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Dear Cardis:

This is in response to your request for written comments on the Executive Summary for the Containment Loads Working Group (CLWG) Final Report. I believe that you have previously received from Dr. Denning my preliminary markup of the subject document. Please note that the only version of this report that I have seen is hand dated March 22, 1985.

My major concerns with the draft executive summary are twofold. First, this report reaches many conclusions and attributes them to the CLWG even though such conclusions involve matters not considered by the working group. Second, this report does not properly represent the nature and comprehensiveness of the standard problem addressed by the working group; in my view the standard problems were more a test of the methodologies for evaluating containment loads rather than an attempt to determine absolute values for such loads. The draft executive summary also appears to misinterpret some of the results of the CLWG analyses. A number of the latter are addressed in the attached comments. I have had some misgivings about the use of the standard problem results throughout the course of the CLWG deliberations and have previously voiced these misgivings. Specific examples of previously expressed concerns are given below.

> "The second point I would like to bring up is the use that is being (or will be) made of the standard problem results. Initially it was my impression that the purpose of the standard problem was to compare different analysts' approaches to the evaluation of containment pressurization and thus arrive at a concensus approach. In this context it did not matter how the standard problem was developed or if it was really representative of the actual conditions of interest, though the latter is obviously highly desirable. As long as each of the several analysts evaluated the same problem, the individual approaches could be compared on the same basis. I now find that the results of the standard problem are being used not only to establish an acceptable approach to the problem, but the results are apparently being used in an absolute sense to reach conclusions regarding the likelihood of challenges to containment integrity. The latter use of the results of the standard problem is not appropriate since it is not at all clear that the problem as given to us is

A3

A3

uniquely appropriate or even bounding for the reactor design being considered. For example, if more material is included in the corium debris, the peak containment pressures could be higher in those cases that are not water limited. Thus, while analysis of the standard problem is very useful for developing a concensus approach, the validity of the numerical results of the standard problem is subject to considerable uncertainty."[1]

"I continue to be concerned about the application of the results of the standard problem analyses. In particular, I am troubled by statements that containment will or will not fail based on the results of the work of the CLWG. My concern with such conclusions is twofold.

First, the conditions that may lead to containment failure are not well known. Thus, any statement regarding the containment's ability to maintain its integrity must be qualified by the failure criteria assumed. Just what those criteria should be are not at all clear at this time. Incidentally, the containment failure criteria need not necessarily be of a threshold nature. Second, even if the failure criteria were well defined, conclusions based on the CLWG analyses regarding containment failure would apply only over the range of conditions examined in the standard problems. While the parameters considered in PWR Standard Problem Number One are clearly in the range of interest, they are not exhaustive and may not even be bounding. For example, while the standard problem considered all the uranium dioxide and Zircaloy in the active core, the amount of steel exiting the vessel could conceivably be greater than given; one of the key factors affecting containment loads was found to be mass of debris involved. Thus, great care should be used in applying the numrical results obtained."[2]

"While it was the intent of PWR Standard Problem Number Two to focus on the issue of steam spike loadings in subatmospheric PWR containment, our analyses indicate the possibility of significant loads due to hydrogen burning in a number of the cases specified. ... under some conditions specified in the standard problem the pressure loads from hydrogen burning could be comparable or greater than those due to steam spikes."[3]

"As I have previously noted, the work of the CLWG has provided much needed testing and demonstration of the methodologies available for assessing severe accident containment loads. Care should be taken in applying the specific results generated by the CLWG to reach generic conclusions regarding the likelihood of containment failure. While the specific problems treated by the CLWG are clearly representative of situations of interest, it is not obvious that the standard problems considered provide a comprehensive treatment of the important phenomenology and/or boundary conditions. Also, any conclusion regarding the likelihood of containment failure (or survival) necessarily implies some notion regarding containment structural capacity; obviously, the latter were not considered by the CLWG. Or, simply put, the work of the CLWG was focused on containment loads, not on containment response. Thus any conclusions with regard to failure

A3

probability must include additional information; the latter should include an assessment of the comprehensiveness of the CLWG standard problems as well as a definition of containment failure level."(4)

