WBN2Public Resource

From: Wiebe, Joel
Sent: Friday, October 22, 2010 11:30 AM
To: Crouch, William D
Subject: Watts Bar Unit 2 - Preliminary Request for Information Regarding IPEEE Fire
Attachments: WBN2 Preliminary RAIs IPEEE Fire.docx

The attached preliminary request for information is provided for discussion to ensure the questions are clear and will result in the appropriate response to allow our review of your submittal to continue.

Hearing Identifier: Watts_Bar_2_Operating_LA_Public
Email Number: 133

Mail Envelope Properties (F371D08C516DE74F81193E6D891DC4AF3949CC879B)

Subject: Watts Bar Unit 2 - Preliminary Request for Information Regarding IPEEE Fire
Sent Date: 10/22/2010 11:30:22 AM
Received Date: 10/22/2010 11:30:00 AM
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Tracking Status: None

Post Office: HQCLSTR02.nrc.gov

Files	Size	Date & Time
MESSAGE	206	10/22/2010 11:30:00 AM
WBN2 Preliminary RAIs IPEEE Fire.docx		29186

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

WBN2 Preliminary RAIs for Internal Fire:

1. The Phase III analysis of fire scenarios is based on an event tree fire modeling approach. The submittal gives one example (which begins on page 232 of the submittal) which defines four fire damage cases; minor self-extinguishing fires, severe fires suppressed by automatic suppression, severe fires suppressed with hose streams, and severe fires that are not suppressed. It is not clear from the submittal how this approach was implemented across individual fire scenarios and plant locations. Please answer the following questions regarding this approach:

    a. How was the fire-induced equipment and cable damage target set (i.e., the equipment and cables damaged by the fire) defined for each of the fire damage cases in the event tree and for each individual fire ignition source and plant location analyzed using the event tree approach?

    b. How were the event tree branch point probability split fractions determined for each fire scenario analyzed and for each branch point in the applicable event tree?

2. Section 4 of the fire analysis (beginning on page 228 of the submittal) provides a nominal discussion of how CCDP (or CCDF as cited in the submittal) values were quantified. Please provide further discussion on this subject that addresses the following points:

    a. Modern fire PRAs consider fire-induced cable failure modes and effects that generally extend beyond the scope of traditional deterministic post-fire safe shutdown success path analyses. The submittal (page 229) states that "…failures involving transfer of valves to the undesired position are considered as a result of the fire (i.e., motive power is conservatively available for such cases)." Has the IPEEE fire analysis limited the scope of the cable failure modes and effects to that defined by the deterministic post-fire safe shutdown success path analysis (e.g., per the fire protection licensing basis) or has the treatment been broadened to include more generalized fire risk considerations? If the analysis has been expanded, please describe the nature and scope of that expansion.

    b. Has WBN2 utilized operator manual actions as a part of its post-fire safe shutdown compliance strategy and, if so, how were these operator manual actions incorporated into and quantified in the IPEEE fire analysis?

3. Section 5.5 in the main body of the licensee submittal (entitled "FIVE Validation" and beginning on page 33) cites several tasks that "will be" performed to validate the Unit 2 IPEEE fire analysis. Please answer the following questions relative to the cited tasks:

    a. Which of these validation tasks have been completed?

    b. For any uncompleted task, provide a completion schedule.

    c. The identified validation tasks typically state that "A representative population of rooms will be reviewed…" On what basis is a "representative" population of rooms selected and how did/does the selection process ensure that potentially risk significant plant features were properly characterized in the WBN2 IPEEE fire analysis?

It appears that the IPEEE analysis for internal fires used the same process/approach/methodology that was used for Unit 1. In reviewing the RAIs that were asked for Unit 1, it is not clear how the information in the response to the Unit 1 RAIs was incorporated into the fire analysis for Unit 2. In responding to the RAIs 4 through 10, below, please provide the information in that context.

