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March 19, 2010

Mr. Michael T. Lesar, Chief
Rulemaking and Directives Branch
Division of Administrative Services
Office of Administration
Mail Stop: TWB-05-B01M
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Response to Request for Comments Concerning Draft NUREG-1921, *"EPRI/NRC-RES Fire Human Reliability Analysis Guidelines"* (Federal Register Notice 74FR65810, dated December 11, 2009)

Exelon Generation Company, LLC (Exelon) is submitting this letter in response to the Nuclear Regulatory Commission's (NRC's) request for comments concerning Draft NUREG-1921, *"EPRI/NRC-RES Fire Human Reliability Analysis Guidelines."*

The NRC and the Electric Power Research Institute (EPRI) have been working on a collaborative effort to develop explicit guidance for estimating Human Error Probabilities (HEPs) for human failure events under fire generated conditions, building upon existing Human Reliability Analysis (HRA) methods. Accordingly, this draft NUREG discusses a methodology and guidance for conducting a fire HRA.

Exelon appreciates the opportunity to comment on draft NUREG-1921 and recommends that the NRC reconsider issuing the document at this time. While there is a great deal of information in the draft NUREG document that is useful, Exelon does not believe the document provides clear, practical guidance on the performance of a fire HRA, and as a result might not provide much benefit as currently written. In addition, Exelon offers the comments contained in the attachment to this letter for consideration by the NRC.

If you have any questions or require additional information, please do not hesitate to contact Mr. Richard Gropp at 610-765-5557.

Respectfully,

D. P. Helker

David P. Helker
Manager - Licensing

Attachment

SUNSI Review Complete
Template = ADM-013

E-RIDS = ADM-03
Cell = K. Hill (KLH)

Comments Concerning Draft NUREG-1921

Exelon Generation Company, LLC (Exelon) performed a detailed review of draft NUREG-1921, *"EPRI/NRC-RES Fire Human Reliability Analysis Guidelines,"* from the perspective of an end user. Based on this review, Exelon does not believe that this draft document should be issued for use at this time. While there is a great deal of useful information in this draft NUREG, Exelon does not believe the draft document provides clear, practical guidance on the performance of a fire Human Reliability Analysis (HRA), and as a result might not provide much benefit as currently written. Furthermore, while there is value in a scoping analysis that is intermediate between a screening analysis and a detailed analysis, the current version of the NUREG is believed to be excessively resource intensive and overly conservative and its use is of little benefit in the effective identification of the significant Human Failure Events (HFEs) that require a detailed analysis.

Exelon offers the following comments for consideration by the NRC.

General Comments

1) Exelon believes that the document is overly complex, in large part because the authors have striven for completeness in addressing the issues associated with performing a fire HRA. What guidance there is has been embedded in protracted discussion. Exelon believes that the guidance and the supporting material should be separated in order for this to be a beneficial guidance document.

2) Exelon considers the discussion of the identification and definition of the HFEs in Section 3 to be confusing, and does not relate well to how a fire PRA is developed. As a consequence, Exelon believes that the categorization of HFEs in Section 3 is unnecessarily complicated. Exelon suggests that the NRC consider modifying this section with the recognition that the starting point should be the identification of fire scenarios and a characterization of the plant response; the identification and classification of the expected operator responses would follow logically.

3) The material presented in Section 4 is interesting and well written, but focuses more on what factors should be considered, rather than how it should be considered, which Exelon believes should be the focus of this guidance document.

4) Demonstrating the feasibility of operator responses is crucial for a realistic fire Probabilistic Risk Assessment (PRA). Discussion of the demonstration of feasibility is distributed over Sections 3, 4, and 5. Exelon believes it would be more helpful if it could be consolidated as a separate section of the report, since it is essential, at some level, whether the HRA is a screening, scoping, or detailed analysis. However, the demonstration of feasibility should be commensurate with the level of analysis, becoming increasingly more detailed and realistic from the screening, through the scoping to the detailed analysis.

