INTERIM REPORT

Accession No. _____

Contract Program or Project Title: Sandia Core Melt and Separate Effects Program

Subject of this Document: Program Progress

Type of Document: Monthly Letter

Author(s): M. Berman, et al

Date of Document: March 6, 1980

Responsible NRC Individual and NRC Office or Division: R. R. Sherry, Fuel Behavior Research Branch

Prepared for
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

INTERIM REPORT

I. Steam Explosions

The small scale experimental program has shown progress in two areas; (1) The final topical report on the arc melter experiments has been reviewed and is to be printed, (2) The trigger characterization tests are continuing successfully both for the bridgewire and the magnetic pressure trigger. The magnetic pressure trigger has successfully been operated and has produced pressures up to 100 MPa with a pulse width as long as 50 μsec. The pressure pulse is quite reproducible and is one-dimensional, being delivered over the whole chamber cross-sectional area ($\sim$250 cm^2).

During January most of the effort on FITS has been devoted to preparing the interaction chamber and site for the first FITS tests. Some of the chamber hardware was delayed in transit but has now arrived and is being installed. The induction power supply has been checked out and is now ready for oxide melting. An additional exo-FITS experiment was also conducted. This experiment successfully produced a spontaneous explosion for a two kilogram mass of Fe-Al_2O_3 fuel melt. The experiment will be repeated for verification of the explosive behavior.

There have been three major accomplishments in steam explosion modelling: (1) A transient one-dimensional macroscopic explosion propagation model has been developed and is being applied to the exo-FITS and FITS experiments. It has the capability of incorporating many different mechanisms for film collapse, fuel fragmentation, and heat transfer during the transient propagation of the explosion; (2) Analysis of a small mass missile penetration of the concrete missile shield has indicated that the missile, generated by an energetic steam explosion (3000 MJ at head impact), cannot penetrate the concrete shield without being destroyed; (3) Analysis of slug-reactor vessel impact and large mass missile generation is continuing and the energetic steam explosion (3000 MJ) case is to be done in February.

II. Core-Concrete Interactions

CORCON Development

CORCON debugging and checkout activities continued during January. A number of programming errors and modelling omissions were identified and corrected. The most significant accomplishments are described below.

A routine for the simultaneous computation of the mass transport and associated energy transport into and out of each layer was written. This routine, MHTRAN, also updates the total mass and energy of each layer. This was done to facilitate the layer energy conservation computation to provide another means of checking out the code by comparing results from the old and new routines. Code efficiency and maintainability were also improved in that two very similar calculations (originally two routines) are now combined in a single routine no more complex than energy transfer alone. MHTRAN and concomitant routines have been coded, incorporated into CORCON, and checked out.

The melt/gas phase chemical equilibrium computation is being modified to reduce the number of iterations required for convergence. The solution of the linear equations employed in the initial version of the equilibrium model was found to be extremely unstable -- the equations are nearly singular. Differences as small as 2 or 3 bits in the inputs to the computation (such as occurred when the input data computation routine was changed to replace X**0.5 by SQRT (X)) caused changes in the amounts of the trace species (reaction products) of as much as three orders of magnitude, while amounts of the major product species differed only in the fourth or fifth place. This sensitivity of the results to machine procedures would have made it impossible to compare results obtained using two different computers. To rectify this, the linear equation solver was replaced with a Singular Value Decomposition solution algorithm (SVDRS, available in the Sandia Numerical Mathematical Subroutine Library). SVDRS computes a well-behaved, approximate (in a least-squares sense) solution to almost singular linear problems. The use of this algorithm has caused a significant reduction in the number of iterations required for a solution, particularly for the oxide/atmosphere reaction calculations. In addition, the computation time has been reduced by a factor of at least three. An additional benefit of this modification is that it eliminates the necessity of introducing (for computational reasons only) fictitious amounts of elements physically absent.

Work on the simplified model for the atmosphere above the pool concentrated on defining various time varying quantities required for the solution: e.g., atmosphere volume, heat transfer surface areas, and atmosphere pressure and composition. Some of the necessary code modifications were undertaken.

During the month of January the structural drawings for Zion and Indian Point reactors were received from the Nuclear Reactor Regulation Division. From these drawings, and MARCH-CORRAL

calculations at Battelle Columbus, the initial input for a CORCON sample problem was defined for the Indian Point 3 reactor. This sample problem is being run concurrently with the debugging efforts described above. The sample problem was successfully run using a constant melt temperature version of CORCON for one hour of real time.

III. Separate Effects Tests for TRAP Code Development

A. Vapor Pressure Experiments at New Mexico Tech.

Chemical analysis of the completed experiments is proceeding. Progress was temporarily interrupted but has resumed with the personal attention of Dr. Miller.

B. Vapor Pressure Experiments at Sandia Labs.

Transpiration experiments are suspended during construction; however, pure SrI_2 has been prepared. In the meantime small computer programs were written and executed using data from the JANAF tables. These computations support the stability of SrI_2 vapor in steam environments.

C. Fission Products Reaction System

Design and fabrication of the system is proceeding on schedule. This month design work has concentrated on the superheater for producing dry steam.

Bob Sallach is presently familiarizing himself with the lasar Raman spectroscopy system.