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NUCLEAR REGULATORY COMMISSION
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PDR

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Mr. William H. Rasin
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SUBJECT: NRC COMMENTS ON DRAFT NUMARC FIRE VULNERABILITY EVALUATION (FIVE) METHODOLOGY

Dear Mr. Rasin:

In response to your letter, dated June 28, 1990, we have reviewed the draft FIVE methodology. A meeting was held on August 16, 1990 to discuss the draft report with your staff and consultants. Our preliminary comments were discussed during the meeting.

In general, we believe that the proposed FIVE methodology can be modified so that it would be an acceptable methodology. Additional work is needed to accomplish the IPEEE objectives for internal fires.

Specifically, we believe that the following should be done in a timely manner:

1. The fire events database. We understand that EPRI is developing this database and the schedule for completion is November 1990. When complete, it should be submitted for review. We expect that the staff will have a number of questions on its development.

2. The fire modeling techniques. We understand that the plant demonstrations will take place in late October 1990. We expect that the plant demonstrations will be used to assess the validity of the fire modeling techniques proposed in the FIVE methodology. It is our understanding that this will be accomplished by applying both the FIVE fire modeling techniques and the modified COMPBRN computer code to assess the degree of agreement between these two techniques during the plant demonstrations.

3. The final FIVE methodology report. The FIVE methodology report should be finalized and the enclosed comments should be properly addressed in the final report.

We will review the final FIVE methodology report to determine its

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acceptability as a viable alternative method for identifying severe accident vulnerabilities due to internal fires. However, the timing of this review is contingent upon completion of your plant demonstrations and receipt of your final document on the FIVE methodology.

Sincerely,

Warren Minners, Director
Division of Safety Issue Resolution
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Enclosure: As stated

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COMMENTS ON NUMARC/EPRI FIRE VULNERABILITY EVALUATION (FIVE) METHODOLOGY

1) Successive-screening approach: The staff believes that the successive-screening approach in FIVE methodology can be a viable approach for accomplishing the objectives of the fire IPEEE. The screening method has been structured such that it has taken advantage of past PRA insights. It is important, however, that the guidance should provide documentation and traceability requirements.

2) Screening criterion: The choice of 1E-6/year frequency as the screening criterion is considered acceptable. The staff recognizes that for the purposes of identifying fire vulnerabilities, the 1E-6 range is about as low as the methodology can support well. Nevertheless, it is important to recognize that systems, components, and procedures could contribute to many sequences and result in a substantial cumulative effect. Screening procedures should consider the potential cumulative effect of dominant contributors, and uncertainties.

3) Reliance on Appendix R-type compliance and documentation: The utilities' attempt to reduce the cost of the IPEEE analyses by utilizing Appendix R documentation is judged to be acceptable, not only because their own in-house staff will be familiar with this documentation but also because it is an excellent starting point for any follow-on analysis.

However, it is very important that the methodology guidance strongly exhort the analysts to check or validate this prior analysis. For example, meeting Appendix R's 20-foot separation requirements will usually be acceptable to prevent fire spreading, but occasionally it won't be.

Also, the plant must be analyzed "as is". For IPEEE purposes, an exemption to the NRC regulations does not constitute an exemption to the IPEEE and the "as built" condition must be modeled in the analysis.

4) Screening approach for non-fire-affected function/systems: In the proposed system screening in FIVE, a fire area can be screened out if two independent means of achieving safe shutdown can be shown to exist assuming that the postulated fire will damage everything within its own area. This is not acceptable. With today's understanding of system behavior, mostly derived from PRA studies, potentially important scenarios exist that would be screened out using the proposed approach. The PRA literature has several examples of sequences of this type with frequencies much higher than 1E-6/year. The reliability and the availability of the two independent means of safe shutdown alternatives must be assessed rather than assuming it was

adequate. An unavailability of the two systems, taken together, of 1E-6/year is the logical choice, given the NRC's reporting criterion.

An approach suggested by Dr. R. Budnitz during the meeting of August 16, 1990 is a reasonable alternative. The suggested approach is to use the models and frequency numbers acquired from the internal events IPE as the method for determining whether the rest of the plant, outside the fire damaged area, can adequately bring the plant to a safe shutdown. The principal advantages are that (1) the use of the IPE is more rigorous and thorough than the use of an arbitrary deterministic criterion such as the two-separate-systems criterion; (2) in most cases, the models and data should be readily available; and (3) decision-making about what to fix, if anything, can be more rational if the insights from the IPE are available. (It should be noted, however, that in cases involving the remote shutdown panel, explicit quantification may be necessary if not performed as part of the IPE.)

