Finalizing Licensing Basis Information for NFPA 805 PRAs

Purpose

The purpose of this paper is to propose a process for finalizing licensing basis fire probabilistic risk assessment (PRA) information during the Nuclear Regulatory Commission (NRC) review of a licensee's conversion to 10 CFR 50.48(c), risk-informed fire protection licensing basis. Finalization of the licensing information would occur at the proposed "freeze point." This paper will also identify methods used to track and control changes to the PRA after the freeze point, divisions of responsibility between the licensee and the NRC, as well as identifying criteria for those changes warranting an NRC notification.

Comment [A1]: New methods are outside the scope of the freeze point.

Background

Regulatory Guide (RG) 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk Informed Activities," is intended to provide an acceptable approach for determining if a particular PRA is technically adequate to justify the results and insights used to support any operational or licensing decisions under consideration. The RG states, "When used in support of an application, this Regulatory Guide will obviate the need for an in-depth review of the base PRA by the reviewers." RG 1.205 also states that a peer review that documents compliance with RG 1.200 is one acceptable way to demonstrate that the baseline fire PRA for NFPA 805 is of adequate quality.

One of the intents of the NRC-endorsed processes for establishing technical adequacy of PRA models in RG 1.200 and RG 1.205 is to allow a stable and predictable process for transitioning to risk-informed programs (such as NFPA 805). Predictability and stability are important factors in any regulatory application to reduce unnecessary burden on the regulator and the applicant and to incentivize transitioning to better/improved programs or systems. However, the NFPA 805 experience thus far indicates that meeting the stability and predictability intent is a major challenge. There are many reasons for this challenge, one of which is the treatment of changes in the state-of-knowledge about key approaches, methods and data used in the fire PRA. While this is true of all hazards evaluated by PRA, it is particularly acute for fire PRA. Internal events PRA modeling methods have been refined over several decades and are broadly understood, accepted, and based on significant operating experience, but fire PRA modeling methods are only fairly well developed in comparison. The methods are subject to changes resulting from, for example, testing or operating experience. Long term, the changes result in better modeling and methods. As to be expected (and to be encouraged), the rate and the extent of the change in the state-of-knowledge is a function of time and the intensity of the research in improving the state-of-knowledge. For a comprehensive application such as NFPA 805, using a rapidly developing technique, such as fire PRA, both the time (over four years from the time fire PRA development is started to the time the application is being reviewed) and research intensity factors provide ample opportunity for changes in the state-of-knowledge. Both the industry and the NRC have been pursuing improvements in this state-of-knowledge. The industry has developed a number of new methods, and submitted them for peer review by consensus panels using the same peer review process approved for peer review of plant PRAs by RG 1.200. However, in the case of the 10 CFR 50.48(c), NFPA 805 transitions and other key risk-informed applications, the NRC has been reluctant to use RG 1.200 in this

manner for fire PRA, and has conducted extensive standalone reviews on PRA methods, even in cases where peer reviews found these methods to be acceptable. Also in many cases, peer-reviewed and industry-approved approaches, methods, and data were questioned by NRC. As a result, technical disagreements between NRC and industry as to approaches, methods and data have been resolved by NRC declarations of non-acceptance despite the consensus of a broad spectrum of technical expert peer reviewers, and every indication that this consensus will ultimately be determined to be justified.

So, new information is a double-edged sword. Incorporating new information "on-the-fly" as it becomes available results is a moving target for both NRC reviewers and the licensee during Licensing Amendment Request (LAR) development and review, resulting in an unstable review process and significant re-work. However, since the implementation for many plants will be 24-30 months after submittal of the LAR, it is important to the final licensing decision that the fire PRA be somewhat predictive of the realism at the time of implementation (as opposed to at the time of submission of the LAR), so failing to incorporate new information that is expected to be shown to be true within two years of LAR submittal can lead to erroneous safety conclusion. This situation is similar to new reactor designs where predicted performance is the basis for the licensing decision and the achievement of that predicted performance is verified by the Inspection, Tests, Analyses, and Acceptance Criteria (ITAAC) process.

