Sandia National Laboratories

Albuquerque, New Mexico 87185

April 21, 1981

Mr. Richard Sherry
Experimental Advanced Safety
Technology Research Branch
Division of Reactor Safety Research
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Rick:

Enclosed are the status reports for the months of January and February for the core melt programs.

Sincerely,

Marshall

M. Berman, Supervisor
Reactor Safety Studies
Division 4441

MB:4441:pr

Enclosure

I. Steam Explosions

During the first two months of 1981, we completed a fourth single droplet test series in which the ambient pressure, P_∞, was varied at a fixed coolant temperature. The results of the experiments indicated that as P_∞ increased the explosivity first increased and then decreased. At moderate values of P_∞ (0.2-0.6 MPa) the bridgewire trigger pressures, P_t, required to induce the explosion decreased from 0.4 MPa to 0.1 MPa. However, as P_∞

was increased further, the required value of P_t to induce the explosion increased rapidly; at P_∞ = 1.1 MPa, a trigger pressure, P_t, of 1.0 MPa was needed to induce the explosion. The reason for the observed behavior is believed to be the competing effects of increased water subcooling and increased ambient pressure. As the subcooling increases, we believe that triggering the explosion becomes easier, overcoming the retarding effect of increasing P_∞. A new test series is now being conducted where the liquid subcooling will be held constant as P_∞ and P_t are varied. In addition, analysis of the experiments is underway.

The second steam generation test, FITS-2G, was conducted in January. This experiment was identical in configuration and instrumentation to FITS-1G, except that the water-melt mass ratio was increased. The planned ratio was 5:1; however, because the graphite crucible unexpectedly failed, only 13.6 kg of Fe-Al_2O_3 melt was delivered to the water resulting in a mass ratio of 8:1. Camera data, while improved from FITS-1G, is still poor due to the presence of steam and water droplets. Preliminary post-test debris analysis indicated that of the 13.6 kg delivered, 43% consisted of large debris particles and the remainder as a large solidified mass. Also preliminary examination of the pressure and temperature data indicated that a hydrogen burn occurred shortly after the melt entered the water pool. The peak pressures and temperatures from the test were quite similar to those from FITS-1G. Analysis of these tests is continuing.

II. Core-Concrete Interactions

Walt Murfin and Dana Powers were given review copies of the draft CORCON-MOD1 topical report/users manual in December. During January and February, we made corrections and modifications to the report in response to their comments and suggestions. Some minor changes were also made to the code to eliminate newly discovered bugs and to modify the printed output.

A copy of the draft report and a tape containing CORCON-MOD1 were given to Loren Thompson of EPRI in January. We anticipate a number of further transmissions of this type in the next few months.

Most of our effort during this period was devoted to an attempt to model the "long-term" interaction. There are two distinct tasks involved in incorporating such a model into CORCON. First, of course, is development of the model itself. Second -- and equally important -- is modification of the existing code to handle the more general relations between variables permitted by the new models. As an example, MOD1 assumes steady state ablation of concrete, so that the ablative heat flux, the concrete recession rate, and the rates of generation of all concrete decomposition products are simply related by time-independent constants of proportionality. It further assumes that all gaseous decomposition products enter the pool up to a body angle of 15° while none enter above this angle. These assumptions are all rather deeply buried in the code. Eventually, transient models will probably have to be used for the concrete, and the possibility considered that a crust will prevent gas penetration. It is important to note that code modifications to relax the restricting assumptions may proceed in parallel with, or even in advance of, development of the more general models.

A major part of the long-term model is the transient heat transfer in and decomposition of concrete. While the USINT code could be used, there are some difficulties. First, extensive modifications would be necessary because USINT does not permit ablation. Second, the existing code is too large (57 k octal) to coexist with CORCON (105 k octal) in CDC7600 fast core and would have to be further enlarged to permit ablation calculations at more than one spatial point. Therefore, we would prefer to develop and use a simpler integral model.

Our first effort in this direction has been a concrete two-dimensional model to predict the heat transfer and downward penetration rate of a hot solid into concrete. The model consists of two parts (i) a 1-D transient model of concrete decomposition and ablation, and (ii) a 2-D quasi-steady model for heat transfer from the solid body to the ablating concrete interface. The model has been used to analyze the solid-steel-concrete interaction test BURN-2. The test results indicated that a solid-steel mass (5 kg @ 1600 K) could melt and penetrate limestone concrete. Post-test measurements indicated an average sideward penetration of 0.9 cm/hr and a downward penetration of 3 cm/hr. The model was used in two ways. First, the downward penetration rate was calculated assuming that no sideward ablation occurred; this resulted in a predicted rate of 7 cm/hr. Second, the average downward and sideward penetration rate was calculated; this resulted in a prediction of 1.5 cm/hr. These preliminary results are encouraging because they are within a factor two of the experimental data. Additional solid-concrete interaction tests are planned for FY82 and it is expected that the model will be used to analyze these tests.

In parallel with this work, we have rewritten the CORCON routines (MASRAT,MASSIN, etc.) so as to eliminate the implicit steady-state assumption. This, incidentally, resulted in a reduction in code size by about 13 k octal, and has given us some insight into a problem observed in MOD1. This is the calculated undercutting, producing a "champagne-bottle-bottom" shape, if the initial cavity has a relatively sharp corner. The experimental evidence suggests that this may not be correct and that a sharp corner quickly becomes rounded. We are trying a modification of the film model in an attempt to eliminate this problem.

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