If a potential vulnerability were to be identified by this process, it would involve fire-caused and non-fire-caused failures together. Such accident sequences can be fixed either by addressing the fire aspect, or the non-fire aspect, or both. Surely the broader perspective can be of great benefit to decision-makers.

5) Firefighter effectiveness: The guidance (p.41) on determining the time required for manual firefighters to arrive at and to control a fire is difficult to follow, and seems to have errors. It is important that the analysts be told that the relevant elapsed time is the time from fire initiation until the fire is controlled.

Also, the current text is confusing about how to determine from "data" the likelihood that firefighters can reach a given area before the fire has spread. The section describing use of drill data is particularly hard to understand. The guidance should be made much more explicit here, including a warning about difficulties in using or combining surprise-drill, planned-drill, and other information. The impact of heat and smoke on manual firefighting effectiveness, the fire fighter preparation time, and the time needed to locate the fire in a smoke filled environment should all be considered (p.42).

6) Non-thermal effects: There is no methodology that could be used today for assessing, with any degree of reliability, the non-thermal effects of fires, such as from spreading smoke. The quantitative analysis of such effects is not feasible today, and indeed the insights available on a qualitative level are not very robust.

Nevertheless, the existence of such potential effects is something that can often be identified by the analyst. It is prudent that the guidance provide instructions to identify such situations, even though the analysis of their effects cannot be done. This identification will assist decision-makers, either in the utility or in NRC, who may be faced with determining which of several available remedies might best improve the plant's resilience against fires.

7) Thermal ignition threshold for cables: 700-degree F is cited as a threshold for cable damage (p.31). This value is appropriate for certain type cables, however, there is no discussion about the thresholds for other electrical components, such as integrated circuitry and components using integrated circuits, penetration seals or other types of cables. The use of a single cable damage threshold across the board sounds inappropriate considering that some cables are qualified and others are not.

8) Self-ignited cable fires: There seems to be some inconsistency with regard to self-ignited cable fires. On page 30, it is stated that self-ignited cable fires can be ignored. However, Reference Table 1.2 of Attachment 10.3 specifically identified cables as potential fire ignition sources for several plant areas, implying that some analysis is needed.

The staff believes that self-ignited cable fires can be ignored for plants which can verify that all cables in a given area are certified IEEE-383 low flame spread cables because testing has demonstrated that self-induced fires in such cables are not likely to spread beyond the tray of origin. However, plants which cannot verify the presence of only certified cables should consider the impact of self-induced fires as stated in Reference Table 1.2 of Attachment 10.3.

9) Fire-initiation data: A Fire-initiation database is being developed by EPRI. The EPRI database should be presented in terms of mean values. Also, since the Sandia fire events database was utilized as the base in the development of the EPRI database, it should be referenced. The staff believes that it is a good idea to develop such a common database, and that after it is reviewed, its use will result in great economies for the implementing utilities.

The exclusion of fire events from the database because they occurred during construction or pre-operation phases may be reasonable, but the rationale or criterion for omission should be explicitly stated in the methodology document.

Foreign plant fire events, such as occurred in Taiwan and Spain, should be examined to determine whether the insights are relevant for consideration in the fire IPEEE.

10) Seismic/fire interactions: This issue needs careful attention. There are three principal concerns: seismically induced fires, seismic actuation of detection and suppression systems, and seismic degradation of detection and suppression systems. The lack of significant seismic experience in the nuclear industry does not negate the potential risk. In the non-nuclear industry, significant experience of this type has been demonstrated. The staff believes that a carefully planned walkdown of the plant is the way to collect relevant information to address this issue. Hence, the guidance provided in the FIVE methodology (p.56) should be expanded to take this issue into account. However, if one wants to address this issue from a design point of view, the option is always open.

11) Transient combustibles: The method of determining the frequency of critical combustibles and inspection for such combustibles, requires clarification. Also, the method for calculating the fraction of transient combustibles uncovered should account for the relative size of the transient combustibles in an exposed state.

"The probability of having a critical transient combustible fire exposure in the compartment ..." (p.44) should read "The probability of having a critical transient combustible fire exposure that is not suppressed in the compartment ..."

12) Phase III walkdown: The phase III walkdown should include a check of things possibly missed or wrong assumptions used in the earlier phase I and II analyses. Another important aspect of the plant walkdown is confirmation of the adequacy of fire barriers. The walkdown should check for missing or degraded penetration seals, open conduits which could transmit water to various locations, damaged fire doors and dampers, etc. Credit should not be given for barriers that have not been confirmed as-built, as operated. The walkdown process used to confirm that the barriers represent the as-built, as-operated configuration should be described as part of the submittal. Some statements should be added to reflect these objectives and provide specific guidance.