Because of that similarity, this paper provides a solution strategy based on the concept of a "freeze point" for licensing basis information. The concept of a freeze point is described in Interim Staff Guidance (ISG) DC/COL-ISG-011, specifically developed for applicants seeking a Combined Operating License (COL) or Design Certification (DC) under 10 CFR Part 52. This paper proposes that, similar to the COL guidance, the licensing decisions for NFPA 805 applicants be based on the information provided on and before the freeze point date, and only supplemented where it is predicted that the fire PRA results would not be representative of reality at the time the Safety Evaluation (SE) is issued. Since the intent of this approach is to be "forward-looking," the fire PRA submitted at the freeze point could use approaches, methods, and data that are either acceptable at the time of submission or expected to be deemed acceptable by the time of issuance of the SE. Therefore, the fire PRA could use approaches, methods, or data that are under review for acceptability, awaiting test results that would support acceptability, or under development and intended to be submitted for acceptance. Any new information to be considered after the freeze point would be evaluated under an existing PRA configuration control processes that meets the ASME/ANS PRA Standard (as endorsed by NRC with RG 1.200) and industry reportability processes. Where approaches, methods or data that are not acceptable as of the freeze point are used, they would be treated in an "ITAAC-like" fashion and thus their acceptability must be verified during implementation prior to "going live" with the self-approval part of the NFPA 805 license amendment. The stability achieved by implementing a freeze point would simplify the licensing review process and establish a predictable schedule for completion of the reviews.

Comment [A2]: The methods and data within the scope of the freeze point approach that arise and meet the criteria that follow need to be reviewed by the NRC staff. Peer-review or approval by the industry does not replace the staff review and approval of the methods. Furthermore, the staff is not clear what methods it has rejected that will ultimately be justified – given the lack of justification, suggest this this statement be removed.

Comment [A3]: Although this statement is a correct description of the ITAAC process, major concepts described in this paper, i.e. using methods and data that are under development or not accepted, don't follow the ITAAC process.

Comment [A4]: Acceptable by the NRC staff.

Comment [A5]: These methods, approaches and data need to have a certain level of development to use in the submittal. Otherwise, the staff cannot attain the degree of confidence in the method in time for the SE. Methods or data should be developed well enough ahead for the staff to perform its review in time to reach its conclusion of acceptability in the SE.

Comment [A6]: As clarified by the Office of New Reactors, ITAACs verify construction and operation in accordance with the information that are acceptable and have been approved by the NRC. The ITAAC process does not verify the method or data that were unacceptable at the time of the review.

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Discussion

Similar to the freeze point described in the ISG guidance for COL applicants, the freeze point for the NFPA 805 applicants would mark that point in time where the licensing basis information from the fire PRA was considered to be final. It is from this point that the NRC licensing review of the NFPA 805 submittal would commence and, perhaps end (depending on the importance of any new information that arises, as discussed later in this paper). The NRC would issue the SE based on the information submitted by the licensee in the fire PRA, subject to verification of the accuracy of the fire PRA model prior to full transition.

Comment [A7]: This applies only to information that is acceptable or covered by the freeze point concept. In the freeze point concept, the method must have an adequate level of fidelity as determined by the NRC prior to its completion of the SE.

The benefits of this concept are greatest for a plant early in transition, but could still benefit plants mid-way through the licensing review process.

The process would develop as follows:

An applicant that has not yet submitted the LAR to transition to the risk-informed fire protection program would propose a freeze point sometime prior to the submittal of the LAR. In this case, the freeze date may be the actual date of the submittal, but more likely would be the date prior to submittal when it is necessary to stop changing the numbers in order to complete the LAR submittal process. Applicants that have already submitted would also propose a freeze point. Here, the freeze point may also be the submittal date, but could also be some later date based on changes made to the information in the original submittal through, for example, the Request for Additional Information (RAI) process. The licensee could also "back date" a freeze date to correspond to the point at which the risk results given in the LAR were considered final. In any case, the licensing basis information would be considered, for the purposes of the NRC review, final at the agreed upon freeze point. Consequently, licensing decisions made by NRC would be based primarily on the information provided on and before the freeze date. Of course, RAI responses, audit results, and other docketed information would warrant consideration. However, the fire PRA would only be *required* to be updated if information with significant negative impacts was identified ***and*** it is believed that this negative information is unlikely to be resolved favorably prior to "go-live" for the transition. Incorporation of information with significant positive impacts would be at the discretion of the licensee. These concepts are discussed in greater detail in the remainder of this paper.