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5) The scoping approach to quantification introduced in Section 5 is considered very resource intensive, and Exelon does not believe that it provides much benefit as an intermediate approach between the screening and detailed approaches. It has the appearance of an alternative approach to a detailed analysis. The major issue is that the authors have written the guidance to require a very detailed demonstration of the timeline for each action. A true scoping approach would provide an approach to identifying the more significant HFEs without this initial detailed demonstration, reserving the detailed demonstration for the risk-significant HFEs.

6) Exelon believes that the decision trees associated with the scoping approach are unnecessarily complex, and perhaps could be simplified by using entry condition indicating that the responses have been demonstrated to be feasible.

7) The use of the scoping approach does not appear to allow the use of the HEPs from the internal events PRA for those responses considered to be unaffected by the fire, in a similar manner as the screening analysis does. The minimum HEP from the scoping analysis is 1E-03, which is significantly higher than many HEPs typically found in internal events PRAs. An obvious example is the failure to initiate suppression pool cooling in a Boiling Water Reactor (BWR). Use of a 1E-03 HEP for this HFE in a fire PRA would distort the importance of the fire initiated sequences.

8) Exelon believes that Sections 6 and 8 of the document provide very little fire specific guidance, and could be deleted without detriment to the overall document. If Section 8 is retained, Exelon suggests that the section be completely rewritten since it appears to contain many incorrect statements.

9) The guidance on a detailed approach is limited to two methods: the EPRI HRA Calculator approach, and the ATHEANA approach. While the guidance for the EPRI approach is detailed, the guidance for the ATHEANA method is minimal. It is noted that this guidance was not included in the peer review of the previous draft of the document. Since the EPRI approach is likely to be used by the majority of licensees, Exelon considers that a peer review would be advisable prior to the release of the document, particularly since there are concerns with some of the guidance contained therein.

Specific Comments

Exelon believes that this draft NUREG could ultimately be a made into a useful reference, but this can only be achieved through a significant restructuring of the document and by re-working the scoping analysis to provide a more reasonable approach as an intermediate step between a screening analysis and a detailed analysis. More specific suggestions for this restructuring are discussed below.

Comments Concerning Draft NUREG-1921

Section 2 - Fire HRA Framework

Exelon recommends changes to this section following changes to other sections of the draft NUREG. However, in Section 2.2, Page 2-1, item 1, "Identify and Define HFEs," the bulleted list does not represent the steps of the process, but types of HFEs. If this information it is to represent the process, Exelon believes that there should be a step to identify the appropriate responses, because it is failure to execute these responses that results in the HFEs. This is recognized in Section 3.

Also, as written, the 5th bullet, "Initial assessment of the feasibility of the HFE," is confusing; it is the responses that have to be determined to be feasible. If they are not feasible, the HEP for the corresponding HFE is 1. This can be addressed by listing the steps of the process, for example:

- for each fire scenario identify responses,
- assess feasibility of response, and
- define an HFE for inclusion in the Fire PRA model.

Section 3 - Identification and Definition

Exelon believes that this chapter is considerably more complex than it needs to be. Furthermore, the structure is difficult to use. The delineation of the fire scenarios and understanding the response required, whether they are called out in Emergency Operating Procedures (EOPs) or fire response procedures should be the starting point for the classification, characterization, and quantification of the HFEs. Given the identification of the responses, the details of the fire scenario, and how the HFEs are defined, it would then be easier to classify how to deal with them. Therefore, Exelon suggests moving the discussion of the identification of operator responses currently in Section 3.4 up to replace and incorporate the current Sections 3.2 and 3.3.

However, Exelon believes that the current Section 3.4 might need to be rewritten. The words in step 1 suggest that the fire HRA might be developed before the fire PRA model, which does not seem appropriate. As an example, the following statement: "For this approach, ideally, the fire FPRA has developed past NUREG-6850 Task 5 risk model development," would be better written as: "Before beginning the HRA task the fire PRA needs to be developed past ...." Part of developing the fire scenarios is the identification of the initiating event caused and the equipment and instrumentation affected. Without this, the identification of operator actions, whether they are in response to EOPs, Abnormal Operating Procedures (AOPs), or fire response procedures is not possible.

