

Severe Accident Issue Resolution -- Definition and Perspective

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Introduction

The purpose of this discussion is to introduce the session on the Progress on the Resolution of Severe Accident Issues. There has been much work in the area of resolution of severe accident issues over the past few years. This work has been focused on those issues most important to risk as assessed by comprehensive studies such as NUREG-1150.¹ In particular, issues associated with early containment failure have been analyzed.

These efforts to resolve issues have been hampered by the fact that "issue resolution" has not always been well defined. The term "issue resolution" conjures up different images for the regulator, the accident analyst, the physicist, and the probabilist. In fact it is common to have as many different images of issue resolution as there are people in the room. This issue is complicated by the fact that the uncertainty in severe accident issues is enormous. (When convolved, the quantitative uncertainty in an integrated analysis due to severe accident issues can span several orders of magnitude.) In this summary, hierarchy is presented in an attempt to add some perspective to the resolution of issues in the face of large uncertainties. Recommendations are also made for analysts communicating in the area of issue resolution.

Issue Resolution

There has always been a strong desire on the part of the reactor safety community to achieve resolution or closure on a number of issues. In 1976, the Nuclear Regulatory Commission directed the staff to develop "a program plan for resolution of generic issues." In 1978 the "Program for Resolution of Generic Issues Related to Nuclear Power Plants" was issued in the Federal Register.² A systematic process for resolution of generic issues is laid out in NUREG-0933.³ The procedure to be followed is provided in RES Office Letter No. 3.⁴ Typically, the information for resolution comes from experience data, experiments, tests, analyses, and probabilistic risk assessments (PRAs).

A systematic issue resolution approach has not been available for most severe accidents. Table 1 presents a systematic issue resolution hierarchy. One would attempt first to achieve resolution at the top of this hierarchy, and go to the next level if necessary. (The last two entries, legal and political resolution, should not be considered part of the hierarchy, but are presented for completeness.)

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Table 1. Issue Resolution Hierarchy

<i>Level of resolution</i>	<i>Example of qualitative definitions of resolution</i>	<i>Examples of quantitative definitions of resolution</i>	<i>Examples of issues in which arguments of this type have been made that the issue is resolved</i>
Deterministic resolution	Bad event is physically impossible	Noncontroversial deterministic analysis proving beyond a shadow of a doubt that event cannot happen	Nuclear reactor cannot explode like a nuclear weapon
			Alpha mode containment failure
Probabilistic resolution	Bad event is improbable	Probability of event < 0.5 (best-estimate calculation)	Direct containment heating (conditional containment failure probability < 0.1)
		Probability of event < 0.1 (this could refer to the median of a set of calculations performed with a model that includes parametric uncertainty considerations, but excludes model uncertainty)	Mark I liner melt through when there is an overlying water pool (due to thermal interactions that impede transport and liner failure)
		Probability of event < 0.01 (this could refer to the subjective 95% value convolved distributions received from a group of experts and includes all types of uncertainty)	
Risk-based resolution	Bad event does not contribute significantly to societal risk	Core damage frequency is < 10^{-4} including event in question	Core-concrete interactions (if the risk metric is early fatalities)
		There are no early fatalities even when event in question is considered	Mark I liner melt through when there is an overlying water pool (due to attenuation)
Resolution by backfit	Change design to eliminate or mitigate bad event	Analysis fails all of the above attempts at issue resolution	Hydrogen issue
			Hardened vent Pinto gas tank
Legal resolution of technical issues	Issue deemed resolved by a court of law	Consensus of a group of nonexperts after listening to expert testimony	Malpractice suits
			Exxon Valdez
Political resolution	Issue deemed resolved by organization or representatives of populace	Consensus of group of consultants	Most identified issues

Recommendations

Prior to the issue resolution process, it is important to specify the following:

- What process is acceptable for issue resolution. Table 1 presents several levels of issue resolution in the order that they should be considered. If one can solve the issue deterministically, one does not have to invoke the additional probabilistic perspective or the more global risk perspective. The deterministic resolution of an issue (in which it is definitively shown that a particular bad event cannot happen) is the most satisfying. Unfortunately, it seems that issues such as these are rare. Therefore, it is necessary to specify the process that one will go through up front: will the analyst go straight to backfit if the issue cannot be resolved deterministically or will the analyst first consider the deterministic, second the probabilistic, third the risk-based resolution, and then finally backfit in a systematic search for resolution?
- What is the quantitative measure of issue resolution that will be used?
- What type of uncertainty analysis is acceptable when providing the quantitative measure of issue resolution? Is there enough confidence in the current set of models to neglect modeling uncertainty?

¹ NUREG-1150, "Severe Accident Risks, An Assessment for Five US Nuclear Power Plants," NUREG-1150, US Nuclear Regulatory Commission, June 1989.

² Federal Register Notice 43 FR 1565, "Program for Resolution of Generic Issues Related to Nuclear Power Plants," January 10, 1978.

³ NUREG-0933, "A Prioritization of Generic Safety Issues," US Nuclear Regulatory Commission, July 1991.

⁴ Memorandum for R. Fraley et al., from E. Beckjord, "RES Office Letter No. 3 Procedure and Guidance for the Resolution of Generic Issues," May 10, 1988, (Rev. 1) December 21, 1988, (Rev. 2) March 27, 1989.

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