gap assessment findings and facts and observations (F&Os) associated with this peer review.

a) Gap finding for supporting requirement HR-A1 – Pre-initiators

The gap assessment finding associated with supporting requirement HR-A1 states that the licensee's modeling of pre-initiator human failure events (HFEs) was limited to events identified as "potentially important." The gap assessment finding observed that the risk significance of a pre-initiator can be sensitive to the configuration modeled in the PRA. The LAR does not define the quantitative criteria used to screen pre-initiators, and does not explain how risk significant pre-initiators, which were previously screened, will be considered in future updates to the PRA that reflect changes in plant configuration.

i. Describe the approach of screening potential pre-initiator HFEs based on risk significance. Include a discussion of the criteria used to justify that the excluded events are insignificant to the NFPA 805 application. If exclusion of these events cannot be justified, then incorporate these events into the integrated analysis provided in response to PRA RAI 03.

ii. Provide an implementation item for LAR Table S-2 to update the risk significance determination of pre-initiators as part of the PRA maintenance and upgrade process, or justify why it is not necessary. The justification should explain how DBNPS will ensure that risk-significant pre-initiator HFEs will not be excluded in post-transition updates to the PRA.

b) F&O LE-E4-01 – Circular Logic

F&O LE-E4-01 states that it was difficult to determine if circular logic was appropriately modeled. The LAR does not provide additional details on how circular logic was modeled. Describe how circular logic loops were modeled. Provide the bases (e.g., timing associated with the particular equipment) for breaking the circular logic and justify that the treatment does not exclude important risk contributors, such as dependent failures.

PRA RAI 02 – Fire Events PRA F&Os

Attachment V, "Fire PRA Quality," of the LAR provides information regarding the peer review of the fire PRA. The following questions relate to the disposition of the associated F&Os and supporting requirement assessments related to this peer review.

a) F&O PP-C3-01 - Spatial Separation and Active Barriers

   F&O PP-C3-01 cites lack of documented justification for non-rated fire barriers and refers to use of spatial separation and active fire barriers for which there are specific considerations that need to be addressed to credit them in the fire PRA. The disposition to the F&O does not explain whether or how spatial separation or active fire barriers were credited in the fire PRA.

   i. If spatial separation is credited in the fire PRA, describe the physical characteristics that justify use of spatial separation and explain how the approach is consistent with the guidance in NUREG/CR-6850. Include a description of the distance used to define spatial separation, and describe the basis for justifying that this space is absent of combustibles and fire ignition sources. If the approach is not consistent with the guidance in NUREG/CR-6850, justify the approach or replace the current approach with an acceptable approach in the integrated analysis provided in response to PRA RAI 03.

   ii. If active fire barriers are credited in the fire PRA, describe these systems and explain how the approach is consistent with guidance in NUREG/CR-6850. Include a discussion of possible fire impact on any cables associated with the active system or fire impacts on other parts of the system that could defeat the barrier. If the approach is not consistent with guidance in NUREG/CR-6850, justify the approach or replace it with an acceptable approach in the integrated analysis provided in response to PRA RAI 03.

b) F&O CS-B1-02 – Modeling Inadequate Circuits

   The disposition to F&O CS-B1-02 identifies calculations which "include some cases where protective device coordination is not confirmed," and describes specific instances of inadequate breaker fuse coordination. The disposition explains that "[i]n these cases, the components and busses were identified as failed (assigned to UNL [unlocated] in the Fire PRA)." Based on this, it is not clear how the inadequate circuits were modeled in the fire PRA.

   i. Explain how inadequate breaker/fuse coordination was modeled in the fire PRA and justify that this treatment addresses the failures that could occur as a result of the identified potential circuit inadequacies.

   ii. Identify the failure modes addressed and discussion of how they were modeled in the fire PRA. Describe and justify the assumptions made in the fire PRA about how fire-induced faults associated with the inadequately coordinated circuits would impact components upstream and downstream from the fault.

   iii. If demonstration of breaker/fuse coordination relies on cable length (such a case is cited in the F&O), then justify that assumptions made for cables evaluated as part the fire PRA relying on cable length are consistent with guidance in NUREG/CR-6850. Guidance in NUREG/CR-6850 states that though commonly employed for Appendix R coordination, the use of cable length does not generically apply to fire PRA analysis, since compartment-level and scenario-level reviews are conducted. If treatment of these cables cannot be justified using NRC guidance, then include modeling of inadequate circuits associated with these cables in the integrated analysis provided in response to PRA RAI 03.

c) F&O PRM-B7-01 –Exclusion of Pilot-Operated Relief Valve (PORV) Failure Mode

F&O PRM-B7-01 states that a thermal hydraulic analysis is needed to support the assumption made in the fire PRA regarding a failure of the PORV to reclose following closure of main steam isolation valves (MSIVs) or loss of main feedwater. The F&O further state that PRAs for similar plant designs have included this failure mode and have found it to be a measureable contributor to core damage. The disposition to F&O PRM-B7-01 states:

> . . . a simulator evaluation was run, which proved the PORV set point is higher than the pressure limits reached following closure of the MSIVs. Therefore, the PORV will not open, and a failure of the PORV to reclose was not added to the model.