13) Hydrogen fires: Hydrogen fires from turbine-generator hydrogen cooling systems should be included in the "turbine" fires listed under turbine building.

14) Plant demonstration: The plant demonstrations should provide a way to assess the validity of the "look up tables" to be used in the FIVE methodology. This can be accomplished by applying both the look up tables and COMPBRN computer code to assess the degree of agreement between them.

15) Secondary fuel sources: In developing the look up tables, the treatment of secondary fuel sources (i.e., heat released from

initial fire source causes a combustible material at a second location to burn, which in turn adds sufficient heat to the overall fire to cause the environmental temperature at the target material to exceed its limits) is not clearly described.

16) Submittal documentation: Include guidance on the documentation of assumptions and the results of the analysis. Use NUREG-1407 as a baseline to identify documentation needs.

17) Initial screening: The methodology states that plant areas where a fire cannot create a fire initiated event or cause the loss of safe shutdown functions will be screened from further evaluation (p.8).

The documentation defines a fire initiated event as one that requires a plant trip. This could result from fire induced system interactions impacting balance of plant (BOP) components, or operator response (manual trip) in response to spurious instrument readings or the fire itself. The methodology appears to focus on safe shutdown components only, and these by themselves may not result in a plant trip or fire initiated event as defined by FIVE. Fires that result in damage to safe shutdown components should not be screened out because they fail to generate a reactor trip but rather should be carefully evaluated and documented in Tier II.

18) Non-Appendix R system: "Non-Appendix R" systems should not only meet the independence criteria, but should include procedures for use, and should be included in a training program. Quantification of the availability of "non-Appendix R" systems will also have to be provided.

19) Generic fire database: The FIVE proposes that the Generic Fire Data Base Reference Tables be used directly for implementation of the fire IPEEE (P.23). The staff believes that only in cases where plant specific data are not available should generic data be used. An attempt should always be made to improve the applicability of generic data to plant specific cases through consideration of past operating experience.

20) Critical distance: The "10 Kw/m-squared or more," should read "10 Kw/m-squared or less." (p.37)

21) Page 46 Item c is not understandable.

22) Availability of the alternate shutdown system(s): Although it is not mentioned, increasing the availability of the alternate shutdown system(s) is an important approach to reducing fire induced core damage frequency (p.48). Add "increase reliability of alternative train via procedures or training" as another example of possible changes to consider to address a vulnerability(p.49).

23) Removing conservatism: Page 49 states that: "A third approach is to further evaluate the subject fire compartment by removing conservatism of the Phase II screening method." Conservatism was not defined, nor is guidance provided on how to remove the conservatism.

24) Containment performance: The containment needs to be assessed to determine if sequences different from those obtained in the internal event analyses are predicted. If they are, the internal event analyses provide the containment insights. If different sequences are predicted, a containment analysis, of the type done for the internal event analysis, is required.

25) Attachment 10.5: Page 52 states that: "Attachment 10.5 provides a list of typical plant attributes that would satisfy the NRC's concerns regarding these issues (p.52)". This statement should be removed or clarified as to how this list would satisfy NRC's concerns or resolve issues stemming from the Fire Risk Scoping Study.

26) Fire protection systems: The assumption is made that fire protection systems (FPS) are designed and installed "correctly". Even if FPSs are installed according to vendor's specifications they are still subject to failures and inadvertent actuation that may result in damage to equipment important to safety in more than one fire area and/or in more than one train at a time.

The plant walkdown should include guidance for spotting design and maintenance deficiencies that would allow the identification of potential problems such as not sealed conduits, floor/wall openings, etc.

27) Availability of safety systems: Page 14 states: "This [phase 1 method] assumes that any safe shutdown component within the fire area of concern could be damaged, the normal (Appendix R) alternative or redundant component or system is unavailable for some reason other than the fire, and yet at least one additional Appendix R system or mitigating system will be available at the same time that could replace the function of the safe shutdown component assumed lost in the fire. The fire area can then be screened from furtner evaluation (p.14)."

Quantification of the availability of a third system following the unavailability of the second system, should be performed and used to justify the screening process. No credit should be given for alternate shutdown methods that do not contain procedures, or operator training.

28) Browns Ferry fire: The staff is concerned that the inspection table proposed in the FIVE methodology does not include a place for the Browns Ferry type fire.