Exelon suggests that Step 2 be rewritten as: "Identify procedural ~~fire response~~ [suggested deletion] actions that are required for mitigation once the fire impacts on equipment and instrumentation become known." This should include both EOP and fire response procedure driven responses. In addition, the examples provided in the table do not seem to help clarify the text. It appears as if the fire response procedure 5.4.30.1 that is quoted in this case is modeled

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along the lines of the EOPs in that it covers all aspects of the response and may not be typical of all fire response procedures (see for example HPCI-OPSOC-CD).

Step 3 introduces the concept of a hybrid approach, although it is not clear what this actually refers to. The example concerns control room abandonment and provides little guidance as to what is intended.

Section 3.2 discusses the operator responses and corresponding HFEs included in the internal events model. They identify a subset of EOP/AOP actions that were not modeled in the internal events PRA or were addressed by using screening values for the associated HEPs. The example provided of such an action, namely the manual back-up of a failed auto signal, may not be currently modeled in an internal events PRA due to low probability of the scenario being recognized. However, these types of responses are probably best identified as part of the recovery analysis (Section 6) since their feasibility and the time available for completion will be scenario or cut set dependent. The same problem occurs in Section 3.3.1. Most, if not all of the response actions identified in the list of examples appear to be better classified as recovery actions, since they are specific to a particular piece of equipment and the feasibility and timing will be dependent on the scenario being modeled.

Section 3.5 addresses undesired action in response to spurious actuations. The screening rules in Step 1 of Section 3.5.2 are reasonable, and would appear to meet HRA-B4 of the standard. However, it is not clear how they meet ES-C2, which seems to imply something more as needing to be considered. In addition, Exelon does not believe that ES-C2 is clearly written and requests further clarification.

The discussion in Step 2 indicates that a review of all Annunciator Response Procedures (ARPs) should be performed to identify undesired operator response actions. This step poses several practical issues. Annunciators are not typically evaluated for their post-fire availability, and their wiring need not meet class 1E separation requirements. A common expectation during an event is that the operators enter a "transient response mode" where annunciators are noted and acknowledged, but each ARP is not pulled and acted on, since a higher priority is given to the governing EOPs and their measured parameters as acknowledged in the discussion in Step 2.

Section 4 - Qualitative Analysis

The qualitative discussion contained in this section is generally good and fairly thorough. However, the information contained is very compact and not easily used. The whole section is full of phrases such as: "may be," "these factors can bear on the likely success of operator actions and need to be evaluated," "should be considered," and "new highest level of stress may want to be considered for fire HRA." However, there is little guidance on how to address these issues. Exelon believes that this information is probably more relevant for the detailed methods than the scoping method. The usability of the document would be enhanced by moving much of this material to an Appendix, and extracting the relevant conclusions used for the scoping analysis.

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As an explicit example, the following paragraph is taken from Section 4.3.1, "Cues and Indication," with the example phrases bolded:

> "For MCR abandonment actions, it is **likely that the crew will have limited familiarity** with the ex-CR panels and how cues for actions are presented. Furthermore, the human-machine interface of these panels **may not be as good as** in the MCR. These issues **must be considered** in evaluating the adequacy of relevant cues for post-MCR abandonment actions. In addition, in cases of MCR abandonment or use of alternate shutdown approaches, **the general effects of crews no longer having access to all the information in the MCR needs to be evaluated**."

Section 4.3 discusses Performance Shaping Factors (PSFs), and in particular a specific subset of PSFs that are considered to be the most significant. While these specific PSFs are not necessarily those explicitly considered in either of the two detailed methods discussed in Appendices C and D, they are, or can be, addressed implicitly. Taking complexity as an example, it can be subdivided into cognitive complexity and physical/execution complexity. The EPRI approach would deal with the former in the CDBT approach and the latter in the development of a THERP HEP, and to some extent this is explicit. ATHEANA addresses it through the expert opinion process and is implicit. By contrast, the discussion of the crew dynamics PSF raises good questions, but it is not clear what an analyst is expected to do. There are some concepts that perhaps could be extracted to be more explicit. For example, it seems reasonable for the analysts to establish the licensee's philosophy with respect to procedures (e.g., under what conditions would equipment be allowed to run to destruction, and this would be used to assess the average or expected response). Crew-to-crew variability is, however, not typically addressed by most HRA methods, and the discussion in the guidance could be considered a distraction.