"....As I have previously noted, care should be exercised in the generic application of the specific results generated for the CLWG standard problems. For example, the BWR standard problems of the enclosed report consider the interaction with concrete of only eighty percent of the fuel and cladding in the core. Thus, even in the absence of any other questions, it would not be possible to assess the magnitude of threats to containment integrity without taking into account the effects of the remainder of the core materials. These concerns may appear to be moot for the Mark I BWR containment but may be quite significant with regard to conclusions for the Mark II design. Any conclusion regarding the likelihood of containment failure are, of course, also dependent on the definition of the failure load. The CLWG did not address the latter."(5)

It is, of course, totally appropriate to use the results of the CLWG for the development of insights and conclusions that go beyond the immediate standard problem results. In the development of such generic conclusions, however, the basis for them should be identified and conclusions on matters not considered by the CLWG should not be attributed to the latter. The draft executive summary of the CLWG fails to recognize the limitations of the standard problems that were actually evaluated and is based to a great extent on concepts and levels of containment performance that were not considered by the CLWG. Many of my concerns with the draft of the executive summary of the CLWG Final Report could obviously be alleviated by changes in wording that attribute specific conclusions to the appropriate bases for them. I also have a number of comments regarding the possible misinterpretation of the CLWG standard problems and their results; detailed observations on the draft executive summary are given in the attachment.

Should you need clarification on any of the above, please feel free to contact me.

Sincerely,

Peter Cybulskis

Peter Cybulskis

PC/sm

Attachment

A3

References

(1) January 16, 1984, letter from P. Cybulskis, BCL, to M. Silberberg, NRC, commenting on CLWG meeting minutes.

(2) June 7, 1984, letter from P. Cybulskis, BCL, to M. Silberberg, NRC, transmitting report on PWR Standard Problem Number One.

(3) June 13, 1984, letter from P. Cybulskis, BCL, to M. Silberberg, NRC, transmitting report on PWR Standard Problem Number Two.

(4) April 9, 1985, letter from P. Cybulskis, BCL, to M. Silberberg, NRC, transmitting final report on Ice Condenser PWR Standard Problem.

(5) April 9, 1985, letter from P. Cybulskis, BCL, to M. Silberberg, NRC, transmitting report on Phenomenological Standard Problem for BWR's.

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A3

Comment on March 22, 1985, Draft of CLWG
Final Report Executive Summary

1. While the standard problem methodology was aimed at unambiguous comparisons among the proposed results by the various analysts participating, (p. 2), this goal was unfortunately not always achieved and differences in problem interpretation occurred and, in some cases, persisted to the very end.
2. The principal containment challenge mechanism in SP-2 was the steam spike, not concrete attack as indicated on p. 2. For some of the specific variations of this standard problem, hydrogen burning was also found to be a potential challenge in some of the analyses.
3. It is not at all clear that direct heating "is relevant only to molten corium dispersal following release from a high pressure primary system." (p. 3). I believe that the experiments at Sandia have demonstrated that debris dispersal can take place with even relatively modest primary system pressures. Also, other mechanisms, such as fuel coolant interactions, could lead to the dispersal of the core debris from the reactor cavity.
4. While "a range of potential loads, rather than a single value, was arrived at for each standard problem" (p. 3), these ranges were not necessarily comprehensive or bounding.
5. In the presence of high steam partial pressures self-sustaining hydrogen flame propagation is not believed to be possible. Dispersion of the core debris into the containment atmosphere could, however, lead to oxygen-hydrogen recombination in an otherwise nonflammable environment. Further, SP-1 considered all of the uranium dioxide and all of the Zircaloy in the core, but only a relatively small amount of structural material was assumed to be included in the core debris. More structural material in the debris could lead to larger steam spikes than calculated in this standard problem. Thus it is not at all clear that the values cited (p. 4) are in any real sense "worst possible" or "upper bound" values.

