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U.S. NUCLEAR REG. COMM.
ADVISORY COMMITTEE ON
REACTOR SAFEGUARDS

March 12, 1980

MEMO

TO: G.R. Quittschreiber

FROM: I. Catton

SUBJECT: Research Review Panel Meeting on Fuel Melt Research Program Plan, 21 February 1980, Silver Springs

The overall objective of the fuel melt research program is to establish a data base, develop methodology for assessing fuel melt consequences and mitigation feature efficacy. It was comforting to see that advanced reactor and LWR work in this area are being integrated. This step should have been taken several years ago. The results of the review panel meeting should help if the quesions posed by Silberberg are seriously addressed.

The basic plan outlined by Silberberg is reasonable yet weak in several respects. I agree with the observations of J. Meyer about too much emphasis on LMFBR technology and a need for a more mechanistic description (analysis) of the meltdown process during the initial stages. Knowledge of the initial progression of the core melt could be very important if mitigation measures are sought. Crucial questions about how the fuel debris will enter the cavity are not being addressed. Decomposition of the concrete will be different if the debris is spread out by the gases resulting from its decompositon. If water precedes the fuel debris, the stream generation may be sufficient to spread the debris over the entire bottom of the reactor cavity and plug the sump.

I am sure that the fuel melt research program plan will change to reflect the results of the meeting. I have, however, included some comments in the following paragraphs that resulted from reviewing the initial plan.

The Fuel Debris Behavior portion of the plan includes new studies of core debris in water to be carried out at SANDIA. A number of successful studies have been carried out at ANL and UCLA using simulant heating methods. It is not clear that these results will be properly factored in the new task. In the past SANDIA has advocated expensive in-pile tests that could be marginally argued when sodium was the coolant. If water is the coolant, then in-pile tests are not necessary. In fact, sufficient understanding of debris bed cooling in water may exist for safety studies and no further work may be necessary. Before another program is initiated, all available information needs to be assessed. A weakness that does exist is our ability to describe the debris bed characteristics (particle diameters, packing and settling characteristics). Fragmentation is a key question if adequate predictions of the containment pressure and temperature are to be made. I have previously commented on the debris bed in sodium program at SANDIA.

Fuel Melt Interactions with Structure/Soil is an important aspect of core melt research. Task A1218 is important if one wants to describe the melt-down process. In particular, if emphasis is placed on understanding the physical processes a lot will be gained. Fuel fragmentation tests in water should be added to allow answers to questions about the containment pressure spike to be obtained. Low amounts of molten fuel debris per unit area tests still do not appear to be included in the test matrix. Under this circumstance significant penetration may not occur. Task A1019 is development and verification of the CORCON code. It is not clear that it will be of value when used for an LWR as the debris energy density is much lower than that of an LMFBR and the debris will most likely not be molten very long. A critical evaluation of its usefulness should be made. The new study involving interaction of core debris with MgO for use in assessing the FNP ladle should yield useful information if backed up with simulatant experiments yielding physical understanding. It was not clear that this is the case. Bounding calculations can already be made and without further understanding of the physical mechanisms it will be difficult to change our present calculation methods.

Fuel-Coolant Interactions studies appear to be emphasizing steam explosion phenomena over fuel-sodium interaction phenomena. I have previously commented on the SANDIA steam explosion (A1030) and fuel-sodium (A1016) work. The small scale triggering and propagation experiments and the single droplet modeling may yield some understanding but, like studies of turbulence, we will still have to resort to empirical data for engineering answers. It is my view that the large scale integral propagation experiments (task 3 of A1030) should be encouraged as they will yield the needed empirical data as should structural modeling and analysis (task 2 of A1030). In-pile experiments should be discouraged unless well justified. Small scale in-pile fuel-sodium interaction studies (task 1 of A1016) may not prove useful due to scaling effects. The new task to study steam explosion mechanical loading looks like it may be very expensive. A clearer definition of how results are to be obtained and applied to a LWR are needed before comments can be made.

Radiological Source Term investigations are the largest item in the budget and projected to be larger. With the information available (Draft Program Plan) I was unable to sort out the role played by the various codes (HAARM-3, CRAB, CORRAL, NAUA, TRAP and TRAP-MELT) in predicting aerosol generation and transport. The aerosols from an LWR may be different from those expected from a LMFBR but the physics of transport should be the same. I hope separate codes are not under development for the different reactor types. The experimental program seems to be well suited to verify the codes. The need for new experiments at HEDL was not obvious. Questions raised by Silberberg in his meeting announcement clearly need addressing.

System Analysis Codes Development efforts involve improvement of the MARCH and CORRAL codes and development of a containment code designated CONTAIN. It is not clear how TRAP-MELT differs from MARCH and CORRAL as the stated purpose of the codes use in aerosol transport prediction appears to be the same. Further, if we added aerosol transport to CONTAIN it appears as if it would yield most of the information needed. No indication of coordination of the CONTAIN code development with the BEACON code development was given in the task description for CONTAIN.

• Hydrogen Behavior has been the subject of a number of studies by NASA, NBS and others. The program plan does not seem to reflect an effort at bringing available information together for use on LWR containment analysis. For example a compendium of hydrogen hazard information was prepared by NASA a number of years ago-- "Hydrogen Safety Manual", NASA TMX-52454. The NBS abstract bulletin contains hydrogen hazard studies as a subject title. The design of mitigation features requires knowledge of the transport of the hydrogen. In my opinion, this is the weakest link in our understanding of LWR hydrogen hazards. It is not clear where one should put hydrogen detectors or recombiner inlets. Most LWR facilities locate recombiner inlets as if the H_2 was perfectly mixed. Zimmer, however, has located the recombiner inlets at the top of the containment and under the vessel skirt. The question of how well the hydrogen mixes under accident circumstances needs to be a prominent part of a hazards study.