NRC Response to EPRI letter dated October 27, 2016 regarding NUREG-2180

This enclosure contains the responses to the Electric Power Research Institute (EPRI) comments identified in Attachment A of the letter dated October 27, 2016, from Mr. Kenneth Canavan of EPRI to Mr. Michael Weber of the Nuclear Regulatory Commission (NRC). These comments were previously reviewed and dispositioned by the NRC staff following the closure of the 60-day public comment period, which ended on September 8, 2015. The responses below represent the staff's disposition of those comments. The additional information in Attachment A regarding the tabletop pilot of NUREG-2180 was previously provided to the U.S. Nuclear Regulatory Commission (NRC). The NRC staff responded to that information in the Agencywide Document Access and Management System (ADAMS) under Accession No. ML16271A158. As no new information has been provided in these comments, nor has additional technical justification for the concern been provided, the response provided to NEI represents the staff position. Responses to those concerns were also communicated in detail to NEI during a September 20, 2016, public meeting.

EPRI Comment #23: End state of "cabinet damage" may still be overestimated based on a review of fire event experience related to electrical cabinet fires which suggest that even fires in cabinets that have observed flaming tend to stay localized within the cabinet.
Discussion: Experience in all electrical cabinet fires (regardless of detection method) suggests that this is grossly conservative and a majority of the fires in low voltage cabinets (the most common application of VEWFDS) is limited to a single sub-component. Failure to allow the realistic end state is inconsistent with past guidance and does not reflect operating experience.

Response to EPRI Comment #23: The NRC staff response to this comment was previously provided in the NEI response letter enclosure (see "Response 3" and "Feedback on specific attachments" sections of ADAMS Accession No. ML16271A159). The approach taken in NUREG-2180 is consistent with the assumptions made in FAQ 08-0046, which stated:

> To simplify the analysis, δ, the factor for the probability of failure to remove power from the device once it has been located, is set to 1. This is done because of the difficulty in assessing the likelihood of successful prevention.
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> If a licensee desires to obtain more credit in this process, the more detailed NRC event tree may be used, including the branches with δ (with adequate and appropriate justification in the form of a detailed human reliability analysis). One way a licensee could achieve significant fire prevention credit would be to "pre-locate" the isolation devices for all ignition sources within each cabinet in an effort to speed up the process. If such an effort was taken, additional credit for preventing fires could be allowed. This would need to include predetermining the isolation devices, conveniently displaying that information for use in response to VEWFDS alerts, training responders so that they could rapidly locate and operate the isolation device(s), and conducting drills to periodically demonstrate this ability.

NUREG-2180 provides additional information to support a site-specific analysis, including assumptions and limitations, to credit prevention and modify the event tree accordingly.

In addition, the current state-of-the-art fire PRA methods assume that a t-squared fire growth begins at time of ignition. This is described in Section 2.2 of this report. If methods become available that incorporate either a pre-growth or different growth profile (duration) then the methods presented in this report can be adjusted to incorporate such changes.

EPRI Comment #28: It may not be appropriate to compare the performance of incipient fire detection systems with conventional detection systems. Roughly 15% of electrical cabinet fires are detected by area-wide fixed detection systems. Most of the remaining fires are detected by plant personnel or other control room indications. Therefore, it is likely that the installation of incipient detection systems would increase the number of fires detected by fixed detection systems. There has been significant industry operating experience with respect to incipient detection that suggest early component failures are being detected on a more frequent basis.
Discussion: The emphasis of the tests compared VEWFDS to conventional spot detectors during a small portion of the overall fire timeline (incipient / pre-flaming stage). As noted in the original comment, only a small fraction of electrical cabinet fires are detected by fixed detection systems. This is often due to nature of the low energy fires that precede an aggressive flaming stage, combined with conventional detection that is placed in high ceilings in nuclear power plants. The installation of incipient detection systems would seem to be beneficial in capturing early component failures exhibiting incipient behavior. This is not reflected in the approach.

Response EPRI Comment #28: The comparison between the performance of common smoke detection systems currently used in nuclear power plants to VEWFD systems is identified as Objective B in Section 1.3 of the report.

Placing smoke detection systems closer to the fire source will result in less dilution (i.e., a larger signal to noise ratio) at the detector for a given fire source, resulting in earlier detection. NUREG-2180 provides an approach for estimating the probability of non-suppression for in-cabinet smoke detection applications, which provides an estimate that is smaller than existing conventional room detection modeling presented in Appendix P of NUREG/CR-6850 (EPRI 1011989).

EPRI Comment #31: Table 10-1 attempts to justify the 30-minute time window for the fire event review, however it appears from the event timeline that a technician or other plant personnel may be in the location of interest within 7-14 minutes (if not sooner). It is likely that even with a few minutes available, an operator would be able to locate and control an early stage fire regardless of the fire progression (nearing the end of the incipient stage or entering flaming (but prior to t-squared) conditions). Again, the thirty-minute time windows appears to be a severe limitation of this method.
Discussion: As designed, the EPRI updated fire events database was constructed to capture fire details and attributes post-fire. It should be acknowledged that a number of events were unable to be characterized definitively for incipient behavior. This is not unexpected, as any insights to fire-precursors are dependent on the reporting practices of the plant and may further depend on the location or severity of the fire. Nevertheless, this results in considerable uncertainty in the alpha factor parameter.

Response to EPRI Comment #31: Table 10-1 (of the DRAFT NUREG, Table 10-4 in Final NUREG) is based on information provided from utility personnel during interviews facilitated by EPRI and documented in Appendix C of NUREG-2180. As stated in the text of the report,

> Table 10-4 below summarizes the HRA timing inputs developed. The ranges of times are either directly provided by plant personnel or are interpretations of more informal estimates (e.g., a “few” minutes can be translated into 3 or 4 minutes). Also, the durations of the field operator response and technician response shown in Table 10-4 represent the range of time estimates provided by both NPPs.

Therefore, Table 10-4 contains information provided to the NRC through interviews with plant personnel. This information is used in the feasibility study (Section 10.5) and to develop human error probabilities (Section 10.6).

The justification of the 30 minutes timeframe for defining an event with an incipient stage is provided in Sections 7, 8, and Appendix D. Based on the comments received during the public comment period, those sections were revised to clarify the basis behind the 30 minute assumption. This was discussed during the April 2016 public workshop held at the NRC and during EPRI facilitated meeting with NEI in July 2016. As stated during these meetings, the 30 minutes is a screening criterion that is based on: 1) an assumed operator response time of 15 minutes, and 2) the normalized time to detection during an incipient stage based on test data (i.e., the time from the start of degradation to when an incipient detector provides an alert). The 30 minute criterion was used during the review of operating experience to determine the fraction of potentially challenging, or greater, fires that exhibit an incipient stage. In this review, the only events classified as not exhibiting an incipient stage were failures on demand that resulted in either an instantaneous fire or a fire that initiated within a few minutes. Consequently, the results from the screening were not dependent on the 30-minutes screening criterion. The events that could not be characterized for an incipient stage were not used in the estimation of the alpha factor parameter. The report also identified additional events that were not in the EPRI fire events database, were characterized as potentially challenging or greater, and did not exhibit an incipient stage. The operating experience reviewed conflicts with the simplifying assumptions made in the interim staff position, and as such, this research as described in NUREG-2180 does not confirm the assumption that all potentially challenging or greater fires exhibit an incipient stage.