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Dear Mike:

I am enclosing a copy of my comments on the QUEST study of the Surry TMLB' scenario. I am sorry that I have not had time to do justice to this review. It is very difficult to assess the QUEST study due to its complexity.

Sincerely,

Al Reynolds

A. B. Reynolds, Professor
Dept. of Nuclear Engineering
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ABR:ph

Encl.

Preliminary Comments on the QUEST Study

A. B. Reynolds

I am still unprepared to make significant comments on the QUEST study. I think a meeting of the review committee would be needed to perform an adequate review of the material. There is so much material in the TMLB' report that was sent to us that I am having trouble focussing on the really significant uncertainties. The combined insights of the peer and observer groups might shed the necessary light and provide the perspective required to assess the QUEST results.

A proper assessment of the QUEST study is important. The wide variations in possible results suggested by the QUEST study cast greater doubt on the value of the BMI 2104 results than I think is warranted, but I cannot argue this working alone. On the other hand, if the review committee comes to a consensus that the results are as uncertain as QUEST indicates, then little definition can be said about the source term unless the containment failure working group demonstrates that early failure is not credible.

Despite my lack of time to assimilate much of the extensive work reported by SANDIA, I would offer a few specific comments, as noted below.

Specific Comments

Tellurium Release

The first point to note is that I am perplexed as to where the data was obtained for the solid triangle (SASCHA) data points in Figure A-3. I have plotted the tellurium data points from the SASCHA tests, as noted

in red (open Δ, □, and o's) on the next page, and they are totally different from the data in Fig. A-3. Also I believe there was a factor of 10 error in the plotting of the HI-2 datum. My understanding of the correct placement of this point is also shown on the next page. The NUREG-0772 curve for Te appears to be close to the upper limit of the release rates for the data as I have plotted them.

In Appendix A, and elsewhere, tellurium is included with iodine and cesium as a volatile fission product, and it is argued that the volatile fission products likely are released from the fuel early. Yet I see a factor of three variation in Te releases in Fig. 6-27, from ~ 30% release in most cases to 90% in the late high case. This is nearly as wide variation as Barium (except for the late low case), Technetium, and total mass aerosolized (Figures 6-28, 6-28, and 6-29).

Moreover, the effect of the presence of oxidized versus unoxidized zirconium on tellurium release was ignored, even though this effect has been reasonably well established experimentally.

The suspended Te for the late high case for code-input uncertainty (δ_c) reaches 7 or 8 kg for about an hour period, while only ~ 1 kg is suspended for the base case. (These numbers compare to the total Te inventory of 25 kg.) One notes that 11% of the Te is released to the environment in the Surry, Volume V calculation for the TMLB'-δ_e accident (Table 7.16, Vol. V). This is a high release so that Te may be important for the TMLB' accident. Hence, treatment of uncertainties in Te release data may have important consequences. Does mis-plotting the data on Figure A-3 of the QUEST study have much significance? I find it disturbing if either mis-plotting the data or ignoring the effect of zirconium on Te release has little effect on the final release to the environment.

○ [illegible] Reactor Safety, Gatlinburg TN, page 44, [illegible] (April 1980)
△ Albrecht & Wild, (in air), Topical Mtg. on Reactor Safety, Sun Valley, Idaho (August 1981)
□ Albrecht & Wild, (in steam), " " " " " " " " " "
(3 coincident points at 2400°C)

The SANDIA location for the HI-2 point was a factor of 10 too high. The correct location is 6×10^{-3} at 1700°C.

