Kernforschungszentrum Karlsruhe

Gesellschaft mit beschränkter Haftung

Kernforschungszentrum Karlsruhe GmbH Postfach 3640 D 7500 Karlsruhe 1

Dr. W. V. Johnston
Fuel Behavior Branch
Reactor Safety Research Division
Nuclear Regulatory Commission

Washington DC 20555

U.S.A.

Institut für
Reaktorbauelemente

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Datum: May 23, 1978/de
Bearbeiter: W.B. Murfin
Telefon: 07247/ 82 -3462
Ihre Mitteilung:

Dear Dr. Johnston:

Enclosed is my eighth report, covering the month of April, 1978

Sincerely,

W.B. Murfin
Kernforschungszentrum Karlsruhe
Institut für Reaktorbauelemente

Copies:

Dr. M. Fischer, KfK-PNS
Prof. Dr. U. Müller, KfK-IRB
Dr. D.J. Mc Closkey, Sandia

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1. Introduction.

This is the eighth report of Walter B. Murfin, U. S. N. R. C. representative at Kernforschungzentrum Karlsruhe (KfK), Karlsruhe, FRG. The report covers the month of April, 1978. My principal duties include core/concrete interaction modelling, cognizance of German research efforts, and tasks assigned in Projekt Kernschmelzen.

2. Projekt Kernschmelzen.

2.1. Core/Concrete Interaction Modeling.

The principal effort during April has been involved in updating and simplification of the WECHSL code.

2.2. Fission Product Release.

Work is continuing on the advanced SASCHA facility. The present effort is concentrated on electrical and instrumentation installation and isolation. Work is also continuing on computer code development.

2.3. Large Experiments on the Interaction between Steel Melts and Concrete (PNS 4323).

A series of experiments will be conducted at KfK to investigate the interaction of steel melts with concrete. This program is a joint undertaking with Kraftwerk Union (KWU) and the Technical University of Hannover. The Kernschmelzen Sachverstaendigenkreis and BMFT will provide oversight and advisory input. Temperature regimes up to 2500° C, steel or thermite masses of 100-1000 Kg, and time-at-temperature of the order of 15 minutes are envisaged.

The principal goal of the experimental program is the collection of data for core/concrete interaction code verification, in temperature, mass, size, and material regimes such that extrapolation to a hypothetical core melt can be confidently carried out.

It is not expected that any new phenomena will be discovered in these tests. Code development will be continued so that adequate predictive capability will exist by the time the tests are performed. To this end, model experiments will be performed for code improvement. Ideally, code predictions and test results will agree so closely in all essential particulars over the tested range of temperatures, masses, geometries, and materials, that extrapolation to the larger masses and different materials of a core melt can be made with confidence. Should the results fall short of this ideal, code improvements and normalization will be performed.

Transient tests have been previously conducted both at KfK and in the USA. These tests have been of great value for the identification of phenomena; however the time scale of the tests has necessarily been short. Attempts to simulate these tests numerically have had only limited success. The initial transient conditions (which are not well modeled) have constituted a large fraction of total test time. Normalizing the codes

to such tests does not lead to great confidence. Furthermore, the decrease of temperature has been rapid and the erosion has been quite small. Normal measurement errors thus lead to major uncertainties in the results. In order to verify the codes successfully, nearly constant temperatures, time durations of several minutes, and appreciable erosion depths are required.

Tests have been conducted at Sandia Laboratories in which steel melts were maintained above their melting points by inductive heating. However, the temperature regime covered in these tests was too low for complete code verification in the equally interesting temperature regime of 1800-2500° C.

The KfK program is to be performed in steps. Whether additional steps will be required, and what form they should take, will depend on preceding results. Consequently, only the first step is planned now. A decision on whether additional steps will be required will be deferred until later. If additional tests are needed, the parameters might include greater mass or more realistic materials.

The test program will cover a temperature, duration, and mass regime that has not been thoroughly investigated before. Simulant materials will be used; it is confidently expected that extrapolation to reactor materials can be reliably carried out. Inductive heating will be used at a sufficient power level to maintain the melt at interesting temperatures for several minutes. All relevant parameters - with the exceptions of mass and energy density - will be similar to those to be expected in a core melt. Energy density should not play a major role in these experiments.

Experiments will be performed to determine - quantitatively - the importance of electro-magnetic forces. Although it is believed that these forces will not represent a major perturbation, an alternative heating method is to be developed in parallel, so that comparison tests can be run if it turns out that the influence of the electro-magnetic forces is unexpectedly high.

Because this is principally a code verification program, instrumentation coverage will be exceptionally thorough. Instrumentation will cover melt front expansion, time and location dependent melt temperatures, crust formation, aerosols, gas liberation and composition, pool behavior, mass balances, and concrete temperature and moisture content in considerable detail.

The experimental facility as presently planned will be housed in a steel building; the building will be so constructed that additions can be made if a second test series is required. The concrete melt crucible, which will also contain the induction coils, will be covered by a hood which will contain a large part of the instrumentation. A thermite reaction crucible will be loacted above the hood. Thermite can be ignited either in the inductively heated test crucible or in the upper reaction crucible. In the latter case, either the metallic fraction or a metal/oxide mixture will be poured into the test crucible. The test crucible will be located over a pit provided with tracks and an elevator so that the crucible can

be prepared outside the test area and moved into place for tests.

Following a detrmination of the importance of electro-magnetic forces, fully instrumented tests of steel/thermite melts will be conducted. Masses will be in the range from 100-300 Kg. The thermite will be ignited in the test crucible. Inductive power will be of the order of 1 MW, and will be varied as required to maintain the desired temperature history. These tests are denoted "BETA 1".

In a following series of tests (BETA 2), the thermite will be ignited in the upper reaction crucible. Metallic or metal/oxide melts will be poured into crucibles of varying geometry.

For comparison with the inductively heated tests, a thermite transient test utilizing about 1000 Kg. of material will be conducted. The larger mass and heat content will give times similar to those in the inductively heated tests.

Because this test program is so ambitious, completion will not be rapid. A minimum duration of three years can be foreseen for the first step. Additional information will be presented in subsequent reports.