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Dear Mike:

I am enclosing a copy of my comments on the final peer review committee meeting and the IDCOR meeting.

Sincerely,

A. B. Reynolds, Professor
Dept. of Nuclear Engineering
and Engineering Physics

ABR:ph

Encl.

COMMENTS ON JANUARY AND FEBRUARY MEETINGS ON SOURCE TERM
A. B. Reynolds
27 February, 1984

General Comments

The overall approach used by Battelle for the NRC of using mechanistic codes with best estimates for imput parameters and physical phenomena to calculate the source term is appropriate.

Three important uncertainties were identified which the study so far has not had time to address. First is the effect of re-release of fission products from the primary system. Second is the effect of bypass of the suppression pool in BWR's. Third is the effect of blowdown from the reactor vessel in high pressure vessel-failure scenarios such as TMLB'.

Except for these items, the BMI results provide strong arguments for reduction of source term numbers to values close to their calculated results. A number of additional uncertainties have also been identified--as described well in Kress's summary of ORNL/TM-8842 and in the QUEST program. Further research and code development now in progress will add confidence to reductions in the source term. It should be possible to define an interim source term much below the TID-14844 source term, however, based on the BMI results.

It is worth commenting that the BMI (NRC) methods are considerably more sophisticated and more nearly validated than the IDCOR methods. It is not yet known to me whether the IDCOR source term will be lower than the BMI values. Based on the methodology presented by both BMI (NRC) and IDCOR, I have considerably more confidence in the BMI (NRC) methods.

Despite my current belief that, based on the year-long review of the BMI calculations, the source term should be reduced, I am concerned that the QUEST program will make such a warrented reduction politically difficult for some time to come. The fact that the SANDIA scientists presented their results without error estimates may place the NRC in an unstable position in light of the current political atmosphere and the way the media treats scientific material. It is imperative that scientists be sensitive to the way their results will be interpreted, and in this case exploited, by non-scientific political forces; and the QUEST program was not sensitive to this problem. I think that error estimates must be placed on the final QUEST EH and LH release results in order for them to be relevant to the source-term study.

I comment further about the QUEST program below.

Technical Comments

Few technical comments come to mind that have not already been rather fully discussed. Kress has done a good job of listing the uncertainties in his summary portion of ORNL/TM-8842.

There is a large difference in the TMLB' releases between SURRY and Zion because the Zion calculation was not carried out to complete melt-through. This needs to be stated clearly (as a footnote) in Table 7.6 of Volume VI. I suggest quoting the concentration of fission products still airborne in the containment when the calculation is terminated if termination occurs before meltthrough and clearly stating that this is what has been done.

Ed Warmen's argument that the openings in the V sequence in SURRY would be underwater appear to be valid and should be incorporated to reduce the rather high source term for that sequence for SURRY.

Figure 6.29 should be for TMLB'. It was incorrect in the material sent to us.

I was pleased to see the BWR suppression pool bypass being analyzed finally. I agree with Kastenburg's comment that normal leak rates (that bypass the pool) should be added into all previous BWR calculations.

I note from Kress's summary in ORNL/TM-8842 that the conversion of CsI to AgI is not treated in the BMI analysis. The BMI analysis predicts large amounts of Ag vaporized (which is a difference with the IDCOR analysis). According to experiments by Albrecht and Wild of Karlsruhe, results of which were reported at Cambridge (August 1983), a large fraction of the CsI released simultaneously with the Ag may react with the Ag to form AgI, which is insoluble in water. Is the presence of AgI important? Would it form an aerosol and fall out or would it remain airborne? In other words would I in the form of AgI have a greater or less chance of escaping from the primary system and eventually from the containment than the I in the form of CsI?

IDCOR considers attenuation of fission products in auxiliary and/or safeguards buildings. I recall Gieseke saying at the IDCOR meeting that the BMI analysis <u>also</u> accounts for attenuation in the auxiliary building, but I do not see this in any of the analyses except for the AB-β and V sequences. Does this mean that all other containment failures, e.g. δ and γ, are assumed to bypass the auxiliary buildings? IDCOR does consider non-bypass, however, and I wonder if calculations should be made for TMLB'-γ, for example, if the containment failure does lead to transport through the auxiliary building. Then the later PRA analysis can choose probabilities of failure with or without bypass of the auxiliary building.

<u>Comments on the QUEST Program</u>

I am very bothered by the results of the QUEST program. My comments are addressed to my general concern of the potentially adverse effect of the present QUEST EH and LH release results on NRC's source term position rather than specific technical details of QUEST.