4. It is important that the human error probabilities (HEPs) used in the analysis properly reflect the potential effects of fire (e.g., smoke, heat, loss of lighting), even if these effects do not directly cause equipment damage in the scenarios being analyzed. If these effects are not treated, the HEPs may be optimistic and result in the improper screening of scenarios. Note that HEPs which are conservative with respect to an internal events analysis could be non-conservative with respect to a fire risk analysis. The Watts Bar submittal indicates the only recovery actions modeled in the fire assessment were in the evaluation of the control room. The submittal does not discuss if and how fire impacts on post-initiator human errors that are in the IPE models (e.g., initiation of feed and bleed) were addressed. Please identify:

    a. The scenarios screened out from further analysis whose quantification involved one or more HEPs,

    b. the HEPs (descriptions and numerical values) for each of these scenarios, and

    c. how the effects of the postulated fires were treated.

5. Fires in the main control room (MCR) are potentially risk-significant because they can cause I&C failures (e.g., loss of signals or spurious signals) for multiple redundant divisions, and because they can force control room abandonment. The Watts Bar submittal indicates that some, but not all, cabinets in the main control room have detectors inside. The Watts Bar main control room was evaluated using the guidance provided in the EPRI Fire PRA Implementation Guide [1]. A review of this methodology [2] has identified problems particularly with regard to the probability of control room abandonment. Although data from two experiments concerning the timing of smoke-induced, forced control room abandonment [3] were used to obtain the probability reported in Reference 1, the data must be carefully interpreted, and use of the data must properly consider the differences in configuration between the experiments and the actual control room being evaluated for fire risk. In particular, the experimental configuration included placement of smoke detectors inside the cabinet in which the fire originated, as well as an open cabinet door. In one case, failure to account for these configuration differences led to more than an order of magnitude underestimate in the conditional probability of forced control room fire abandonment [4]. In addition, another study raises questions about control room habitability due to room air temperature concerns [5].

    a. Please provide a more detailed discussion on the evaluation of the main control room including the identified fire sources, the assumed fire frequency, and any frequency reduction factor. Identify which fire sources were modeled and discuss the fire damage that can be caused by each fire source including the potential for fire propagation and assigned probabilities.

b. Also discuss how fire detection and suppression were modeled, provide any suppression failure probabilities used in the analysis, provide the probability of abandonment used in the evaluation and its basis, and describe what recovery actions were credited and their probabilities. In particular, if the probability of abandonment is based on a probability distribution for the time required to suppress the fire, please justify the parametric form of the distribution and specify the data used to quantify the distribution parameters.

6. NUREG-1407 [6], Section 4.2 and Appendix C, and GL 88-20, Supplement-I [7], request that documentation be submitted with the IPEEE submittal with regard to the Fire Risk Scoping Study issues [8], including the basis and assumptions used to address these issues, and a discussion of the findings and conclusions. NUREG-1407 also requests that evaluation results and potential improvements be specifically highlighted. Control system interactions involving a combination of fire-induced failures and high probability random equipment failures were identified in the FRSS as potential contributors to fire risk. The issue of control systems interactions is associated primarily with the potential that a fire in the plant (e.g., the MCR) might lead to potential control systems vulnerabilities. Given a fire in the plant, the likely sources of control systems interactions could happen between the control room, the remote shutdown panel, and shutdown systems. Specific areas that have been identified as requiring attention in the resolution of this issue include:

    a. Electrical independence of the remote shutdown control systems: The primary concern of control systems interactions occurs at plants that do not provide independent remote shutdown control systems. The electrical independence of the remote shutdown panel and the evaluation of the level of indication and control of remote shutdown control and monitoring circuits need to be assessed.

    b. Loss of control equipment or power before transfer: The potential for loss of control power for certain control circuits as a result of hot shorts and/or blown fuses before transferring control from the MCR to remote shutdown locations needs to be assessed.

    c. Spurious actuation of components leading to component damage, loss-of-coolant accident (LOCA), or interfacing systems LOCA: The spurious actuation of one or more safety-related to safe-shutdown-related components as a result of fire-induced cable faults, hot shorts, or component failures leading to component damage, LOCA, or interfacing systems LOCA, prior to taking control from the remote shutdown panel, needs to be assessed. This assessment also needs to include the spurious starting and running of pumps as well as the spurious repositioning of valves.

    d. Total loss of system function: The potential for total loss of system function as a result of fire-induced redundant component failures or electrical distribution system (power source) failure needs to be addressed.