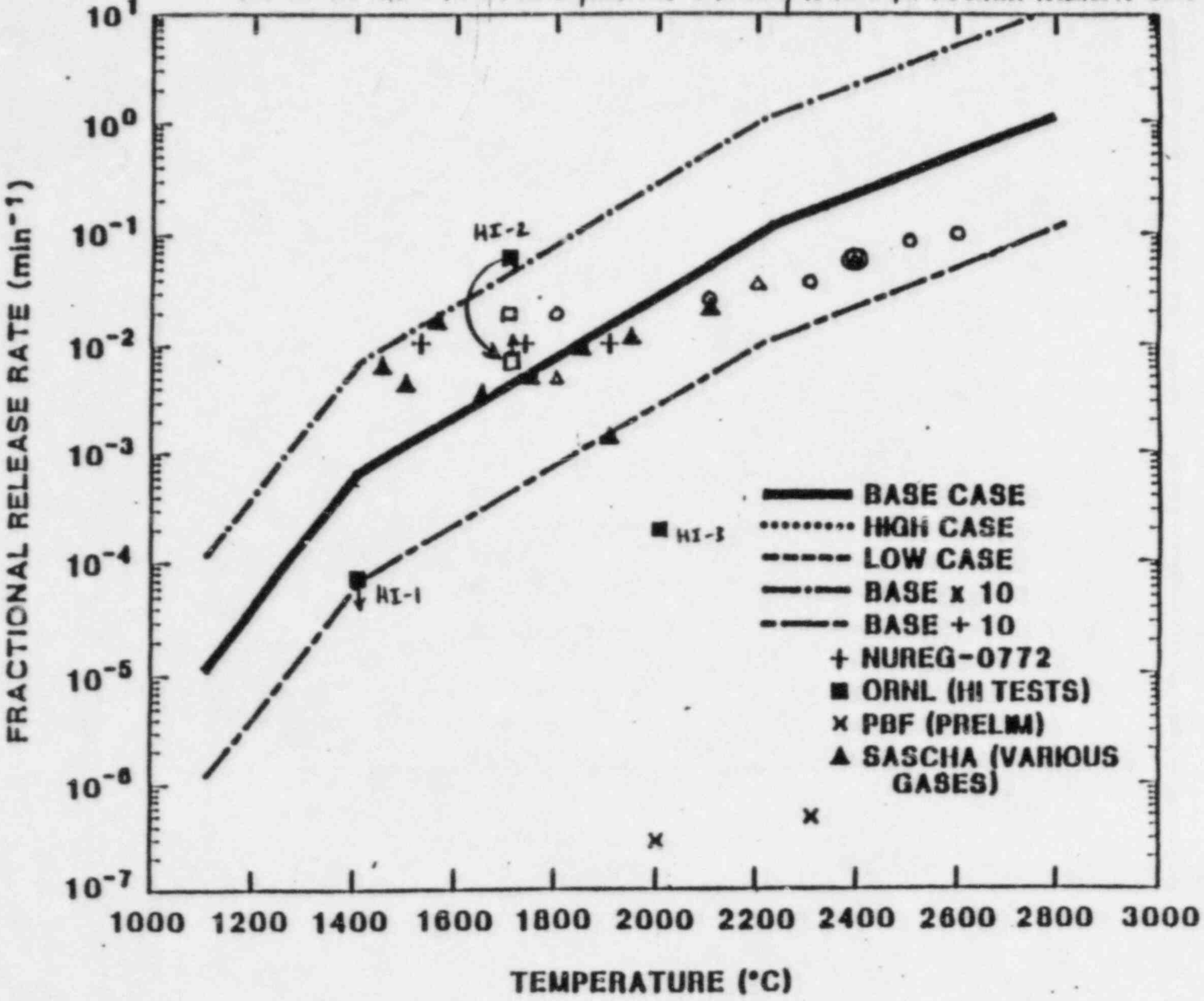

Figure A-3. Tellurium release rates used in CORSOR.

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Next, I note the effect of δ_p uncertainties on Te release. The uncertainties in temperature histories in the δ_p uncertainty section lead to Te release uncertainties similar to antimony, barium, and molybdenum releases (compare Figures 7-3, 7-4, 7-6, and 7-7). Hence Te acts like a low volatility element, not like the high volatility iodine and cesium. These results later propagate to potentially large Te releases relative to the base case (Figure 7-30). Again I question the effect of errors in the basic Te release data (either the mis-plotting or the ignoring of the effect of Zr) on these QUEST results.

Overall Results

I note that the end result of QUEST is not the same as in the BMI study. The BMI analysis concludes with fraction of fission products released from the containment. QUEST does not present this. Based on the QUEST results of fission products suspended versus time, perhaps that ratio can be related to the fission products released.

I note that most of the QUEST results fall below the BMI base case, which is encouraging. However, some of the early failure cases fall much above the BMI case, and some of the high late cases fall somewhat above the BMI case.

Hence, it is difficult to assess the proper source term, especially if early containment failure is possible, without more understanding of the complex QUEST analysis than I now have.

Effect of Natural Convection Velocities

The presence of large natural convection velocities relative to forced-flow steam velocities identified in the QUEST study may be important. This appears to create significant differences from the BMI

analysis. The problem is so complex, however, as discussed in Appendix B, affecting condensation of fission products on aerosols and aerosol settling in the core versus the upper plenum in addition to temperature distributions, that I cannot tell yet how important all of this is. It appears to be quite important--somewhat like the whole problem of resuspension and re-evaporation that was also neglected in the BMI base case analysis.

In the time available to me so far, without a meeting of the entire peer review committee, I have difficulty assessing a problem of this kind.

Uncertainty in Steel and Zirconium Melt Fractions in the Melt

Uncertainties examined in CORCON-VANESSA in both steel in the melt and zirconium melt fraction in the melt are large (4000 to 70 000 kg for steel; 0 to 80% for Zr--Table 4-2). I realize that examining such large uncertainties in one code does not necessarily imply that the MARCH code actually leads to such large uncertainties in these parameters, though I am concerned that some may look at Table 4-2 and wonder that, if our uncertainty range has to be this large, then do we have any confidence at all in what MARCH is telling us?

Therefore I looked at the MARCH uncertainty analysis to see if I could gain any information on the steel and zirconium melt fraction in the melt. So far I have not been able to determine this from the MARCH results. I do note that there is not a large variation in hydrogen generation from the MARCH results. This would indicate that there is not a large variation in the amount of zirconium that reacts with steam. Hence there should not be the tremendous variation in zirconium metal available in the melt.