The applicability of a simulator run as the basis for establishing success criteria for the fire PRA is not clear. Justify how a simulator run constitutes a thermal hydraulic analysis and provides an adequate basis to support exclusion of the cited PORV failure mode. Alternatively, provide a basis that does not rely on a simulator run or include this failure mode in the integrated analysis provided in response to PRA RAI 03.

d) F&O PRM-B7-02 – Update of the Fire PRA after Modifications are Complete

The disposition to F&O PRM-B7-02 indicates that the PRA model management procedure requires that the fire PRA be updated when modifications are implemented. Implementation Item DB-1695, “Revise PRA for Plant Modifications,” in LAR Attachment S, Table S-2, does not indicate which PRA is to be updated (i.e., the internal events PRA, fire PRA, or both) and does not specify a plan in the event that updated fire PRA results do not meet risk acceptance guidelines in RG 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” Revision 2, dated May 2011 (ADAMS Accession No. ML100910006). Also, Implementation Item DB-1695 does not indicate that updates to the fire PRA should include changes needed as a result of completing other implementation items such as update of fire procedures.

Revise Implementation Item DB-1695 to include (1) updating the fire PRA following completion of modifications and other implementation items, and (2) a plan of action if the updated, as-built, as-operated fire PRA results in risk estimates that exceed RG 1.174, Revision 2, risk acceptance guidelines. The plan of action should include implementing additional modifications or refining the analytic estimates. Alternatively, justify why these revisions are not needed.

e) F&O PRM-B9-01 – Fire PRA Modeling of Diverse and Flexible Coping Strategies (FLEX) Equipment

The disposition to F&O PRM-B9-01 states that modeling of FLEX equipment credited in the fire PRA was expanded from a point estimate of 1E-2 into a system fault tree model. Item DB-1983 in LAR Attachment S, Table S-1, identifies a modification consisting of two FLEX RCS charging pumps that are credited in the fire PRA model. LAR Attachment G, Table G-1 (pp. G-8 to G-10), identifies deployment of a 480 volt alternating-current generator and manual alignment of a FLEX RCS charging pump as part of the RA. However, the generator is not identified as FLEX equipment and is not listed in Table S-1. It is not clear what FLEX equipment is being credited in the fire PRA, what failures were modeled, or how potential fire impacts on credited FLEX equipment were addressed.

i. Describe the FLEX equipment and operator actions credited in the fire PRA. Clarify whether or not the generator mentioned above is FLEX equipment. Include discussion of whether the equipment currently exists, where it is located, and whether the equipment needs to be relocated and installed before using.

ii. Explain how random failures associated with set-up and operation of the FLEX equipment was estimated. Discuss how the time available and time required to complete operator actions were estimated, particularly for equipment that needs to relocated and installed.

iii. Discuss the procedures used to install and operate the FLEX equipment and whether those procedures are completed yet. If the procedures for using FLEX equipment credited in the fire PRA are not completed, provide an implementation item for LAR Table S-2 to complete the relevant procedures or justify why it is not needed.

iv. Explain how fire impacts to FLEX equipment were addressed in the fire PRA. If FLEX equipment needs to be relocated and installed, include discussion of the treatment of fire impact on the storage and installation locations of the FLEX equipment.

f) F&O PRM-B13-01 – Failure-to-Run Rate for Diesel-Driven Pumps After One Hour

F&O PRM-B13-01 discusses the new emergency feedwater (EFW) system and indicates that the estimated failure-to-run rate for diesel-driven pumps after 1 hour (9.48E-5/hour) is inconsistent with more recent experience (2.16E-3/hour). Based on the disposition to F&O PRM-B13-01, it appears that the licensee continues to use the 9.48E-5/hour failure rate published in NUREG/CR-6928, "Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants," dated February 2007, (ADAMS Accession No. ML070650650), and not the updated failure rate of 2.16E-03/hour provided on the NRC Reactor Operational Experience Results and Databases Website[1]. LAR Table W-3 indicates a very large risk reduction associated with the installation of the EFW system. This suggests that there could be a strong sensitivity in the fire PRA risk estimates to the cited failure rate.

