MCR Abandonment Illustrative Examples
July 2, 2013

Overview

A dialog was started between industry and the USNRC regarding evaluation of the reliability of MCR abandonment following fire. This document captures those items agreed upon, and takes the next step requested by the NRC – to define illustrative examples of MCR abandonment scenarios where a failure probability of 0.1 is bounding.

Objective

One of the initial NRC questions was - what was the objective of the FAQ? From the industry perspective FAQ 13-0002 originated from the NRC's list of issues that they were generating RAIs in the FPRA portion of the NFPA 805 LARs. It would be useful to know what the NRC's objectives are for this FAQ.

NRC's objective for this FAQ is to support its review of the evaluation of the ASD transfer and execution of the plant shutdown upon MCR evacuation. It has become clear to NRC that this issue needs to be further addressed to ensure the success of its NFPA 805 review, and of industry's response, to move forward efficiently in the NFPA 805 review process. A quick response is needed in this issue due to NFPA 805. This resolution is not limited to NFPA 805, but the immediate need is to support NFPA 805 reviews.

Approach

Industry and the NRC discussed during a call in June that the detailed HRA portion of the FAQ could be divided into three categories of HRA considerations, each with varying degrees of difficulty/discussion needed. Industry then asked the NRC to take a look at the FAQ and see if the agreed with the following categorization, and please identify NRC concerns and considerations within each group (with the suggested primary focus on loss of habitability).

1. Scenarios where MCR Abandonment credit is not feasible – based on NRC comments there seemed to be no comments on this group. It was suggested to skip this group and focus on the loss of habitability as no NRC comments were expressed.

2. Loss of Habitability – Since the decision to abandon is "given" for this group (agreed to in 6850, 1921 and the FAQ) then this should be the group to focus the discussion on first (due to difficulties associated with the decision to abandon). Within this group, there are 2 sub-groups as follows.

   NRC agrees that the decision to abandon is much simpler upon LOH considerations than for LOC. NRC will be making decisions on LAR submittals very soon, and requires a set of criteria to make that decision very soon to meet its schedules. To meet that need in this process, NRC proposes a simplified approach for remote shutdown operations. ***For LOH, it proposes that NRC and industry discuss those remote shutdown operations that would lead to, at most, a 0.1 failure***

probability. NRC needs examples of abandonment scenarios with the identification of actions needed, including those away from the ASD panel to accomplish this shutdown. These examples should distinguish between different ASD panel capabilities; so that it can work in this collaborative process to identify what characteristics of remote shutdown operations meet the 0.1 failure probability. 0.1 would be the lowest failure probability associated with remote shutdown operations in this approach. By identifying those types of remote shutdown operations that would meet these criteria, other sets of operations can be compared to these criteria and assigned a 0.1 as appropriate. In this vein, it invites those fire protection engineers knowledgeable of these operations to participate fully in this activity. NUREG-1921 supports failure probabilities greater than 0.1 and as such could be used for more complicated remote shutdown conditions.

The industry response to this request builds on the summarization provided in item 2i below, as further delineated in the attached tables. Once this approach is agreed upon, the discussion will shift to item 2ii below then Loss of Control (item #3).

i. Scenarios where no SSCs are affected and no spurious component operation (the "simplest" MCR Abandonment case). Since the cognitive decision to abandon is given, the primary HRA concern is the number of critical tasks (execution actions) and the amount of coordination/control needed for these actions. Traditional HRA methods deal well with the modeling of critical tasks (execution actions). The issues of Complexity, Communication and Coordination are captured via timing impacts, stress and the number of critical tasks. For example, additional coordination/control issues come through in the quantification using existing HRA methods in that the manipulation times are longer (e.g. if tasks are accomplished in sequence vice parallel, or if limited by staff such that it takes longer to complete all tasks, or if there needs to be a hold point for coordination/briefings) and/or the number of critical tasks is larger (e.g. if establishing a series of local shutdown panels vice 1 RSP). From a feasibility standpoint, these tasks are the proceduralized, trained, and timed via JPMs (typically). These types of examples can be added to ensure the issues are addressed appropriately. Agreed? Comments?