To begin with, the whirlwind tour of this very complex program at our final review meeting was simply too fast for the review committee to absorb the results. I thought that I was favorably impressed at the time of the presentation. On reflection, however, I have serious misgivings about the final QUEST results.

The positive thing that comes out of the present QUEST results is the identification of the important uncertainties. The method of working backwards through each code to identify the important parameters and phenomena is good. The division into δ_c and δ_p uncertainties is good. The concentrated effort of many capable people in a short time period was commendable; they accomplished more than I expected.

My disappointment with the QUEST results comes from the propagation of the uncertainties in the EL, EH, LL, and LH cases. Propagation of uncertainties without error estimates or without attention to propagation statistics is unacceptable. Despite SANDIA's arguments that they had no time to do anything different and that their results do have meaning, I disagree with the concept of presenting upper-limit final results as they did.

The QUEST variations of EH and LH lead to source term results far higher than any reasonable regulatory body ought to require for design, siting, or public health considerations. Who knows whether these EH and LH results have 10^{-3} or 10^{-6} or whatever probabilities lower than BMI's base case calculations--which are probabilities to be added on to the already extremely low probabilities for the accident sequences themselves. To me the lack of statistical propagation of the uncertainties and the failure to estimate uncertainties on the ranges of the parameters diminishes greatly the usefulness of the final EH and LH results.

On the other hand, the use of these EL and LH releases in NRC's source term evaluation may make it extremely difficult for the NRC to argue for a realistic and reasonable source term in today's political climate--a consequence which is frustrating since the EL and LH results have little meaning from a scientific point of view. I am convinced that it is unreasonable to base source-term judgements and conclusions on numbers as high as the LH results of QUEST; but if NRC contractors like SANDIA say it can be this bad (for that's what they show in their graphs), it will be dificult for the NRC to defend a reasonable source term against the misinterpretation and exploitation of these numbers that the non-scientific news media will make of them. I think a realistic source term, based on what we now know, is of the order of the BMI calculations--and I expect that future research now sponsored by NRC and others will show that even the BMI numbers are high--but the QUEST high numbers will negate much of what we have learned since TID-14844 in the view of the media and a technically skeptical public.

The EH and LH QUEST results convey a scientifically unrealistic picture of what we know about the source term and should either be excluded from NRC's source term evaluation or replaced with meaningful error-propagation calculations.

Some slightly more specific comments are the following. Over and over again, the limits used by QUEST to test each parameter in each code were excessive. I recognize that these excessively wide ranges were not used in the final EL, EH, LL, and LH calculations, but political activists will certainly exploit these wide limits. Examples are 4000 to 70 000 kg steel and 0 to 80% of the zirconium inventory in the melt in CORCON, 0.002 to 0.99 for the fractional Barium release in CORSOR,

enormous variations in form factors in NAUA, and many others. In NAUA, some of the form factor variations were made apparently just to dramatize errors in treatment of γ and the need for consistency between γ and χ, but the graphs show factors of 50 increases in airborne CsI for $\chi = 4.0$ at 10 hours over the base case and factors of 150 increase for $\chi = 10$ and $\gamma = 3$ at 10 hours. Variations like this throughout the report will make it difficult for the NRC to argue that more mechanistic methods allow a more accurate calculation of source term. Instead these graphs will be used to convince the media that scientist don't know the answers to within factors of 100 and, hence, the mechanistic calculations that should be reducing the source term by a factor of the order of 10 cannot be trusted.

The values used for δ_c variations in the final calculations of LH, EH, etc, are not quite as extreme as the variations used for the individual code sensitivity studies, but they are still large. I do not have the final QUEST release values for Cs and iodine. I do have their Te and Ba curves that show releases up to 85% for Te and 40% for Ba at 10 hours. I don't know what the releases are from, however; the graphs don't say. Are they from the fuel or from the primary system and concrete-core debris region? I hope they are not from containment. If so, it shows how ridiculously extreme the numbers can get without attention to error propagation. In reviewing my copies of the charts shown at the meeting, I cannot resurrect what was being concluded.

I do not have the charts presented for the final release-or containment concentrations-for the δ_p variations. I recall that most of these variations tended to reduce the source term below the base case. It was variations in δ_c, as I recall, that indicated that the source term could be much higher than the BMI results.

Finally, I wish that a writeup of the QUEST results would be sent to the NRC consultants prior to the May IDCOR meeting. I found it difficult to review the QUEST results only from the charts presented at the January meeting.