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[1] http://nrcoe.inel.gov/resultsdb/publicdocs/AvgPerf/ComponentUR2010.pdf

Use the most current NUREG/CR-6928 failure rate for the cited failure mode in the integrated analysis provided in response to PRA RAI 03. Alternatively, justify that not using the most current NUREG/CR-6928 failure rate has an insignificant impact on the transition risk estimates and will have an insignificant impact on post-transition risk estimates supporting self-approval.

g) F&O PRM-B15-01 – Basis for Excluding Containment Buckling Scenario

The disposition to F&O PRM-B15-01 states that discussion of the LERF scenario identified in the F&O was added to the fire PRA documentation, but no change was made to the fire PRA model because sub-atmospheric containment pressure created by the scenario is not expected to challenge containment integrity.

i. Provide a basis for the statement that the cited scenario would not challenge containment integrity. Include a discussion of the normal leak rate and operator actions to vent containment and the extent to which they would offset negative pressure for the scenario.

ii. If a sufficient basis cannot be provided for excluding the cited scenario, incorporate this failure into the integrated analysis provided in response to PRA RAI 03. Note that credit for operator actions that are not modeled in the PRA does not provide a sufficient basis for excluding the failure mode.

h) F&O FSS-C8-01 – Fire PRA Credit for Use of Kaowool

The disposition for F&O FSS-C8-01 states that fire modeling calculations credits use of Kaowool. Explain how Kaowool is credited in the fire PRA and provide justification for this credit. Discuss the performance characteristics of Kaowool relative to how it is credited in the fire PRA and how it is monitored to ensure its continued performance.

i) F&O FSS-G2-01 – Multi-Compartment Scenario Screening

The disposition to F&O FSS-G2-01 states that the multi-compartment scenarios were screened based on estimated scenario frequency using guidance from NUREG/CR-6850, Section 11.5.4.4, without regards to the cumulative risk of screened scenarios. Explain how DBNPS ensures that the cumulative risk contribution from the screened multi-compartment scenarios is insignificant to the application and self-approval guidelines.

j) F&O IGN-A8-01 – Modeling Self-Ignited Cable Fires in Containment

The disposition for F&O IGN-A8-01 explains that self-ignited cable fires in containment do not meet the definition for fires to be included for fire ignition frequency Bin 12 (plant-wide self-ignited cable fires), and, therefore, the cable weight of containment cables was not included as part of the Bin 12 cable weight. From this explanation, it appears that self-ignition of containment cables was not addressed in the fire PRA. NUREG/CR-6850, Appendix R.1, states that “self-ignited cable fires should be postulated in rooms with unqualified cables only or a mix of qualified and unqualified cables.”

Justify that self-ignited cable fires in containment have an insignificant impact on the application. Alternatively, model self-ignited containment cable fires in the integrated analysis provided in response to PRA RAI 03.

k) F&O CF-A1-01 – Use of Updated Guidance on Circuit Failure Mode Likelihood

F&O CF-A1-01 and its disposition indicate that updated guidance on circuit failure mode likelihood analysis provided in NUREG/CR-7150, "Joint Assessment of Cable Damage and quantification of Effects from Fire (JACQUE-FIRE)," Volume 2: Expert Elicitation Exercise for Nuclear Power Plant Fire-Induced Electrical Circuit Failure, Final Report, May 2014 (ADAMS Accession No. ML14141A129), have not yet been applied to the fire PRA. New guidance on using conditional probabilities of spurious operation for control circuits is contained in a letter dated April 23, 2014, from Joseph Giitter, NRC, to Michael Tschiltz, NEI, "Supplemental Interim Technical Guidance on Fire-Induced Circuit Failure Mode Likelihood Analysis" (ADAMS Package Accession No. ML14111A366), and in Section 7 of NUREG/CR-7150. This guidance includes:

i. Replacement of the conditional hot short probability tables in NUREG/CR-6850 for Option #1 (including removal of credit for control power transformers and conduit) with new circuit failure probabilities for single-break and double-break control circuits (Option #2 in NUREG/CR-6850 is no longer an adequate method and should not be used);

ii. Replacement of the probability of spurious operation duration shown by Figure 1 in FAQ 08-0051, "Hot Short Duration," dated April 1, 2010 (ADAMS Accession No. ML100900052)[2], for alternating-current control circuits and additional guidance to address duration for direct-current control circuits;

iii. A method for incorporation of the uncertainty values for the circuit failure probabilities and spurious operation duration in the state-of-knowledge correlation for developing the mean core damage frequency (CDF) and large early release frequency (LERF); and,

iv. Recommendations on the hot short probabilities to use for other cable configurations, including panel wiring, trunk cables, and instrument cables.

Provide an assessment of the assumptions used in the fire PRA relative to the updated guidance in NUREG/CR-7150, Volume 2, specifically addressing each of the items (i through iv) above. If the fire PRA assumptions do not bound the new guidance, justify each difference or provide updated risk results, using the guidance in NUREG/CR-7150, Volume 2, as part of the integrated analysis requested in PRA RAI 03,.

