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INTERIM REPORT

NRC Research and Technical Assistance Report

SSC Project Highlights

for

May 1979

P ᐧAM: SSC Code Development and Validation

NRC Research and Technical Assistance Report

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486 338

This is the monthly highlights letter for (1) The SSC Code Development and (2) SSC Code Validation Programs, Fast Reactor Safety Assessment, for the month of May, 1979. These programs are covered under the budget activity number 60-19-20-01. Only major accomplishments are noted in this letter.

A. CODE DEVELOPMENT (J. G. Guppy)

I. SSC-L Code (J. G. Guppy)

1. Studies on Piping Model (I. K. Madni)

The 2-radial node model for the piping runs currently in SSC-L was compared with a more detailed model that was formulated to account for heat loss through insulation. A representative severe temperature transient with flow coastdown was applied to a pipe section. Included in the comparisons were pure fluid mixing and pure transport delay. The outlet temperature response showed excellent agreement between the 2-radial node model and the detailed model (~0.2 K deviation), whereas, the fluid mixing and pure transport delay models were grossly in error.

2. Effect of Pump Inertia on Core Coolability (I. K. Madni)

A systematic study was carried out to investigate the influence of pump stored-kinetic energy on core coolability during a coastdown to natural circulation event in a loop-type LMFBR. It was found that certain combinations of primary and secondary pump inertias can lead to flow reversal and sodium boiling in the core.

3. Natural Circulation from Near Isothermal State (M. Khatib-Rahbar and E. G. Cazzoli)

Calculations were carried out to nearly three hours at the pony motor condition. Loss of power to the pony motors was postulated at various times into the transient. It was observed that (1) the minimum core flow at natural convection conditions is insensitive to pony motor trip time for trip times greater than one hour; (2) the maximum coolant temperature remains well below the saturation limits and is much lower than the maximum temperature for a natural circulation case from high power, high flow conditions.

The work will continue to determine the influence on the natural convection level of feedwater conditions as well as loss of pony motor after several days of operation.

4. Multidimensional Effects in LMFBR Piping Systems (M. Khatib-Rahbar)

The transient behavior of sodium temperature in the piping system during coastdown to natural circulation is being studied and compared to similar three dimensional calculations.

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486 339

Preliminary calculations reveal that although flow redistribution effects can not be represented by the 1-D model, the overall outlet temperatures compare quite favorably with the temperature predicted by the 3-D model.

Furthermore, studies are being done to compare the sodium temperatures at various locations along the pipe with the 3-D results.

5. Plant Protection and Control Systems
(M. Khatib-Rahbar and E. S. Srinivasan)

An error in the Plant Protection System Flux-Delayed Flux Subsystem logic was discovered and corrected.

A meeting is planned with the CRBR project office and WARD staff at Oak Ridge on June 7, 1979 to obtain more updated design information for CRBRP.

6. Sodium Boiling (R. Pyare and T. C. Nepsee)

Initial coding work was completed to add the effects of the hex-can structure and wire wrap heat transfer to the sodium boiling code.

7. User Support (J. G. Guppy, R. J. Kennett, and S. F. Carter)

A staff member from the Gesellschaft für Reaktorsicherheit in Cologne, West Germany is currently at BNL. Assistance is being given to (1) enable a simulation of the SNR-300 using the SSC-L code and (2) to improve the adaptability of SSC-L on an IBM operating system.

II. SSC-P Code (I. K. Madni)

1. Code Development (I. K. Madni and E. G. Cazzoli)

Tank energy balance equations are being code[illegible] equations are coupled with primary hydraulic computations, and they are based on a two-zone stratification model for the hot pool, and account for metal structures and hot pool-cold pool thermal interaction.

2. Code Management (S. F. Carter)

Work was continued in keeping all SSC-P code updates current, and following the SSC-L code as it progressed to a new cycle.

III. SSC-W Code (J. G. Guppy)

1. Work Plan (J. G. Guppy)

A preliminary work plan for the implementation of a version of the SSC code applicable to light water reactors was accomplished. The first working version will be aimed at simulations of B&W type PWR reactor systems.

2. Pressurizer Model (G. J. Van Tuyle)

A two region non-equilibrium model is currently under development. The model is based on one developed by Nahavandi and incorporated in RETRAN (with minor changes in numerical solution). While the model is relatively straightforward and appears to be inherently stable, some care must be taken to insure that transitions (in either region) across phase lines (x=0, x=1) are made as accurately as possible.

3. Steam Generator Considerations (W. L. Weaver)

Changes to the steam generator module were identified in order to simulate operational transients in B&W plants. Some of these changes are:

1) placing primary fluid on the tube side and secondary fluid on the shell side of the heat transfer module,

2) addition of turbine control valve, turbine bypass system, pressure relief valves, and feedwater systems,

3) changes in the phase separation model in accumulators so that the internal recirculation in the heat transfer module can be modeled,

4) changes in the critical quality correlation as well as primary side heat transfer coefficient, and

5) change in the fluid model from homogeneous to slip flow.

4. Plant Data (R. Pyare and E. S. Srinivasan)

Initial effort was begun to collect all required data for an SSC-W simulation of the TMI-2 plant.

IV. SSC-S Code (W. L Weaver)

1. Inter-Assembly Heat Transfer/Intra-Assembly Effects (G. J. Van Tuyle)

Efforts were begun to use the Steady-State, Porous-Body Assembly Code (SPAC, an improved version of ENERGY) to estimate the temperature profile flattening effects of intra-assembly heat transfer and flow redistribution. Calculations were made for various flow and power values, us[illegible] the base case reported by Khan. This case was for a bl[illegible]nket [illegible] with a radial heat generation ratio of approximately 1.75 (pe[illegible] [illegible]erage). Some preliminary efforts were made to compare results f[illegible] these calculations to those from Professor John E. Meyer's simplified model. There was, in general, qualitative agreements between the results from the two efforts. Quantative agreement was not as strong as we might have anticipated, although this may be largely due to the, as yet unexplored, differences in our representation of assembly characteristics.

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486 341

B. CODE VALIDATION (J. G. Guppy)

1. Modifications to DHX Model (W. L. Weaver and S. F. Carter)

Due to torque limiting of the fan drive system, the DHX module cannot hold the desired sodium outlet temperature. The fan drive algorithm was changed so that the fan speed will be less than the demand speed whenever the drive system is torque limited. The plant balance algorithm also was changed so that it would work properly whenever the DHX module was not able to hold the desired sodium outlet temperature due to fan drive torque limiting.

The DHX heat transfer coefficients were modified to reflect the addition of baffles during the testing of the DHX modules at LMEC. During testing with SSC-L, it was discovered that the FFTF will not be able to operate at full power (400 MW) with the specified initial operating conditions (primary and secondary cold leg temperature and flows) for air temperatures above approximately 70 F due to torque limiting of the fan drive system.

Finally, operating conditions involving the fan off and the dampers closed result in very low air flow rates and the solution algorithm had to be modified to work properly for this condition. This problem was discovered while trying to initialize the FFTF for the first phase of transient natural circulation test 5A008 where the reactor will be operating at 5% power and 75% sodium flow.

2. FFTF Simulations (L. G. Epel)

A sample transient, involving pump trip followed by reactor scram from full power, was run for a simulation time of 60 seconds to give some assurance that the new input data and revised DHX coding would function properly within the code.

486 342

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