Comment [A8]: Same as the comment above.

Comment [A9]: Same as the comment above. As stated above, an adequate level of acceptability is needed to write the SE.

Proposal, and concurrence, of the freeze date would be made via formal correspondence between the licensee and the NRC. Once the applicant and the NRC agree on the freeze point, the NRC would generally not require changes to, or sensitivity studies on, the as-submitted fire PRA in any subsequent RAIs, again, unless~~depending on~~ the significance of the ~~any~~ issue~~s~~ warrants NRC review or confirmation by the licensee~~ that may arise~~. In these cases, sensitivities may be required.

Comment [A10]: Again, for methods discussed in the previous and depending on the significance of issue.

The applicant would use a well-defined PRA configuration control process to evaluate, track, and manage the changes identified to the fire PRA after the freeze date. This would be the procedurally controlled processes normally used to track and monitor changes to the PRA along with their specific

tracking mechanisms. These processes are typically based on RG 1.200 through its endorsement of Section 1.5 of ASME/ANS RA-Sa-2009. The requirements of this section have been converted by the industry peer review group to "supporting requirements" that are reviewed during PRA peer reviews to ensure that licensee PRA configuration control processes are adequate. Processes compliant with these supporting requirements include criteria for revising the model(s) based on changes in core damage frequency (CDF) or large early release frequency (LERF), sometimes referred to as "quantitatively significant." These criteria are applied to emergent issues such as a discovered error, the results of operational experience and testing, or availability of new methods, as well as for routine items such as plant design changes; if any of these changes were determined to be "quantitatively significant" with respect to CDF or LERF, the model(s) would have to be updated. For example, the criteria may be any potential issue that results in a greater than 25% change in CDF or LERF, or results in a differential CDF greater than or equal to 1E-5/yr. This well-defined criterion ensures that items potentially affecting the model(s) are objectively considered. The change process procedures usually also contain guidance for periodic review of relevant information that could affect the model(s). For example, reliability data, unavailability data, initiating events frequency, and human reliability data are examined on a routine period. Plant design changes, procedure changes and Technical Specifications changes are also routinely monitored for their potential effects on the PRA model(s).

Comment [A11]: NRC needs clarification on what is meant by differential CDF in the context of NFPA 805. Also, the criteria depends on how close the current values are to acceptable limits.

Finally, a PRA upgrade is followed by a PRA peer review, whenever necessary as a result of, for example, a new methodology used in the PRA. Licensees will describe their specific change control process either in their NFPA 805 submittal, or their freeze point submittal. Furthermore, it is expected the NRC would focus part of their review on the rigor and completeness of processes used for configuration control of the PRA models.

Comment [A12]: Per FAQ 12-0061, any upgrade should be peer-reviewed and is not limited to new methods. NRC does not rely on peer-review for acceptance of a new methodology.

Most of the changes to the fire PRA that would be required after the freeze point are not expected to alter the conclusions of the original LAR. These include changes required to the model as a result of plant design or procedure changes not credited in the NFPA 805 LAR. Minor errors in the model, and updates to the model due to, for example, reliability data, unavailability data, and initiating event frequency data updates, are also examples of the type changes that would not normally require a change to the LAR. As part of the configuration control process, the applicant would review each required model change and make a determination as to whether it would affect the conclusions of the original submittal. They would document the determination it would not alter the conclusions and therefore not require an out-of-cycle update to the fire PRA. The applicant would also make a determination of the cumulative impact of all deferred model changes to ensure that an out-of-cycle update is not required.

However, there is the possibility that some issues, discovered after the freeze point, would be significant enough to warrant notification to the NRC. To recognize and identify such changes, the applicant would provide written guidance defining the criteria for identifying when a change to the model requires consideration during the review process (e.g., sensitivity studies and/or base model changes). In such an event, the NRC would be notified. Note: licensees with RG 1.200 compliant models have triggers for

model updates; however, this guidance could alternatively be included via a revision to an existing procedure or in a new procedure, or in some other type of formal written instruction or guidance.