PRA RAI 03 – Integrated Analysis

Section 2.4.4.1 of NFPA 805 states that the change in public health risk arising from transition from the current fire protection program to an NFPA 805 based program, and all future plant changes to the program, shall be acceptable to the NRC. RG 1.174, Revision 2, provides

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[2] Also see NUREG/CR-6850, Supplement 1, dated September 2010 (ADAMS Accession No. ML103090242).

quantitative guidelines on CDF, LERF, and identifies acceptable changes to these frequencies that result from proposed changes to the plant's licensing basis and describes a general framework to determine the acceptability of risk-informed changes. The NRC staff review of the information in the LAR has identified additional information that is required to fully characterize the risk estimates.

The PRA methods discussed in the following RAIs may need to be revised to be acceptable by the NRC:

- PRA RAI 01.a.i regarding screening of pre-initiator HFEs
- PRA RAI 02.a.i regarding spatial separation
- PRA RAI 02.a.ii regarding active fire barriers
- PRA RAI 02.b regarding inadequate circuits
- PRA RAI 02.c regarding exclusion of a PORV failure mode
- PRA RAI 02.f regarding EFW pump failure-to-run after one hour
- PRA RAI 02.g regarding containment buckling
- PRA RAI 02.j regarding self-ignited cable fires in containment
- PRA RAI 02.k regarding use of updated guidance in NUREG/CR-7150, Volume 2
- PRA RAI 06 regarding application of a minimum joint human error probability
- PRA RAI 07 regarding assumed cable routing
- PRA RAI 08 regarding state of knowledge correlation
- PRA RAI 09 regarding exclusion of transient fires in inaccessible floor space
- PRA RAI 15 regarding large risk reduction credit

This list may be revised following the NRC review of the licensee's response to all the RAIs (not just those listed here).

a) Provide the results of an aggregate analysis that provides the integrated impact on the fire risk (i.e., the total transition CDF, LERF, change in CDF (ΔCDF), change in LERF (ΔLERF)) of replacing specific methods identified above with alternative methods which are acceptable to the NRC. In this aggregate analysis, for those cases where the individual issues have a synergistic impact on the results, a simultaneous analysis must be performed. For those cases where no synergy exists, a one-at-a-time analysis may be done. For those cases that have a negligible impact, a qualitative evaluation may be done.

b) For each method (i.e., each bullet) above, explain how the issue will be addressed in (1) the final aggregate analysis results provided in support of the LAR, and (2) the PRA that will be used at the beginning of the self-approval of post-transition changes. In addition, provide a method to ensure that all changes will be made, that a focused-scope peer review will be performed on changes that are PRA upgrades as defined in the PRA standard, and that any findings will be resolved before self-approval of post-transition changes.

c) In the response, explain how the RG 1.205 risk acceptance guidelines are satisfied for the aggregate analysis. If applicable, include a description of any new modifications or operator actions being credited to reduce delta risk as well as a discussion of the associated impacts to the fire protection program.

d) If any unacceptable methods or weaknesses will be retained in the PRA that will be used to estimate the change in risk of post-transition changes to support self-approval, explain how the quantification results for each future change will account for the use of these unacceptable methods or weaknesses.

PRA RAI 04 – Internal Events PRA Peer Review

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 2, dated March 2009 (ADAMS Accession No. ML090410014) describes a peer review process using an associated ASME/ANS standard (currently ASME/ANS-RA-Sa-2009) as one acceptable approach for determining the technical adequacy of the PRA once acceptable consensus approaches or models have been established.

LAR Attachment U explains that an assessment was performed in April 2008 by a contractor on the internal events PRA against supporting requirements in PRA Standard ASME/ANS RA-Sb-2005, "Addenda to ASME RA-S-2002 Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," dated December 30, 2005, as qualified by RG 1.200, Revision 1. Differences exist between the supporting requirements in PRA Standard ASME/ANS RA-Sb-2005, as qualified by RG 1.200, Revision 1, and the supporting requirements in ASME/ANS RA-Sa-2009, as qualified by RG 1.200, Revision 2. In accordance with RG 1.200, Revision 2, it is expected that the differences between the current version of the PRA standard and the earlier version of the standard used in the internal events PRA assessment be identified and addressed (i.e., a gap assessment be performed). While LAR Table U-1 provides a cross reference between the two versions of the standard, the LAR does not address the additional changes between the standards that would require re-evaluation of the PRA against the current ASME/ANS PRA standard. Provide a gap assessment of the internal events PRA against ASME/ANS RA-Sa-2009, as qualified by RG 1.200, Revision 2.