Section 4.3.2 discusses the PSFs related to timing, but a significant portion of this section relates to feasibility demonstration, which is also addressed in Section 3.6, and again in Section 5.2.2. Since this plays such an important role in the analysis, whether it is a screening analysis, a scoping analysis, or a detailed analysis, Exelon believes that the feasibility discussion would be better if included in a section completely on its own. A graded approach would be helpful, so that a detailed demonstration of feasibility as addressed in Section 5.2.2 would only be required for significant HFEs.

Section 5 - Quantification

This section contains a revision to the screening approach of NUREG/CR-6850 and a new scoping approach that is an alternative to performing a detailed analysis for each HFE not screened out.

Section 5.1: Screening HRA Quantification. The principal difference between this approach and that of NUREG/CR-6850 is the recognition that after some period of time, fixed as 1 hour, the fire will have been controlled and the effects of the fire on the operators will be negligible. In Section 5.1.1.2: Screening under Set 2 criteria, a different factor is applied for the long term actions. It is not clear why the same philosophy as that for the Set 1 criteria is not used. The

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discussion under the heading Set 2 criteria would support this, and furthermore, there is no basis presented for doing anything different for Set 2 than Set 1.

Section 5.1.1.1 – A large fraction of fires that occur in Nuclear Power Plants (NPPs) involve the failure of energized electrical equipment. Most of the time these types of equipment failures result in failure of the device itself with little or no collateral damage. The frequency of these events occurring should already be captured in the plant's baseline internal events frequencies. To an operator, the response to these events would be indistinguishable from the internal event for failure of the device. It does not appear appropriate to penalize the operator response to these events by multiplying the HEP by a factor of 10, nor does it appear appropriate to treat them separately from existing internal event frequencies solely because they may involve smoke or fire. That merely results in "double counting" of the events (counted in Internal Events PRA and again with additional penalties in Fire PRA). Only fire events that extend damage beyond the initially failed piece of energized electrical equipment (e.g., failure of the component with additional complications or casualties), should be evaluated in the Fire PRA and treated using the Fire HRA methodology. However, since this would involve examining the basis for the fire initiating event frequencies, this comment may be more applicable to NUREG/CR-6850 rather than to NUREG-1921.

Section 5.2 - Scoping Analysis:

The scoping analysis is intended to be intermediate between a screening analysis and a detailed analysis, but in many ways it is very detailed. In particular, the demonstration of feasibility described in Section 5.2.2 is extremely detailed. However, the purpose of Section 5.2.2 is two-fold: a) to demonstrate feasibility, and b) to provide an assessment of the time taken to use in the estimation of time margin, which is a key factor in the scoping analysis. Because of this it is not clear that this scoping analysis provides any significant benefit without relaxing the approach to feasibility and the assessment of the time margin. As an example, is it really necessary to perform an actual demonstration as described in Section 5.2.2 if there is reasonable assurance that the time available is long, and a realistic talk-through provides a time needed that is much shorter? It is acknowledged that a surrogate may be used under some circumstances. For a scoping analysis it would seem to be appropriate to use an expert judgment approach to determine the performance times and then do the full demonstration for the most significant HFEs. In other words, there should be a graded approach, more like an enhanced screening approach.

The approach uses six characteristics (listed below) to determine the HEPs for in-control room and ex-control room HFEs with no control room abandonment.

- Time since the occurrence of a fire greater than or less than 60 minutes
- Time available for response greater than or less than 30 minutes
- Execution complexity high or not
- Smoke or other hazardous elements
- Are Self Contained Breathing Apparatus (SCBA) to be used
- Time margin

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Exelon requests further clarification on whether this scoping assessment is intended to be used for already existing HEPs. If so, the best HEP would be 1E-03, and that for a response occurring after 1 hour, with a long time window, of low complexity, and a time margin greater than 100%. Use of a different approach to fire HRA and internal events HRA in this case could lead to misleading results.