Some issues that would require immediate notification are:

I) Errors significant enough to affect (increase) reported risk values such as ΔCDF, ΔLERF, or total CDF and LERF. Also, errors significant enough to cause an increase in those risk metrics such that compliance with established limits was exceeded,

II) Changes needed to ensure compliance with NRC regulations,

III) Changes needed to address significant vulnerabilities identified in the fire PRA model and,

IV) Plant design or procedure changes that could significantly affect reported risk values.

These type issues would require notification of NRC via formal docketed correspondence.

With respect to issues I, III, and IV above, each licensee would have specific criteria for defining "significant." In all likelihood, this would coincide with the "quantitatively significant" criteria used in the routine change control process for maintaining PRA technical adequacy, described earlier in this paper. For example, if an error was discovered that resulted in a quantitatively significant change in the reported ΔCDF, notification would be required.

There are several ways in which these types of issues could be addressed:

1) Change the baseline fire PRA and revise the results. The revised results would be documented in a re-quantification of the baseline CDF, LERF, ΔCDF and ΔLERF, and preparation of an updated LAR Attachment W.

2) Change a proposed modification (a plant design or procedure modification, for example) and implement it in the fire PRA. This would require a re-quantification of the baseline CDF, LERF, ΔCDF and ΔLERF, and an update to both LAR Attachment S and LAR Attachment W, and possibly updates to LAR Attachment C and/or Attachment G.

3) Leave the fire PRA results unchanged and commit to achieving the stated performance goals. In other words, commit to the baseline CDF, LERF, ΔCDF and ΔLERF, already claimed in the original LAR. This would not require any re-quantification, and the verification of the commitment to achieving the risk values would become part of the generic Attachment S Implementation Item to update the fire PRA prior to full transition. The individual confirmatory items would be tracked as part of the applicant's PRA configuration control process, and would not necessarily need to be individually listed in LAR Attachment S.

(The above list indicates three *options*; it is not meant to preclude any other option a specific applicant may develop and deem appropriate.)

Comment [A13]: There needs to be a generic criteria for making this determination. Plant specific criteria may supplement this.

Comment [A14]: This option is only acceptable when the NRC staff has confidence that the PRA model has an acceptable level of quality as submitted in the LAR.

Comment [A15]: Somewhere, not sure where, the process needs to recognize that developing information may eventually invalidate acceptable methods, in addition to rendering methods acceptable.

Comment [A16]: Using other options is subject to review and acceptance by the NRC staff.

If, rather than changing the fire PRA, a licensee wishes to use option 3 above:

a) The licensee may use predicted future performance of systems and components for which the design, installation, and operating procedures are not yet in place. For example, a modification to a system is proposed that will maintain the risk values assumed in the original LAR.

OR

b) The licensee may use approaches, methods, or data that are not currently accepted, but are expected to be accepted prior to issuance of the SE. For example, if it is believed that changes in reliability data or unavailability data will maintain or lower the reported risk values.

The concept behind Option 3 is that the overall performance goal is established in terms of the upper limit on CDF, LERF, ΔCDF, ΔLERF, and other metrics required under RG 1.174. In other words, while the issue warranting notification may have increased the reported risk values based on the current state of knowledge and current accepted methods, the expectation is that RG 1.174 compliance will ultimately be demonstrated by the end of the implementation period based on the evolution of that state of knowledge and future accepted methods.

With Option 3, however, the licensee would take a risk that the risk performance goals would not be met, in which case the transition to NFPA 805 would likely be delayed as changes to the fire PRA are made, possibly followed by a peer review.

Finally, the licensee must demonstrate, through the fire PRA, that the post-NFPA 805 transition plant achieves compliance under the NFPA 805 criteria. Indeed, this would be an on-going effort throughout the life of the plant. However, immediately following the transition, licensees should document such compliance for the changes occurring post-freeze point, ready and available for inspection by internal auditors and NRC inspectors.

The Attachment to this paper presents an example where Option 3 using a performance goal could be used.