PRA RAI 05 – Internal Events PRA Focused-Scope Peer Review

LAR Attachment U explains that focused-scope peer reviews were performed by a contractor on the LERF element of the internal events PRA in October 2011 and on the internal flooding PRA in July 2012 using the current PRA standard. The licensee's March 7, 2016, supplement to the LAR states that the focused-scope peer reviews were performed using ASME/ANS RA-Sa-2009, but does not indicate that these reviews were consistent with RG 1.200, Revision 2, or met industry and NRC criteria (e.g., NEI 05-04 guidance). Clarify whether the focused-scope peer reviews were performed using PRA standard ASME/ANS RA-Sa-2009, as qualified by RG 1.200, Revision 2, and that the peer review process met criteria for a focused-scope peer review.

PRA RAI 06 – Minimum Joint Human Error Probability

NUREG-1921, "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines - Final Report," dated July 2012 (ADAMS Accession No. ML12216A104), discusses the need to consider a minimum value for the joint probability of multiple HFEs in human reliability analyses. NUREG-1921 refers to Table 2-1 of NUREG-1792, "Good Practices for Implementing Human Reliability Analysis (HRA)," dated April 2005 (ADAMS Accession No. ML051160213), which recommends that joint human error probability (HEP) values should not be below 1E-5. Table 4-4 of EPRI 1021081, "Establishing Minimum Acceptable Values for Probabilities of

Human Failure Events," provides a lower limiting value of 1E-6 for sequences with a very low level of dependence. Therefore, the guidance in NUREG-1921 allows for assigning joint HEPs that are less than 1E-5, but only through assigning proper levels of dependency.

a) Confirm that each joint HEP value used in the fire PRA below 1E-5 includes its own justification that demonstrates the inapplicability of the NUREG-1792 lower value guideline (i.e., that the criteria for independent HFEs are met). Provide an estimate of the number of these joint HEP values below 1.0E-5, discuss the range of values, and provide at least two different examples where this justification is applied.

b) If joint HEP values used in the fire PRA below 1E-5 cannot be justified, set these joint HEPs to 1E-5 in the integrated analysis provided in response to PRA RAI 03.

PRA RAI 07 – Assumed Cable Routing

The cable selection analysis and F&Os ES-A3-01 and PRM-B10-01 refer to UNL logic and in the latter case states that "equipment not cable traced were assumed to be failed using the UNL tag." F&O FSS-E4-01 refers to cables which are failed due to assumed cable routing. The assumption that untraced cables are failed is a conservative approach for modeling untraced cables for the post-transition plant model, but can lead to underestimation of the change in risk when used in the compliant plant model.

a) Describe the extent of untraced fire PRA cables and how they were treated in the fire PRA. Explain how they were treated in the compliant and post-transition plant models.

b) Justify that assumptions made about untraced cables do not contribute to underestimation of the transition change-in-risk.

c) If the failing of all untraced cables in the fire PRA leads to underestimation of the transition change-in-risk, replace this approach with an acceptable approach in the integrated analysis requested in PRA RAI 03.

PRA RAI 08 – State-of-Knowledge Correlation

LAR Section W.3.1 states that risk estimates provided in LAR Table W-3 are based on point estimates rather than mean values, but that an uncertainty analysis was performed as a sensitivity study to support use of point estimates. In the variant case of the sensitivity study, mean values from parametric probability distributions were used and state-of-knowledge correlation was performed. The study results show that the difference between the CDF and LERF values based on point estimates and mean values are minimal. LAR Section W.3.1 explains that the uncertainty analysis was performed using the software program UNCERT and that ignition frequency, weighting factors, and non-suppression probability were assumed to be independent. The LAR does not explain what fire parameters were correlated in the state-of-knowledge correlation. In addition, the UNCERT software tool is typically used for performing internal events uncertainty analysis, as opposed to fire event uncertainty analysis.

a) Clarify which fire parameters were addressed and correlated in the state-of-knowledge correlation. If circuit failure probabilities were not addressed in the state-of-knowledge correlation, then perform this correlation for the integrated analysis provided in response to PRA RAI 03.

b) Provide an implementation item for LAR Table S-2 to update the use of point estimates and exclusion of state-of-knowledge correlation in the PRA maintenance and upgrade process, or justify why it is not needed. The justification should explain how DBNPS will ensure that the difference in estimated risk values based on using point values versus using mean values is still insignificant relative to the risk criteria for self-approval of post-transition changes (i.e., risk increase less than 1E-7/year for CDF and less than 1E-8/year for LERF).