Please provide an evaluation of whether loss of control power due to hot short and/or blown fuses could occur prior to transferring control to the remote shutdown location and identify the risk contribution of these types of failures (if these failures are screened, please provide the basis for the screening). Provide an evaluation of whether spurious actuation of components as a result of fire-induced cable faults, hot shorts, or component failures could lead to component damage, a LOCA, or an interfacing systems LOCA prior to taking control from the remote shutdown panel (considering both spurious starting and running of pumps as well as the spurious repositioning of valves).

7. The Watts Bar submittal indicates that hot shorts were conservatively assumed whenever necessary to fail a system function. However, only the potential for LOCA due to a hot short opening the pressurizer power-operated relief valve (PORV) was explicitly discussed in the submittal. Hot short considerations should include the treatment of conductor-to-conductor shorts within a given cable. Hot shorts in control cables can simulate the closing of control switches leading, for example, to the repositioning of valves, spurious operation of motors and pumps, or the shutdown of operating equipment. These types of faults might, for example, lead to a LOCA, a diversion of flow within various plant systems, dead heading and failure of important pumps, premature or undesirable switching of pump suction sources, or undesirable equipment operations. For MCR abandonment scenarios, such spurious operations and actions may not be indicated at the remote shutdown panel(s), may not be directly recoverable from remote shutdown locations, or may lead to the loss of remote shutdown capability (e.g. through loss of RSP power sources). In instrumentation circuits hot shorts may cause misleading plant readings potentially leading to inappropriate control actions or generation of actuation signals for emergency safeguard features.

   Discuss to what extent these issues have been considered in the IPEEE. If they have not been considered, please provide an assessment of how inclusion of potential hot shorts would impact the quantification of fire risk scenarios in the IPEEE.

8. The submittal indicates that a probabilistic approach was used to model fire propagation and suppression in 45 fire compartments. This was accomplished by partitioning the fire frequency for a fire compartment into one or more cases (i.e., scenarios) for evaluation. The partitioning was accomplished using a fire event tree that incorporates a fire severity factor and, in some compartments, both automatic and manual suppression. A specific level of fire damage to equipment that can mitigate an accident was assigned to each of the event tree sequences. Fire event tree sequences resulting in similar size fires were combined into one case. An example of a fire event tree is provided in the submittal for the auxiliary building corridor.

   The submittal also indicates that the fire damage potential for fire sources in unscreened compartments was examined by reviewing the individual fire sources in the fire compartments and the zone of influence of the fire source, and by determining the equipment located within that zone of influence. The submittal indicates that the FIVE fire modeling techniques were used to determine the damage potential of each fire source. Details about the fire modeling including equipment damage thresholds, heat release rates, and heat loss factors were not provided in the submittal.

   Based on the description of the fire propagation and suppression analysis, it is not clear that the results of the FIVE fire modeling effort described above were used to determine the actual damage for each sequence of the fire event tree. The wording in the example provided in the submittal states that a specific level of damage was "assumed" for each case. Thus, from the language in the submittal, it is not clear that the probabilistic approach used in the Watts Bar fire assessment included a plant-specific evaluation of fire source and target combinations and that the competing impacts of fire growth and suppression were modeled.

a. Please provide a more detailed description of the probabilistic propagation and suppression method used in the fire assessment and include the following: (a) a more detailed description of how the fire modeling was incorporated into the analysis, and (b) a description of important fire modeling parameters including equipment damage thresholds, the heat release rate from each source, and heat loss factors. Please provide the documentation of the analysis for the following three fire compartments: the auxiliary building corridor (713.0-A1), the cable spreading room (729.0-C1), and 250V battery room 2(692.0-C2). Include a description of the possible fire scenarios including the equipment damage related to each fire source taking into account the competing effects of propagation and suppression.
b. If damage levels were assumed for each case evaluated in the probabilistic model, indicate whether the damage levels are considered to be bounding estimates. If so, provide a discussion supporting the assumption of these estimates as bounding. Alternatively, reevaluate the 45 fire compartments using the FIVE methods for fire modeling that take into account the actual equipment layout and potential for propagation and suppression.