Summary and Conclusion

Establishing a freeze point for NFPA 805 submittals would provide a point at which the licensing basis information for the fire PRA would be considered final, with the exceptions noted above, for the purposes of the NRC submittal review.

Following proposal of the freeze date by the licensee, and subsequent approval by NRC, the licensee would implement a change tracking and monitoring program that would track the changes to the fire PRA that occur after the freeze date. Additionally, this change process would identify those changes that are significant enough to warrant NRC notification after the freeze date was set and past. If a change required such notification, the licensee would either change the fire PRA or claim that the

Comment [A17]: Design, installation, and operating procedures must be understood well enough to provide confidence in analysis.

Comment [A18]: This option may be used on a very limited basis. This option could delay the review schedule and complicate the process for identifying and closing RAIs.

Comment [A19]: This outcome should be minimized or not occur. As a result, NRC must have confidence in the PRA upon its writing the SE.

performance goal, based on the risk metrics such as ΔCDF and ΔLERF presented in the original submittal, would still be met.

Comment [A20]: See comments on Option 3.

Upon completion of the transition to the risk-informed fire protection licensing basis, the licensee would verify and document compliance to the NFPA 805 criteria, considering the changes to the fire PRA that occurred after the freeze point. An inability to verify compliance would require engagement between the licensee and NRC to determine how compliance would be achieved and a corresponding timeline for attaining compliance.

Concluding, use of a freeze point would simplify the review process, thus providing stability to the NFPA 805 review process that has been lacking in the process for many of the fire protection submittals currently under NRC review. There is precedence for using this concept in the NRC review of Part 52 applications.

Comment [A21]: There is no precedent in the review of Part 52, for using methods or data that are not acceptable (under review or development) in the submittal.

Attachment

Option 3 Example

Comment [A22]: Comments on preceding general section apply.

Modeling as of Freeze Date: The licensee had decided to install Westinghouse SHIELD seal, and had modeled this taking the credit, as was known at the time of the freeze. The NFPA 805 submittal date was September 2012.

The internal events model of a Westinghouse three-loop pressurized water reactor (PWR) had identified seal leakage following a loss of cooling as a significant contributor to risk several years ago. The utility partnered with the original equipment manufacturer (OEM) and installed this shutdown seal package in both its units. After installation, the utility credited the SHIELD in its internal events model, as well as in a fire PRA developed for NFPA 805. Once credit for the shutdown seal was integrated into the internal events PRA model, it became part of other risk-informed applications, such as the 10 CFR 50.65 (Maintenance Rule) and the Mitigating Systems Performance Index (MSPI), which depend on the PRA model.

New Information: Operating experience (post-operation testing) indicated a new design of PWR reactor coolant pump (RCP) seals designed to minimize seal leakage with a loss of cooling did not function as designed. Once the shutdown seal failed its in-plant test, the utility followed its procedures for configuration control. This issue resulted in a Part 21 report issued by the seal vendor in 2013. As a result, the defective seals were entered into the utility's corrective action program, with an eventual commitment to replace the seals at the first opportunity with an enhanced design. The Maintenance Rule scheduling tool (EOOS) was updated with the revised PRA model and MSPI updated and credit removed for the shutdown seal. Credit for an improved seal design has been retained in the NFPA 805 fire PRA, but with a commitment to replace the seals with an enhanced design. Note the new information on SHIELD reliability occurred midway in the NRC review of the NFPA 805 LAR.

Licensee Response: Licensee evaluates the information regarding the seal performance, and determines their best option is to install an enhanced seal design, even though uncertainty exists. In addition, they consider that there is another seal option available, which also has the potential to offer similar performance as claimed by the Westinghouse seal. Therefore, the licensee commits to achieving the risk performance goals already committed to in the original LAR. In other words, the licensee claims that by the end of the implementation period, there will be a proven seal package such that loss of coolant accident (LOCA) risk will be no worse than indicated in the original submittal, even with the current knowledge about the seals.

