October 27, 1983
1007 Birmingham Drive
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Peer Review Report

To: Accident Source Term Program Office, RES, NRC.
Attention: M.W. Jankowski and M. Silberberg

Subject: Post Meeting (of Oct. 12-13) Comments and Suggestions Regarding BMI-2104

By: L.R. Zumwalt, Consultant and Professor Emeritus of Nuclear Engineering, N.C.S.U.

The reviewer was greatly impressed by the quantity and quality of the work on BMI-2104 presented by the personnel of Battelle Columbus and also by the studies and proposed work presented by personnel of the Sandia and the Oak Ridge laboratories. On the other hand the reviewer had expected more complete versions of Volumes IV, V and VI than were actually presented but understands there was not time enough by the October 12-13 Peer Review Meeting to complete the required accident sequence calculations and to fully reflect on the results that were obtained. It is understood that a substantial editing effort will be made before draft versions of the report volumes are completed. Specific comments follow.

1. The zero point of time for any figure or table relative to the zero point (start) of given accident sequences should be clear.

2. For a review of the chemical interactions of fission product elements or compounds with surfaces and aerosols in the RCS it is highly desireable to have:

(a) Specification of the material of the surface (alloy composition), mass transfer equivalent area (perhaps, equivalent heat transfer area will do), and surface temperatures of the walls of the control volumes (taking decay heat into account, if possible) as a function of time.

(b) The composition (H_2/H_2O ratio) and temperature of the gas passing through the control volume as a function of time.

(c) The aerosol composition and mass per unit gas volume in the control volumes as a function of time. The composition should include the elements B, Ag, Cd and In from control material in the core or primary coolant. This detail may not all need to be included in the Report Volumes but should be available.

3. Volume IV "bottom line" data (i.e. the total release of cesium, iodine, tellurium to the environment) did not include a comparison with WASH-1400 estimates. Should not this be done?

Rather than make more comments on the details of the report volumes, the reviewer would like to present a look at the "bottom line" data available as of the Oct. 12-13 Meeting.

This is done by plotting on a log-log scale total release to the environment (release fraction) vs. failure time of containment of a given reactor plant accident sequence. In the graph a containment isolation failure release fraction is taken as occuring at a failure time of one minute (rather than zero time, at minus infinity on log time scale). Similarily the release fraction point for a no failure case is placed at 10,000 minutes (167 hours) rather than at plus infinity. These plotting choices are somewhat arbitrary but seem reasonable.

The plotting of total release fraction (RF) versus containment failure time (TCF) was done separately for cesium, iodine and tellurium. The graphs enable the viewer to readily see all the release results for a given fission product. These are well separated due to the sensitivity of RF to type of reactor plant, accident sequence and TCF.

The plot also enables the viewer to get an idea of the reasonableness or uncertainty of RF values. The reviewer believes this is possible because, intuitively from the nature of the physical system and calculational models involved, it would seem that for a given reactor plant and a given accident sequence the functional relationship between RF and TCF should be a smooth curve wherein RF decreases with increasing TCF and approaches an asymptote corresponding to the no containment failure case for the given reactor plant and accident sequence.

Reference is now made to the three attached graphs corresponding to cesium, iodine and tellurium release. A brief study of the graphs indicates the following:

1. The pattern of points and curves for cesium, iodine and tellurium are similar. The differences are due principally to differences in the ch ry of these fission product elements. The similarity of pattern indicates other phenomena independent of chemistry, such as aerosol behavior, are quite important in determining release.

2. Only calculations on SURRY AB cover a sufficient variety of containment failure cases to permit drawing an approximately complete RF vs. TCF curve. For the cesium and iodine graphs the solid curve is drawn as in-between the results of SURRY AB VolumeI and Volume V calculations while the dashed curve is an approximate fit of the SURRY AB Volume V results alone. These latter curves have a shape similar to that given in the tellurium graph which fits both Volume I and Volume V results fairly well. There appears to be an anomaly in Volume V results in that the AB-γ (TCF = 152 min) fractional release (0.16) is higher than AB-β fractional release (7.1×10^{-2}).

3. Two reactor plant, accident sequences had only two points for drawing a segment of the curve. The others have only one. This is immediately

seen by inspection of the graphs.

It is recommended that this type of graph be used to present BMI-2104 results. Also, it is a useful graph for program management: to follow results, check for anomalies and indicate possible need for additional calculations to be made on the variation of total fractional release with containment failure time.