ii. Scenarios where SSCs are affected and/or spurious component operation occurs. For example, fire in the MCR panel with the electrical plant controls causes LOSP and SBO, or fire in the panel with the primary relief valves causes a spurious RV opening. This group of scenarios is more complicated than group "3bi" above since it starts with the same "base case" set of required operator actions but then adds additional demands for actions such looking for additional electrical power sources or isolation of a primary relief valve that spuriously opened. Even though this group is more complicated, the FAQ and associated HRA process is similar to "3bi" above. The additional actions to respond to fire-induced SSC failure or spurious component operation become additional critical tasks, and addressing these tasks must be integrated into the response with the other actions in the "base case". For example, the isolation of the spuriously opened primary Relief Valve must be accomplished by a certain point in time and this action may then mean that other actions are accomplished later. Thus, the issues of Complexity, Communication and

Coordination are still captured via timing impacts, stress and the number of critical tasks. Agreed? Comments?

c. Loss of Control - Since the modeling of these scenarios is more controversial, I suggest focusing on the loss of habitability first. Once we are in agreement on the loss of habitability, here are key issues to address in addition to those identified for loss of habitability.

For LOC, the simplified process would put forth a probability of 1.0 for failure to perform remote shutdown operations. Credit for a lower failure probability would require a detailed HRA for transfer and execution, as timing and other aspects of the analysis would be more complicated than for LOH

Background from NUREG-1921

The proposed approach to addressing this issue builds on the guidance of NUREG-1921, which developed the screening guidance of NUREG/CR-6850 into the scoping and detailed Fire HRA quantification approaches. So the first step is to understand what NUREG-1921 says with respect to using an HEP of 0.1 for MCR Abandonment.

NUREG/CR-6850 suggests that the use of a single overall failure probability value to represent the failure of reaching safe shutdown using alternate means can be used if the probability value is evaluated conservatively and a proper basis is provided. It notes that this approach is consistent with what used in several IPEEE submittals and that in many cases, 0.1 was used as a point value estimate for the probability. Additionally, section 5.1.3 of NUREG–1921 (July 2012) further supports the use of 0.1 as follows

> *NUREG/CR-6850 [1] suggests that the use of a single overall failure probability value to represent the failure of reaching safe shutdown using alternative means can be used if the probability value is evaluated conservatively and a proper basis is provided. It notes that this approach was used in several IPEEE submittals and that, in many cases, 0.1 was used as a point value estimate for the probability. Before crediting this approach, the analyst must have applied the criteria discussed in Section 4.3 for assessing the feasibility of the operator action(s) associated with that HFE.*

Section 4.3 of NUREG-1921 describes feasibility assessment and consideration of the following items, which the plant meets as described in the subsequent text.

- Required actions are proceduralized or skill-of-the-craft
- Operators are trained on the required actions
- Necessary and sufficient cues and indications are available
- Sufficient manpower is available
- Required tools and parts are available

- Areas where actions are required are accessible
- Sufficient time is available to perform the required actions

Illustrative Examples of 0.1 HEP

The approach taken in the illustrative example is summarized below.

- Use the general HRA process and factors defined in NUREG-1921
- Identify the simplest MCR Abandonment fire scenario, including the PRA context and the associated operator actions needed to reach and maintain a safe and stable condition.
- Define the critical tasks related to achieving safe shutdown.
- Qualitative analysis – review information available from the feasibility analyses, which address the factors listed in Section 4.3 of NUREG-1921.
- Quantification – conduct quantification to evaluate the resultant HEP.

Identification. The simplified MCR abandonment scenario is represented by a back-panel fire where no SSCs are fire damaged and there are no spurious component actuations. The back-panel fire is likely to make up about a majority of the MCR ignition frequency from fixed sources.