The licensee would indicate to the NRC in its formal notification that the risk numbers are not expected to change, or that the upper limits are not compromised, because of a proposed modification. Effectively, the licensee is expecting that the seal design will be improved, or an alternative design will achieve the required performance, or some other technology or methodology improvement will be available and accepted that will verify that the performance credited in the fire PRA will be achieved. Therefore, the licensee establishes a performance goal that, if proven to be met, ensures compliance

with NFPA 805 risk criteria. This performance goal is modeled in the fire PRA. An example of such a performance goal could be as follows:

- If after a loss of cooling or injection to the seals, the RCP initially does not trip and all cooling is lost, the fire PRA may assume that the seals will not fail for 30 minutes. This timeframe may be based on the modification of emergency procedures and an human reliability analysis (HRA) that shows that in order to achieve a human error probability (HEP) that supports the risk goal, the operators would need to have 30 minutes of available time to trip the RCPs or restore cooling or injection, which would preclude seal failure. Since the fire PRA assumes in this case no seal failure for 30 minutes, the performance goal for the seals would be to run for 30 minutes without cooling. Any seal design that could be verified to achieve that would be allowed.

- If the RCP were tripped upon the loss of cooling and injection (e.g., station blackout situation), credit in this case could be taken for a reduced probability that a very small or a small LOCA would occur. Suppose the PRA showed that the risk goals would be met if the conditional probability of a very small LOCA was 0.01 and a small LOCA was 0.001. These would then become the performance goals and any seal design that could be verified to achieve that would be allowed.

The licensee bases the fire PRA results, and the compliance argument, on these assumptions. They request that NRC review the NFPA 805 LAR as if these assumptions are proven. They add an implementation item to the LAR Attachment S that states that they are required to verify that the performance of the plant in the situations specified above (30 minutes without a LOCA with no RCP trip; very small LOCA probability < 0.01; small LOCA probability < 0.001 with RCP trip) is achieved.

NRC Response: NRC would review the LAR on the basis of the licensee meeting the performance goals stated. They would not request the licensee to perform any sensitivity analysis assuming that these goals are not met, since the licensee is committing to meet or exceed these performance goals. They would base their approval of the NFPA 805 LAR on the fire PRA results as submitted by the licensee. NRC could issue an RAI requesting that the licensee provide the verification that they meet the performance goal prior to the issuance of the SE.

Licensee Follow-up: As soon as the licensee has sufficient information to verify that they will be able to meet the committed performance goal for small and very-small LOCAs, they will submit that evidence to the NRC and request that the Attachment S implementation item would be "cleared." Note that this submittal would not be required if NRC issues a generic approval of the new seal model and the performance goal in the fire PRA is the same as or conservative with respect to the new model.

NRC Follow-up: NRC would review the evidence presented and determine whether it verifies that the small and very-small LOCA performance goal will be achieved (or bettered). Assuming they concur, they would "clear" the implementation item and the SE can be issued without condition.

Accounting for the Case when Verification Cannot be Provided Prior to Issuance of the SE: There is always a risk in such approaches that the necessary data do not support the verification of seal

performance prior to the schedule for issuance of the SE. If this is the case, then achieving the performance goal would become a license condition in the SE, to be required prior to allowing self-approval. This condition on the transition is essentially a given because it would be an Attachment S implementation item that had not been accomplished, and would be treated the same way as other Attachment S implementation items that would need to be completed prior to transition. The schedule and approach for coming into compliance would be negotiated between the licensee and the NRC. Compensatory measures would have to remain in place until that time.

Additional Comments: The same approach could be used for any other input to the PRA. For example, a hot short probability could be assumed in the Fire PRA in anticipation of the issuance and acceptance of updated hot short probability guidance. The commitment that the actual hot short probability is less than the assumed value would have to be proven as part of transition. The same would apply if hot short duration probabilities were used prior to their formal acceptance.

Another example would be that the heat release rate for a particular cabinet configuration would be less than some value in anticipation of the results of a testing program. The commitment would be that the testing would verify that the HRR would be no more than the assumed value.

These would become Implementation Items, and as long as the condition could be verified before full transition to NFPA 805, it would be acceptable.

Presuming the risk numbers did not change or the upper limits were not compromised after taking credit for the seal performance or other performance parameter as discussed above, the performance goal would be met.