The decision trees could be significantly simplified by using, as an entry condition, a demonstration of feasibility. The minimum criteria in Section 5.2.1, for example, appear to be closely related to the feasibility analysis. For example, in Figure 5-2, there is no need to include boxes D-1 and D-6, since they should have been addressed as part of the feasibility assessment. The flow charts would be best reserved for cases where the action is feasible. There are other cases (e.g., D40 which could also be left out of the Figures) which are too complex, at least for an initial scoping assessment.

The following paragraphs contain more minor comments.

Section 3.5 – This section indicates that an operator might be misled by a single instrument reading. In practice, this is rare. Operators are trained to confirm indication readings whenever possible, and not base actions on unverified information.

Section 3.5.2 Step 2 – indicates that a review of all Annunciator Response Procedures (ARPs) should be performed to identify undesired operator response actions. This step poses several practical issues. Annunciators are not typically evaluated for their post-fire availability, and their wiring need not meet class 1E separation requirements. A common expectation during an event is that the operators enter a "transient response mode" where annunciators are noted and acknowledged, but each ARP is not pulled and acted on, since a higher priority is given to the governing EOPs and their measured parameters.

Sections 3.6 and 4.2.8 – These paragraphs suggest that a "full area burnout" mentality has been taken in defining operator success/failure. Experience has shown that the "full area burnout" is a conservative design approach, but does not reflect actual NPP fire behavior, and is not reflective of the as-designed/as-operated plant. For the Fire HRA to realistically reflect the as-designed/as-operated plant, simply setting the HEP to 1.0 for these scenarios is unrealistic, especially considering the enormous size of fire areas at some plants, and the likelihood that most of these large areas would be habitable during a "typical" fire.

Section 5.2.3 – Time Margin. In this section, the time margin is characterized as being used to address uncertainty in the assessment of the time taken to perform the action, based on the discussions in NUREG -1852. The factor of 2 used in NUREG-1852 was indeed included to account for potential variability of the time due to factors that could not be controlled during the demonstration. However, in the context of the scoping analysis the time margin is essentially being used as a surrogate for operator reliability, and is essentially a crude parameterization of a time-reliability curve.

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Section 5.2.5 states that the HEPs are based on, among other factors, level of diagnosis complexity. This is not addressed explicitly in the flowcharts, but could well be a significant factor.

Section 5.2.6.1: There is a considerable amount of good discussion here, but much of this will not be the HRA analysts' responsibility alone, but will be determined by the scenario characteristics. For some issues, however, it would be useful to have more guidance. For example, one of the critical factors with control room abandonment is the determination of when it is likely to occur, and what the crew may have been able to perform before abandoning the control room. The only guidance is: "analysts will need to estimate when switchover is likely to occur relative to the start of the initiating event." This is part of the fire scenario development, and should be incorporated into the definition of the relevant HFE. Furthermore, the proposed criteria for control room abandonment analysis seem out of line with what is supposed to be a scoping analysis.

Section 5.2.6.3: Apart from the last paragraph, Exelon considers the information in this section to be unnecessary, and even the last paragraph could be addressed under feasibility. If there are no procedures and yet the response is considered skill of the craft, the response would be typically dealt with as a recovery action and addressed in Section 6.

Section 5.2.7: Exelon requests further clarification as to whether it is the expectation that fire scenarios be developed to the level that it has been determined that there is smoke in the control room but there has been no evacuation.

Section 5.4: Exelon does not believe that an analysis of a situation where SCBA are used, regardless of how good they are, should be included as part of the scoping analysis.

Section 6 - Recovery

Exelon believes that most of the material included in Section 6 is not required. In particular, there is no need to define the three types of recovery in Section 6.1; the term as used in the PRA Standard refers to Type 2 only.

Section 7 - Dependency Analysis

Exelon believes that there is little new guidance in this section that is specific to fires. The example decision tree for determining the level of dependence between two HFEs is taken from the EPRI calculator, which is characterized as the detailed EPRI HRA methodology. It is not known whether this methodology for the treatment of dependency has been subjected to a peer review, but if it has not, Exelon suggests a peer review. It is noted that the correction for dependency is made at the total HFE level, i.e., the sum of the cognitive and execution contributions to the HEP. It is reasonable to suggest that the factors affecting dependency for the cognitive portion may be different from those affecting the execution portions. Since the screening and scoping approaches do not separate the cognitive and execution portions, such an approximation may be acceptable. It should, however, be noted that this proposed approach may not be adequate for the detailed analysis.