A3

6. There is no basis in the work specifically addressed by the CLWG "that steam-spike-induced failure of the Zion containment should be considered an event of vanishingly small probability" (p. 4). The conclusion itself may be reasonable, but if so, it is based on substantial additional information beyond that generated by the CLWG.
7. The last statement on p. 4 contrasts the inferred conclusion for SP-1 with results from the RSS. The Zion containment was not considered in the RSS and one should not confuse the issue by comparing the Zion-based results for SP-1 with the Surry-based results in the RSS.
8. Bounding case analyses for direct interaction of the core debris with the containment atmosphere would lead to higher containment pressures and temperatures than those cited on p. 5.
9. The postulate (p. 6) that natural circulation within the primary system will lead to the overheating and failure of other parts of the primary system prior to vessel bottom head failure must be recognized as at least somewhat speculative. Further, dispersal of core debris has been experimentally demonstrated as possible at relatively modest pressures; thus even if the above postulate turns out to be plausible, unless the induced failure leads to complete primary system depressurization, the argument may be irrelevant.
10. In discussing cavity designs in subatmospheric PWR containments, it may be well to recognize that the containment sprays, if operable, can also lead to water ingress into the reactor cavity.
11. The discussion of the results for SP-2 largely ignores the potential loadings due to hydrogen burns. At least some of the results for this problem indicated that hydrogen burning could lead to substantial loadings for those cases with minimal steam spikes.
12. The work of the CLWG does not provide a basis for the conclusion (p. 7) that "steam-spike-induced failure of the Surry Containment is an event of vanishingly small probability."
13. The conclusion (p. 7) that "containment failure within the first few hours is still physically unreasonable" is not supported by the

results of the CLWG, particularly considering the results of the direct heating analyses. Also, such a conclusion makes assumptions about the containment strength; the latter topic was not addressed by the CLWG.

14. The contrast of the results of SP-2 with those of the RSS is somewhat ironic. The principal reason for the inferred lower probability of containment failure is the assumed higher failure pressure; the calculated loads are quite comparable to those derived in the RSS. The bases for the assumed failure pressure were not reviewed by the CLWG.
15. Ice condenser containments are not susceptible to challenges by steam spikes only if significant quantities of ice are still available. Accident scenarios in which the ice has melted by the time of such challenges are quite possible.
16. The ability of igniters to successfully accommodate the burning of hydrogen generated during core meltdown accidents is subject to considerable uncertainty. If anything, the specific analyses undertaken by the CLWG raise questions regarding the efficacy of igniters under meltdown accident conditions.
17. The ability of the ice bed to suppress pressure rises due to hydrogen burns (p. 8) is of little relevance if the burns take place in the upper compartment of the ice condenser containment; the latter are the situations that typically lead to challenges of containment integrity.
18. Higher containment pressure loads than those cited on p. 8 were calculated for the Ice Condenser Standard Problem.
19. The last statement (p. 9) under SP-3 regarding possible implications of early primary system failure or operability of igniters is not necessarily correct and may, in fact, be irrelevant.
20. The statement (p. 9) regarding the likelihood of developing large leaks prior to catastrophic failure may have some basis, but not in the work of the CLWG. If it is included in the report, it should be attributed to the proper source and qualified as necessary.

21. The conclusion (p. 10) that "Mark I failure, within the first few hours following core melt, would appear rather likely" should be qualified by explicitly noting the failure level assumed.
22. With regard to the effect of the spreading of the melt on the Mark II floor (p. 10), it should be recognized that such spreading is an assumption; it is also quite plausible that the debris would reamin within the confines of the reactor pedestal.
23. The conclusion (p. 10) that "early failure of the Limerick containment is rather unlikely" is not warranted on the basis of the work of the CLWG. It again implies assumptions about strength of the containment that were not developed by the CLWG. Also, it should be recalled that the definition of SP-5 only considered eighty percent of the fuel and cladding in the active core, and there were some questions regarding the inclusion of the entire core decay heat in some of the analyses.
24. The statements on p. 11 regarding the possible effects of global burns on pressure loads in Mark III containments is totally unsupportable.
25. For many of the reasons noted above, the summary of tables of results on pp. 13-14 are quite misleading. Many of the loadings so-labeled are in no real sense "upper bound" or limiting values and many of the stated conclusions are not necessarily supported by the results of the CLWG analyses.

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