PRA RAI 09 – Fire Modeling of Inaccessible Floor Space

LAR Table J-2 (p. J-19) states that “[t]ransient and hot work fires were not postulated in locations within fire compartments that were considered inaccessible.” Inaccessible areas are defined, in part, as: “An area where access is prohibited or extremely difficult due to the presence of a permanent fixture (as defined above) and there is no credible reason to expect transient material to accumulate (e.g., areas on top of half height rooms, confined areas behind a floor to ceiling stack of cable trays with no expected reason for access).”

Guidance in NUREG/CR-6850 pertaining to exclusion of locations for transient fire analysis states:

> It is assumed that transient fires may occur at all areas of a plant unless precluded by design and/or operation, such as inside a BWR [boiling-water reactor] drywell or torus during power operation. Administrative controls significantly impact the characteristics and likelihood of transient fires, but they do not preclude their occurrence, since there is industry evidence of failure to follow administrative control procedures.

The exclusion of locations from transient fire analysis because there is no credible reason to expect accumulation of transient material does not appear to meet the guidance in NUREG/CR-6850. Furthermore, areas on top of half-height rooms and confined areas behind a floor-to-ceiling stack of cable trays are not visible during normal operation and transient material accumulation could go unnoticed. Additionally, excluded transient fires near cable tray stacks could represent important risk contributors.

Justify that exclusion of locations because there is no credible reason to expect transient material, such as on top of half-height rooms and in confined areas behind a floor-to-ceiling stack of cable trays, is consistent with NRC guidance on transient fire analysis. Alternatively, include these excluded transient locations in the integrated analysis provided in response to PRA RAI 03.

PRA RAI 10 – Reduced Transient Heat Release Rates

LAR Attachment J (p. J-20) identifies three fire compartments (D-01, BF-01, and BG-01) for which the transient fire heat release rate is reduced from 317 kW to 69 kW or 142 kW per the guidance endorsed by the June 21, 2012, memo from Joseph Giitter, NRC, to Biff Bradley, NEI, “Recent Fire PRA Methods Review Panel Decisions and EPRI 1022993, 'Evaluation of Peak Heat Release Rates in Electrical Cabinets Fires'” (ADAMS Accession No. ML12171A583). LAR Attachment J explains that walkdowns and review of combustible materials, flammable liquids, and activities in these areas provide a basis for assuming that the reduced heat release rate is consistent with the specific attributes and considerations applicable to those locations. LAR Attachment J also explains that transient combustible control permits are required prior to taking any combustible or flammable material into these areas and that compensatory actions will be implemented as appropriate. The criteria that triggers the need for a combustible control permit for Fire Compartments BF-01 and BG-01 is wood scaffolding or flammable liquids greater than one gallon.

a) Explain why combustible control permits are not required for solid combustibles other than wood scaffolding and how administrative controls justify the reduced heat release rates used for Fire Compartment BF-01 and BG-01 without restricting such combustibles.

b) Given that combustible and flammable materials are allowed to be taken into the three fire compartments for which a reduced heat release rate is credited, explain what kind of compensatory measures will be taken when such materials are taken into these fire compartments.

PRA RAI 11 – Main Control Room (MCR) Abandonment on Loss of Habitability

LAR Section W.3.7 and other sections of the LAR indicate that fire modeling was performed to determine when the MCR needs to be abandoned due to loss of habitability and that the conditional core damage probabilities (CCDPs) of associated scenarios were evaluated using a simplified fault tree model. LAR Table W-2 presents a single MCR abandonment scenario due to loss of habitability in the list of dominate fire scenarios, but states that this single scenario represents “the summation of all scenarios leading to abandonment.” The LAR did not describe the event tree logic that would define multiple scenarios for MCR abandonment due to loss of habitability. It is not clear whether the treatment of MCR abandonment due to loss of habitability addresses the complexity associated with the range of fire impacts that can occur from fires in the MCR. The NRC staff notes that use of overly conservative assumptions in the compliant plant model can lead to underestimation of the transition change-in-risk.

a) Describe how MCR abandonment was modeled for loss of habitability for the post-transition and compliant plant. Include an explanation of how the CCDPs and conditional large early release probabilities (CLERPs) were estimated. Include identification of the actions required to execute successful alternate shutdown and how they are modeled in the fire PRA, including actions that must be performed before leaving the MCR.

b) Explain how various possible fire-induced failures are addressed in the CCDP and CLERP estimates for fires that lead to abandonment due to loss of habitability. Specifically include in this explanation, a discussion of how the following scenarios are addressed:

   i. Scenarios where fire fails only a few functions aside from forcing MCR abandonment and successful alternate shutdown is straightforward;

   ii. Scenarios where fire could cause some recoverable functional failures or spurious operations that complicate the shutdown, but successful alternate shutdown is likely; and,

   iii. Scenarios where the fire-induced failures cause great difficulty for shutdown by failing multiple functions and/or complex spurious operations that make successful shutdown unlikely.

c) Provide the range of CCDP and CLERP values determined for the post-transition and compliant plant models.

d) Provide the frequency of MCR abandonment scenarios due to loss of habitability for the post-transition and compliant plant cases.