9. As mentioned above, the probabilistic approach used to partition the fire frequency in each compartment included the use of a fire severity factor. The submittal indicates that the ignition source/zone of influence evaluation described above was incorporated in some fashion in the severity factor determination. The severity factors and the partitioning event trees for each fire compartment are not presented in the submittal, and thus it is not clear if each fire source in each compartment was evaluated separately or if the fire compartment was modeled at a simpler level (i.e., all fire sources assigned the same severity factor and damage potential).

   The submittal indicates that fire suppression is not credited in the quantitative screening assessment. However, fire suppression was credited in the detailed analysis of some unscreened compartments in the auxiliary and control buildings. Based on the auxiliary building corridor example provided in the submittal, both automatic and manual fire suppression appear to have been credited in some compartments. The probabilities for automatic and manual fire suppression failure are not provided in the submittal.

   Allowing for suppression of severe fires can potentially lead to double counting of suppression since the severity factor evaluation could have counted fires that were not suppressed as severe fires. It could not be determined from the information provided in the submittal if double counting of fire suppression and fire severity factors was used in the WNS analysis.

Please provide the following additional information concerning fire severity factors and suppression failure probabilities: (a) indicate if fire severity factors were evaluated for each fire source or if a single value was assigned to each fire compartment,(b) provide the fire severity factors used in the analysis of the auxiliary building corridor (713.0-AI), the cable spreading room (729.0-CI), and 250V battery room 2 (692.0-C6) and include a description of their bases such that it can be determined if fire events that involved suppression were categorized as non-severe-fires, and (c) provide a table of the manual suppression failure probabilities used in the analysis including the bases for selecting the manual suppression failure probabilities.

10. The FIVE methodology [9] suggests values for automatic suppression failure probabilities for use in a FIVE assessment. This data is acceptable for systems that have been designed, installed, and maintained in accordance with appropriate industry standards, such as those published by National Fire Protection Agency (NFPA).

    Please provide a list of the automatic fire suppression systems failure probabilities used in the Watts Bar fire assessment. Indicate if the automatic fire suppression systems at Watts Bar are designed and maintained according to NFPA standards.

References

1. EPRI, "Fire PRA Implementation Guide," EPRI TR-105928, December 1995.
2. J. Lambright and M. Kazarians, "Review of the EPRI Fire PRA Implementation Guide," ERI/NRC 97-501, Energy Research, Inc., August 1997.
3. J. Chavez, et al., "An Experimental Investigation of Internally Ignited Fires inNuclear Power Plant Cabinets, Part II-Room Effects Tests," NUREG /CR-4527/V2, October 1988.
4. J. Lambright, et al., "A Review of Fire PRA Requantification Studies Reported in NSAC/181," prepared for the United States Nuclear Regulatory Commission, April 1994.
5. J. Usher and J. Boccio, “Fire Environment Determination in the LaSalle Nuclear Power Plant Control Room,” NUREG/CR-5037, prepared for the United States Nuclear Regulatory Commission, October 1987.
6. J. Chen, et al., "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," NUREG-1407, United States Nuclear Regulatory Commission, June 1991.
7. "Independent Plant Examination for External Events (IPEEE) for Severe Accident Vulnerabilities -1OCFR 50.54(f),” Generic Letter 88-20, Supplement No.4, United States Nuclear Regulatory Commission, June 1991.
8. J. Lambright, et a1., "Fire Risk Scoping Study: Investigation of Nuclear Power Plant Fire Risk, Including Previously Unaddressed Issues," NUREG/CR-5508, prepared for the United States Nuclear Regulatory Commission, January 1989.
9. EPRI, "Fire-Induced Vulnerability Evaluation (FIVE),” EPRI TR-100370, April 1992.