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Section 8 - Uncertainty Analysis

Exelon believes that this section provides limited guidance. It also seems to contain inconsistent statements relative to the concepts of aleatory and epistemic uncertainty and how they play into the determination of uncertainty characterization for the HEPs. The guidance that is provided does not comport with processes used to evaluate uncertainty. For example, if the screening values are supposed to be conservative, there would appear to be no need for an uncertainty evaluation. Furthermore, several statements providing guidance are made without a technical basis. An example of the latter is found in Section 8.2.2 on page 8-7 (emphasis added): "The scoping HEP values **can be considered as median values** to be adjusted by the EF to become mean values so they match with the other mean values in the PRA model."

Exelon suggests that this section needs to be completely rewritten, based on an understanding of what the uncertainty on the HEPs is supposed to convey, and relating it to the fire specific modeling issues that affect that uncertainty. For example, a considerable uncertainty associated with control room abandonment is the determination of the time that the decision would be made. This guidance should explain how such an uncertainty is taken into account. For example, it could be dealt with in the scoping analysis by providing a conservative bias on the HEPs for such responses. Since the lowest HEP for control room abandonment actions is 0.1, this may already include the conservative bias.

Appendix B - Fire Event Review

Exelon does not believe that this Appendix enhances the report. The events that have been analyzed are not described, and therefore, the discussion related to the PSFs is difficult to understand. The conclusions drawn with respect to the HRA are either obvious (e.g., "The HRA process should support a screening HEP value increase through the use of the screening sets. Detailed HRA response modeling needs to look at timing of cues, time windows and manipulation time.") or so vague as to provide no real guidance (e.g., "Hence the HRA fire process guidance should not necessarily penalize operator performance too severely for having to be in multiple procedures concurrently in fire situations."). Again, in one case it is stated: "The HRA process guidance should address both possibilities of leaving the MCR when it is not really necessary as well as leaving when perhaps it is too late." That guidance was not apparent in the main report.

Appendix C - Detailed Quantification of Post-Fire Human Failure Events Using EPRI Fire HRA Methods

This Appendix appears to be well thought out and thorough. Regardless of whether the scoping analysis is used for some HEPs, it is nevertheless a good idea to use the same method for the significant fire HFEs and IE HFEs, and if the method can address the effect of fires directly that would be considered a good concept. Considerable thought has been given to doing this, particularly with respect to the effect of the fire on instrumentation (Section C.5).

However, the following specific observations are offered:

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1. Figure C-1 is not the figure recommended in EPRI TR-100259 for the quantification. The intent of that document was that the cognitive (p_c) contribution term is the greater of p_1 or p_2.

2. In Section C.5 it would be useful to discuss the nuisance value of affected instrumentation other than that required to make the decision.

3. Section C.6.2.6: The manpower requirement assessment indicates that: "If there is not enough crew available to complete the actions then the HEP should be set to 1.0." Exelon would agree that this would be the case, but can a condition in which there are too few crew members to perform a task be defined? For example, there may be three actions each requiring two reactor operators that would occur in overlapping timeframes (i.e., the cues have occurred and the response phases may have begun), but the times by which the actions must be complete may be such that all three actions could be performed consecutively. In that case, would one assume that adequate crew is available? Would the resource assessment be performed differently for fires than for internal events? How would one determine which concurrent action did not get performed for assessing the CCPD impact? How would the operator's prioritization of actions be factored in? A note on how the HRAC uses the manpower assessment may be helpful to add as a use tip since the section includes HRAC interface information.

4. Section C.6.2.7 does not explicitly address the manipulation time for in-CR actions. It states: "The manipulation time (Tm) should account for any travel time to reach the execution location. This travel time could be significantly impacted due to the fire location. Tm can be obtained from a demonstration of feasibility, job performance measures (JPMs) or walk-through or talk-through with the operators. As an initial estimate for existing internal events HFEs, it is recommended to increase Tm by at least 10 minutes."