PRA RAI 12 – Loss of Control from the MCR

The NRC staff reviewed the MCR analysis (C-FP-013.10-35) as part of its audit of licensee documents. The analysis indicated that the fire PRA treats scenarios where there is a loss of control from the MCR the same as any other fire scenario in which the control room remains habitable, with the exception of one scenario involving the whole panel burn of electrical distribution panel C5715. The LAR does not describe how the fire PRA modeled these loss of control scenarios. Fires that lead to loss of control in the MCR are inherently different from other fires in the MCR for which control is maintained.

It is not clear if the loss of control scenarios are conservatively modeled by assuming that such fires lead to core damage. It is also not clear if actions taken from the alternative shutdown panel were credited as RAs when command and control is retained in the MCR. The NRC staff notes that the information in the MCR analysis was not sufficiently clear to address these questions.

a) Indicate those locations in the plant for which fire could lead to loss of control in the MCR.

b) Explain how fire scenarios in the MCR or other locations that could lead to loss of control, such as the cable spreading room, were modeled. Explain whether RAs from the alternate shutdown panel are credited.

c) Provide an explanation of how various possible fire-induced failures are addressed in the CCDP and CLERP estimates for fires that lead to abandonment due to loss of control from the MCR. Specifically include in this explanation, a discussion of how the following scenarios are addressed. As a part of this response, indicate if the plant response is fully integrated into the PRA.

   i. Scenarios where fire fails only a few functions aside from forcing MCR abandonment and successful alternate shutdown is straightforward;

   ii. Scenarios where fire could cause some recoverable functional failures or spurious operations that complicate the shutdown, but successful alternate shutdown is likely; and,

   iii. Scenarios where the fire-induced failures cause great difficulty for shutdown by failing multiple functions and/or complex spurious operations that make successful shutdown unlikely.

d) Identify the range of CCDP and CLERP values determined for the post-transition models. Identify those scenarios which have a CCDP of 1, or explain why there are no such scenarios.

e) Indicate how the decision to abandon the MCR is incorporated into the PRA model.

f) Separately, provide an answer to each of these questions for the scenario involving the whole panel burn of electrical distribution panel C5715.

PRA RAI 13 - Calculation of the Change in Risk

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. Section 2.4.4.1 of NFPA 805 further states that the change in public health risk arising from transition from the current fire protection program to an NFPA 805 based program, and all future plant changes to the program, shall be acceptable to the NRC. RG 1.174 provides quantitative guidelines on CDF, LERF, and identifies acceptable changes to these frequencies that result from proposed changes to the plant's licensing basis and describes a general framework to determine the acceptability of risk-informed changes. LAR Section W.2.1 provides a high-level description of how the change in risk associated with VFDRs is determined, but additional information is needed to fully understand the approach.

a) Describe the types of model adjustments made to remove different types of VFDRs from the compliant plant model, such as adding events or logic, or use of surrogate events. Clarify whether the approach is consistent with guidance in FAQ 08-0054, "Demonstrating Compliance with Chapter 4 of NFPA 805" (see ADAMS Accession No. ML15016A280 and associated references therein). In addition, identify any major changes made to the fire PRA models or data for the purpose of evaluating VFDRs.

b) For the MCR abandonment scenarios, describe the model adjustments that were made to remove the VFDRs to create the compliant plant model. Clarify the statement in LAR Section W.2.1 that the compliant plant model for these scenarios "includes setting the contribution from control room abandonment due to loss of habitability to zero."

c) Describe the types of VFDRs identified, and discuss whether and how the VFDRs identified, but not modeled in the fire PRA, impact the risk estimates. Describe the qualitative rational for excluding VFDRs from the change-in-risk calculations. Also, explain whether VFDRs were identified differently for MCR abandonment areas compared to non-abandonment areas.

PRA RAI 14 – Additional Risk of Recovery Actions

LAR Attachment W provides the total additional risk of RAs for each fire area, but does not provide a description of how the additional risk of RAs was calculated. Footnote 3 to LAR Attachment W, Table W-3, states:

> There are many operator actions that are modeled in the PRA. In order to verify all operator actions are captured, the Additional Risk of RAs is equal to the All VFDR resolved case, and the delta is reported without credit for the risk offset; therefore, the threshold is exceeded. However, this value is not used for compliance with RG 1.174 or RG 1.205.

The meaning of this statement is not completely clear. For example, the CDF and LERF values reported in LAR Table W-3 in the "All VFDRs Fixed' column (which is presumably associated with the risk of the compliant plant) are not the same as the CDF and LERF values presented in the “Additional Risk of RAs” column as stated in Footnote 3. Thus, it is not clear how the additional risk of RAs was calculated.

