NRO Staff Concerns About USAPWR Chapter 19 Material on Level 2 PRA and Severe Accident Evaluation

Office of New Reactors

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Background

- Staff has completed an initial review and sent the requests for additional information, including nearly forty questions.
- About 35 responses have been received.
- Most responses appear to be satisfactory, but the NRC Staff has a number of major concerns.

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Major Concerns About Some Severe Accident Progression Assumptions (Ch. 14 of PRA)

- The assumptions do not always follow the APWR PRA's own description of the dominant and expected phenomena.
  - For example, issues such as geometry and scale-dependence of detonation are discussed; nonetheless, it is stated, the geometric effects cannot be incorporated into the detonation criteria.
- Use of NUREG-1150 and supporting documents, which are about 20 years old, need to be put into more recent context. Neglecting recent work is not acceptable
  - See discussion of RAI question 19-159

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Major Concerns About Some Severe Accident Progression Assumptions (cont.)

- The technical bases for some of the Level-2 PRA assumptions are not always fully stipulated or justified.
  - It is stated that hydrogen release behavior under hot leg creep-rupture conditions is the same as for LOCA events. Why?
  - It is stated that hydrogen does not accumulate under SGTR accident. What about under SBO-induced SGTR accident?
  - Even though creep rupture of RCS is predicted in high-pressure accidents, the depressurization by blowdown through the point of rupture is not actually simulated. Why not?
  - Heat removal by natural convection to fan heat exchangers is assumed to be the same as fan forced operation. Why and on what basis?

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Other Major Concerns

- In some cases, the intent of RAIs is not understood. For example, the RAI on the impact of instrumentation tube failures on RCS and containment response was misunderstood.
- Reference is often made to the work of a specific individual without actually including the source in the reference list (e.g., response to RAI 19-153 (c) refers to “Walker model”).
- 10CFR50.44 is intended to guide need for combustible gas control in light-water-cooled power reactors. The submittal and the responses to RAIs are not clear on the rate, the time, the composition (including steam, oxygen, etc.), and the location of hydrogen release into the containment for combustion analyses.
- Specifics of the GOTHIC code used for hydrogen distribution analyses, are not provided. Furthermore, reasons for not considering the MAAP information have not been provided.
  - MAAP has been successfully benchmarked against HDR E11.2 test. We need to see a similarly successful benchmark for GOTHIC.

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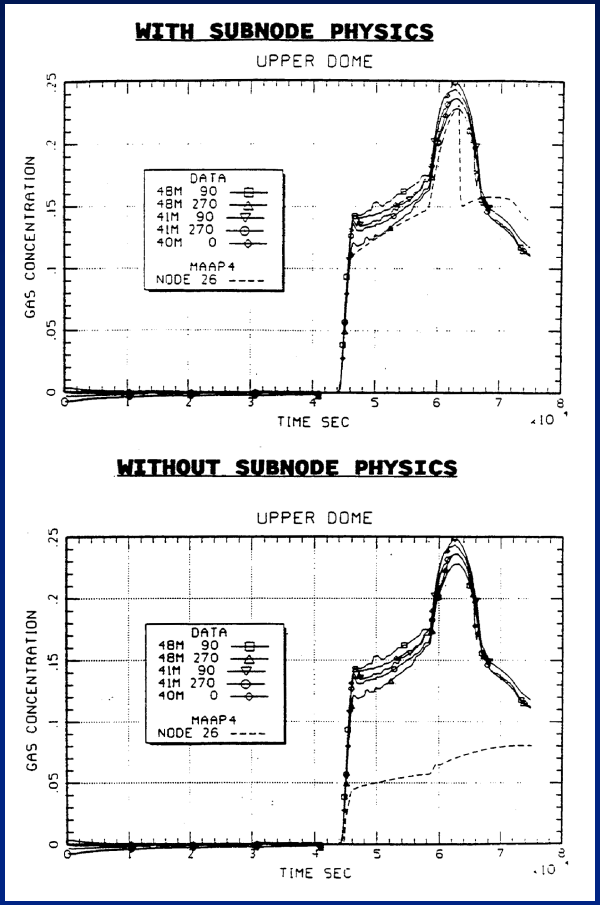
MAAP4 Calculations of Hydrogen / Helium Concentration in the Upper Dome, With and Without Subnodal Physics Model for Thermal Stratification (HDR E11.2 Hydrogen Mixing Experiment)

From Subroutine AUXFLO-Rev 2 Description in the MAAP4 Users Manual. The subnodal physics model is also described.



Basis for AUXFLO Model: Epstein, M., and Kenton, M., 1989, "Combined Natural Convection and Forced Flow Through Small Openings in a Horizontal Partition with Special Reference to Flows in Multicompartment Enclosures", J. Heat Transfer 111, p. 980.

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Problematic RAI Response: Question 19-159

- The problem is that NUREG/CR-4551 is outdated and that much significant work has been done since then. This work should form the basis for evaluating induced steam generator tube ruptures.
- The choice of a 1/3, 1/3, 1/3 split for TISTGR, hot leg rupture, and no rupture is arbitrary, and may not be conservative. Methods now exist to more accurately do the required analyses. Reference to these methods was made in the question.
- The question asked for an updated analysis based on the new work, but none was provided with the response.

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Problematic RAI Responses: Question 19-160

- The answer to Question 19-160 merely speculates that the core debris may temporarily be solidified. An analysis is required to support the statement.
- There is also a mistaken notion that the statement in Generic Letter 88-20 that refers to maintaining less than a 25 cm deep debris pool to assure coolability. In fact, an analysis is required to show this.
- Given the fact that all of the core debris may not be relocated from the RPV into the cavity all at once, it is necessary to assess the potential impact of melt entry into the cavity over discrete times and with fixed quantities, and if this could impede uniform spreading over a large surface area.

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Problematic RAI Responses: Question 19-162

- Contrary to the answer to Question 19-162, it should be noted that there is not yet sufficient data to conclude that an overlying water pool can impede core debris from attacking the concrete.
- The model in MAAP assumes this, but the model in MELCOR does not.
- A test program is still underway to address this issue.
- In doing a Level 2 PRA it should not be assumed that the most likely path is always the success path, especially when there are lingering uncertainties.

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Problematic RAI Response: Question 19-181

- The question was completely misunderstood, so the answer did not provide the Staff with the information needed.
- The point of R. E. Henry's presentation to the MAAP Users Group was that, contrary to the way accident progression is currently modeled, evidence from the TMI accident indicates that hydrogen and fission products escaped from the RCS through very many failed instrument tubes (in the core itself), prior to the restarting of the B-loop pump. This release has major implications for high-pressure core damage scenarios, including:
  - Natural circulation of the high-temperature gases in the RCS may be reduced or eliminated, thus reducing the likelihood of induced steam generator tube ruptures or hot leg creep rupture.
  - A large amount of hydrogen may rapidly exit the RCS at the instrument seal table, allowing for the possibility of a major hydrogen burn if igniters are not close by to allow for a controlled burn.
- The NRC Office of Research has carried out a preliminary analysis of this for TMI-2 and for Zion.