   Since the control room operators are already stationed in the control room, it should be clarified that this increase is not necessary for in-control room actions.

5. In Section C.6.3, Table C9, under the guidance on decision node, "All Cues As Stated?" states: "If the instrumentation is considered to be fully impacted by fire then the no branch should be used.

   If the instrumentation is considered to be partially impacted or not impacted by fire then the yes branch should be used."

   It would seem that unless all control room instrumentation is unaffected, the NO branch should be selected. That is, not all cues are as stated if even partial instrumentation impact is present. (Similar to Item 2 above concerning Section C.5.)

   Furthermore, the way this guidance is written now, it appears to be addressing an issue that has already been addressed in PcA, which is whether or not the instrumentation is impacted by the fire. For fires, it may be difficult to distinguish between instrumentation

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availability and accuracy. It may be worth considering if this node should be deleted or if it should be reserved for phenomena that would impact the instruments beyond what is expected from a fire event or something that is not necessarily related to the fire event.

6. Exelon believes the NUREG-1921 approach for applying increased execution stress multipliers to be overly simplified and conservative, and does not fully allow detailed consideration of the context of the given HFE scenario. There is no mention of considering the time available for recovery and the PSFs are treated as having equal impact. This approach appears inconsistent with other areas of NUREG-1921.

   As examples:

   1) Section C.6.5.2, Execution Stress, states: For existing EOP actions, the (execution) stress levels should always be increased to a minimum of high stress.

      This statement appears too conservative. It does not account for the time available for recovery in the given fire scenario. High stress is usually applied for both bad PSFs and high workload. However, if there is substantial time available for recovery, then the workload could be considered low and a high execution stress level could be considered to be too conservative. A moderate stress level might be more appropriate (X2) for negative PSFs and extensive time available. Stress level is also related to fire severity, since the less severe the fire (the more localized the damage) the lower the operator burden and the higher the available recovery.

   2) Section C.6.5.2, Execution Stress, also states: For fire response actions, a **high** stress level should be used if any of the execution PSFs are negative. A **fire** stress level should be used if more than 2 execution PSFs are negative.

      Again, if there is extensive time available for recovery, and there is only one negative PSF, then the automatic increase in stress to "high" might not be warranted.

   PSFs are varied and should not be treated equally. "Smoke" alone could warrant an increase to fire stress whereas the requirement for tools that are readily available to the operator, such as a locked valve key, would not likely warrant an automatic increase to high stress.

   The PSFs for any given scenario should be assessed on a case-by-case basis without the generalization of assigning a multiplier of 2 if any two negative PSFs occur.

   For some actions, the internal events version of the action already has two negative PSFs. It is not clear if the analyst is expected to increase the execution error if the fire scenario does not introduce any new negative PSFs.

   Also, if accessibility is limited, then that would be sufficiently addressed by an increase in manipulation time (Tm) alone to cover the increase in transit time. As long as access is not prevented, the manipulation error could be the same as that for the internal events action, assuming that no new negative PSFs were introduced by the fire scenario.

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The example HEP calculation at the end of Appendix C assigns high stress because, "Due to the fire and the spuriously opening of valves the plant is not responding as expected." Yet the cue for the action occurs at 180 minutes and the fire location does not impact the operators from reaching the execution location. Based on Appendix P of NUREG/CR-6850, it is assumed that most fires will be extinguished or contained within 65 minutes of the start of the fire. If the given operator action is not necessary within the first 65 minutes (which is the case for this action), the fire can be assumed to be out and thus not continuing to cause delayed spurious activity and other late-scenario complicating disturbances. (The previous sentence is quoted directly from NUREG-1921 - Appendix G and Section 5.1.1.3.) For HFEs where there are several hours available after reactor trip to perform the action, it is assumed that the action is time independent of the fire, and fire impacts will have very little if any effect on the operator performance. (The previous sentence is quoted from NUREG-1921 - Section 2.4) The SPAR-H execution ratio for this action is over 4. A high workload assessment (x5) appears excessive unless that execution stress matches the execution stress applied in the internal events version of the action.