RAs to reduce risk are identified for certain fire compartments in LAR Attachment G, Table G-1, but in some cases no corresponding additional risk of RA values were reported in LAR Attachment W, Table W-3, for these same fire compartments (e.g., BF-01, BG-01, G-01, HH-01, UU-01). In addition, LAR Attachment G, Results of Step 3, states that “[a]ssessment of potential adverse effects of operator actions is addressed in the development of operator actions in the fire compartment specific Fire Risk Evaluations.” It is not clear whether any potential adverse effects associated with operator actions were identified, and if they were identified how they were treated in the fire PRA.

a) Explain how the additional risk of RAs was calculated and confirm that the approach is consistent with guidance in FAQ 07-0030 and RG 1.205.

b) Reconcile the apparent inconsistencies in the LAR in which RAs to reduce risk are identified for fire compartments in LAR Attachment G, Table G-1, but no additional risk of RAs is reported in LAR Attachment W, Table W-3, for these same fire compartments.

c) Explain whether any potential adverse effects associated with operator actions were identified, and if they were identified how they were treated in the fire PRA.

PRA RAI 15 – Large Risk Reduction Credit

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. Section 2.4.4.1 of NFPA 805 further states that the change in public health risk arising from transition from the current fire protection program to an NFPA 805 based program, and all future plant changes to the program, shall be acceptable to the NRC. RG 1.174 provides quantitative guidelines on CDF, LERF, and identifies acceptable changes to these frequencies that result from proposed changes to the plant’s licensing basis and describes a general framework to determine the acceptability of risk-informed changes. The NRC staff notes that conservative calculation of the compliant plant CDF and LERF can lead to a non-conservative calculation of the ΔCDF and ΔLERF.

Appreciable risk reduction credit (i.e., large negative CDF and LERF values) is presented in LAR Attachment W, Table W-3, for non-VFDR related modifications referred to as the “risk offset.” The risk offset is defined to be the risk reduction resulting from modifications that do not bring a fire compartment into compliance with NFPA 805 deterministic requirements. Section 3.2.5 of RG 1.205 states that risk decreases may be combined with risk increases for the purposes of evaluating combined changes in accordance with regulatory positions presented in Sections 1.1 and 1.2 of RG 1.174, Revision 2, but that the total increase and total decrease in the ΔCDF and ΔLERF should be provided. LAR Table W-3 appears to report the total decrease associated with non-VFDR modifications in the form of risk offset values, but does not appear to report the total increase associated with unresolved VFDRs.

a) Provide the total risk increase associated with unresolved VFDRs and the total risk decrease associated with non-VFDR modifications.

b) Summarize the risk significant scenarios for fire areas in the compliant plant model that are most significantly impacted by risk reduction modifications, and discuss the contribution of fire-induced failures for those scenarios.

c) Discuss the impact of any important modeling assumptions contributing to the risk significant scenarios for important fire areas in the compliant plant model. Specifically include discussion of conservative modeling assumptions made in the compliant plant model that may artificially reduce the calculated change in risk.

d) If conservative modeling of the compliant plant is identified as contributing to the under estimation of the total change in risk, demonstrate that the total risk increase associated with unresolved VFDRs is offset by the total risk decrease associated with risk reduction modifications even when the conservative modeling is removed. Alternatively, replace the conservative modeling with realistic modeling that does not underestimate the total change in risk in the integrated analysis provided in response to PRA RAI 03.

PRA RAI 16 – Defense-in-Depth (DID) and Safety Margin

Section 1.2 of NFPA 805 requires the fire protection standard to be based on the concept of DID, and specifies the three elements (or echelons) of DID which must be balanced. LAR Section 4.5.2.2 provides a high-level description of how impacts on DID and safety margin were reviewed for the transition to NFPA 805 and includes a discussion of plant improvements made in response to this review. However, additional information is needed to fully understand the approach. Also, LAR Section 4.5.2.2 states that "[f]ire protection features and systems relied upon to ensure DID were identified as a result of the assessment of DID," but LAR Table 4-3 does not identify any fire protection systems or features to be credited for DID.

a) Explain the criteria used to determine when a substantial imbalance between DID echelons exist in the fire risk evaluations, and identify the types of plant features and administrative controls credited for providing DID for each of the three DID echelons.

b) Clarify what fire protection features and systems were relied upon to ensure DID and explain why none are identified in LAR Table 4-3. Explain how DID is ensured given that automatic fire detection systems are not credited for maintaining DID.

c) Discuss the approach for reviewing safety margin using the NEI 04-02, Revision 2, criteria for assessing safety margin in the fire risk evaluations.