Definition. There were 5 critical tasks identified for consideration. These are listed in Table 1 and are defined as functional tasks. The actual number of critical steps, and the time associated with completing these tasks will vary from plant to plant depending on their safe shutdown strategy, staffing, and construct of the MCR abandonment procedure.

Table 1 Fire in Back Panel of MCR (no SSC impacted, no spurious) Leads to MCR Abandonment on Loss of Habitability							
Performance Influence Factor	**Task 1 Decide to Abandon**	**Task 2 Isolate MCR**	**Task 3 Establish Remote Instrumentation**	**Task 4 Restore/Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Conditions Where HEP > 0.1**	**Notes**
Procedure	Yes	Yes	Yes	Yes	Yes	Procedure not available or not used	Procedure is the MCR Abandonment procedure.
Training	Yes	Yes	Yes	Yes	Yes	Training conducted more infrequently than biannually	If Job Performance Measures used, then this clearly documents training and timing.
Cues/Indications	Yes, smoke	Yes (Note 3)	Yes (Note 3)	Yes (Note 3)	Yes (Note 3)	Cues not attended to	
Staffing	Yes	Yes	Yes	Yes	Yes	Expect staff limitations to result in a longer time required to complete each task.	Some plants take from MCR staff for Fire Brigade; and some plants have additional staff (beyond the minimum complement).
Tools/Parts	N/A	Available (if needed)	Available (if needed)	Available (if needed)	Available (if needed)	Available (if needed)	
Accessibility	N/A (Note 1)	Accessible	Accessible	Accessible	Accessible	Accessible	
Communications	Available	Available	Available	Available	Available	Expect comms limitations to result in a longer time required to complete each task.	
Additional Notes Regarding the Tasks	Critical task but the HEP is negligible in this simplified case.	Non-Critical Task for a back-panel fire.	Critical task. Plants with RSP have 1 step in this task, and plants with several remote panels have more steps.	Critical Task	May or may not be a critical task depending on the plant.	Only when the tasks are not feasible, or can only be accomplished without any margin will the HEP exceed 0.1	"Tasks" taken as functional tasks. For the simplified case we will assume and evaluate the equivalent of 4 HFEs representing 1 for each task.

Table 1 Fire in Back Panel of MCR (no SSC impacted, no spurious) Leads to MCR Abandonment on Loss of Habitability							
Performance Influence Factor	**Task 1 Decide to Abandon**	**Task 2 Isolate MCR**	**Task 3 Establish Remote Instrumentation**	**Task 4 Restore/Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Conditions Where HEP > 0.1**	**Notes**
Timing	3 timing elements for each task	3 timing elements for each task	3 timing elements for each task	3 timing elements for each task	3 timing elements for each task	If the Time Required Is close or equals the Time Available	Note 2
1) Time Available	Note 4	Note 4	Note 4	Note 4	Note 4	If the Time Required Is close or equals the Time Available	From T/H calcs
2) Time of the decision abandon							
3) Time of Cue	Note 4	Note 4	Note 4	Note 4	Note 4	See Time Available	Part of Time Required, represents a time delay for detection, diagnosis and decision-making,. For each task it is the time to reach the associated procedure step (the cue for that task).
4) Time to Execute	Note 4	Note 4	Note 4	Note 4	Note 4	See Time Available	Part of Time Required, includes transit time plus time to obtain tools and/or PPE.

Notes:

1. While initially accessible, the accumulation of smoke leads to inaccessibility resulting in MCR evacuation.
2. Since no SSCs are impacted, this fire results in a reactor trip with a transient loss of decay heat removal. There is not a SI actuation signal nor a loss of offsite power.

3. Given the decision is made to abandon, a MCR Abandonment procedure step is the cue for this task.
4. Will develop a table using HCR/ORE showing various Time Available and Time Required to identify 0.1 breakpoints.