Appendix D - Detailed Quantification of Post-Fire Human Failure Events Using ATHEANA

Exelon believes that this Appendix does not contain much useful guidance on how to use ATHEANA.

Editorial comments

Section	Issue	Proposed resolution
Page xx: Summary Results – last sentence	"This fire HRA methodology is intended to provide an in-depth, realistic way to account for the key fire-induced influencing factors that determine the ***probability of failure of those*** human actions needed to prevent core damage or large early releases."	Exelon recommends that the bolded text be added.
Section 3.2, Step 3, Page 3-3	A minor editorial point: Step 3 includes the statement: "For this identification step, it is important that the internal events HRA meets ASME category II and a review of plant procedures had already been completed for the internal events model." However, that is not necessary for the identification task (HR-E1), which is the same across all categories.	Exelon recommends removing the requirement for CC II.
Section 3.3.5, Page 3-7	Is it true that manual actuation is part of the HRA task and not included in fire suppression curves? This is not addressed further in this document.	

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Section 3.6:	The statement: "Once the operator action has been identified and the HFE defined, the HRA analyst needs to initially determine if the HFE is feasible. "	Exelon suggests that the statement be rewritten as follows: "...determine if the response is feasible." Since an HFE is a PRA model artifact, feasibility of actions should precede the definition of the HFEs. The correct order should be: • Identification of responses • Assessment of feasibility • Definition of HFEs
Section 4.2, Page 4-1	Exelon requests further clarification whether CC II is needed in HR-F2 for the scoping analysis. The only difference between the requirements for CC I and CC II is that in the former an assessment of complexity is needed whereas for the latter a high level task analysis is required. In practice, there's probably little difference except for documentation.	
Section 4.2.7, Page 4-4	Another example of the tone of the report: "The fire location must be identified and any changes to the operators' work environment must be considered." The HEPs are being evaluated for HFEs for defined fire scenarios. For each scenario the fire location is known; therefore, the fire location has been identified.	Exelon does not believe that this sentence is necessary.
Section 4.3.1, Page 4-6	"NUREG-1852 [6] notes that, in addition to the SSCs needed to directly perform the desired function, instrumentation and cues needed to provide diagnostic indications (either EOOs or EOCs) relevant to the desired operator manual actions."	The parenthetic remark seems out of place.
Section 4.3.2, Page 4-9	Exelon requests further clarification concerning the following quote from NUREG/CR-6850: "Potential fire growth and suppression could alter equipment failure considerations from those considered for internal events."	If this is considered important, possibly because of the relative times to failure of certain pieces of equipment, it should be clarified.
Section 4.5, Page 4-20:	Quote: "Discussion with operators can often reveal that there are "informal rules" among operators about which even the training staff maybe unaware."	Exelon considers this to be assertion and believes a recharacterization of the statement to be appropriate.

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Section 5.1.1.3, Page 5-6	For Set 3 the guidance for long term responses states "set the HEP to 0.1 for screening or 10 times the internal events HEP", with no qualifying clause.	Presumably the qualifying clause should be, "whichever is the greater."
Section 5.2.6, Page 5-23	Why is Figure 5-2 called a search scheme? It is a selection scheme based on the HFE characteristics. Quote: "The search scheme (Figure 5-2) uses **pertinent** (emphasis added) questions in determining which action is being quantified and directing the analyst to one of the following flowcharts:"	Exelon recommends changing the title of the figure.
Figures 5-3 through 5-5:	Action time is not really clear, and it should be as clear as possible.	Exelon believes a better term would be "available time" or "time available for action," and it should be clear that this is measured with respect to the time the cue is received.
Section 5.2.6.2:	Exelon believes that this is guidance for the scenario developer rather than the HRA analyst per se.	
Section C.1, Paragraph 2, Sentence 2:	Exelon believes that the text is implying that post-initiators are latent errors, which it should not do.	
Section C.4 First Bullet:	T_{SW} is defined as the time from the reactor trip to an undesired endstate while the next bullet defines T_{delay} as the time from the start of the fire until the cue is reached. T_{delay} should probably be defined to begin at reactor trip as it is for T_{SW} to be consistent with the figures.	