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SSC Project Highlights

for

March 1980

PROGRAM: SSC Code Development and Validation

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This is the monthly highlights letter of (1) the SSC Code Development and (2) SSC Code Validation Programs, Fast Reactor Safety Assessment, for the month of March , 1980. These programs are covered under the budget activity number 60-10-20-01. Only major accomplishments are noted in this letter.

A. CODE DEVELOPMENT (J. G. Guppy)

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

1. Plant Protection and Control Systems (M. Khatib-Rahbar)

A topical report describing the PPS-PCS models of SSC is being prepared. The report covers various plant system controllers and their associated mathematical representation as included in the latest cycle of SSC-L.

The draft report is expected to be completed by the end of April and will be subsequently issued as a BNL topical report.

2. Part Load Profile Calculations (M. Khatib-Rahbar, S. Dang, and J. G. Guppy)

A part load profile based on constant throttle conditions at the steam generator system outlet is being calculated. The impact of pressure loss coefficients at low power conditions on the steady state convergence of the steam generator thermohydraulics will be investigated.

3. Transient Heat Conduction in Fuel Elements (W. C. Horak)

In order to provide improved modeling capability and also to yield adequate fuel pin temperature information even when as few as one radial node is utilized, a new numerical method is being implemented into SSC for the solution of the transient temperature profiles in the fuel pins. This method makes use of a weighted-residuals procedure in space, to form a set of coupled ordinary differential equations for the average temperature in a fuel pin node as a function of time. When applied to a simplified test problem, this method yielded accurate answers, using time steps as large as 1 second.

Work is now proceeding on reducing the computational time needed for the weighted residuals procedure and in selecting efficient and stable algorithms for the solution of the coupled o.d.e. set.

4. Steam Generator Modeling (G. J. Van Tuyle, R. J. Kennett)

During the effort to complete the first version of SSC-W, several relatively minor errors in the generic steam generator model were discovered and corrected. The most notable modification was made in the solution of the time-dependent wall heat conduction equation, where the heat flux terms were altered to contain current values, rather than advanced time values. This change makes the solution of this equation consistent with the energy equation solution for the fluids on either side of the tube.

5. LMFBR Accident Progression Analysis (K. M. Jamali)

A presentation was made on the progress achieved so far and the intended work plan for the future. The reconstruction of the existing SHRS fault tree is continuing.

6. User Support (J. G. Guppy, R. J. Kennett)

The German user of SSC-L (GRS) was given a set of the latest update corrections recently made to the SSC program library. The GRS is nearing a point where SSC-L will be applied to verify certain SNR-300 licensing calculations. An input deck for the SNR-300, generated by GRS, will be sent to BNL shortly.

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

1. Analysis of Long-term Behavior (I. K. Madni)

The SSC-P code is being applied to simulate long-term core behavior under low power conditions. Thus far, no problems have been uncovered in exercising the code.

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

1. First Version of SSC-W Operational

The first version of SSC-W, applicable to PWR system designs with OTSGs is now operational at BNL. System-wide transients are now starting to be run on a routine basis. The longest test case to date has been a coastdown to natural circulation run, which was simulated out to 180 seconds. Extensive testing and applications work are initiating.

2. Steam Generator Modeling (G. J. Van Tuyle, W. C. Horak, S. F. Carter, R. J. Kennett, T. Nepsee)

As all steam generator changes presently being modeled as part of the SSC-W development effort are being incorporated into the SSC program library on a generic basis, please refer also to the appropriate section under SSC-L Development.

The modifications made in converting the generic steam generator to represent B&W once-through steam generators are now debugged to a level where transients can be run. The correction set used to modify Cycle 31 of the SSC-L program library was altered to make equivalent modification to Cycle 32. Several of the changes made in going from Cycle 31 to Cycle 32 of SSC-L were done so to improve the flexibility in representing some of the peculiarities of the B&W once-through steam generator. Thus, many of the parallel efforts made over the last several months have now come together.

3. SSC-W Future Plans

In order to better plan the future work for the SSC-W development effort, a meeting was held at BNL between BNL staff members and SSC consultants. The main focus of the meeting was to discuss the potential for, and ramifications of including a drift flux model in the steam generator. Professor John C. Lee (Michigan) discussed his experiences and preliminary results gained through application of various formulations of the drift flux model in the TRANSG code. Professor John E. Meyer (MIT) contributed thoughts concerning the potential for the application of drift flux to the SSC momentum integral model, as well as to the analysis of certain transient conditions.

IV. SSC-S Code (J. G. Guppy)

1. Inter- and Intra-assembly Effects (B. Chan)

Work on the SPAC code (Steady-state Porous-body Assembly Code) has been resumed. SPAC, developed at BNL from the ENERGY-III code, is being used to formulate the methodology to account for intra-assembly effects within the framwork of SSC. This work encompasses a portion of the overall effort to account for inter-assembly effects in SSC.

B. CODE VALIDATION (J. G. Guppy)

1. FFTF Acceptance Tests (L. G. Epel)

The FFTF version of SSC-L has been used to simulate a transient involving reactor scram from an initial steady state power of 20 MWt. The scenario assumes primary pump coastdown without the pony motors being activated but with secondary pumps coasting down to pony motor speed (10% of rated speed). Power to the fan motors in the DHX is also tripped. This transient has the potential to minimize distances between thermal centers in the primary circuit and thus decrease natural circulation flow. Analysis of the results of this case is proceeding and comparisons with HEDL results using IANUS will be made.

2. Inter-Code Comparisons of SSC-L/FFTF to IANUS (L. G. Epel)

A minor FORTRAN error that caused the fission power calculation to behave erratically for certain combinations of input parameters has been corrected. Four different pipe rupture cases were rerun and the results are being compared to analagous IANUS runs done at BNL. Differences in modeling the discharge through a break, check valve behavior, and pump response are evident in these runs, but the overall agreement between the two codes is good.

3. Inter-Code Comparisons of SSC-L to DEMO/CRBRP (R. Pyare)

In order to better investigate the differences between SSC-L and DEMO, a case with detailed DEMO output was sought. The case selected involves a pump coastdown transient to pony motor speed. In the new input deck, the core was represented by average fuel and average radial blanket assemblies. Hot channels were not simulated because DEMO, while making "hot channel calculations", does not couple any channel hydraulic information into the loop simulation as the SSC-L code does.

A 300 second transient was run, and the results carefully reviewed. The power responses match very closely between SSC-L and DEMO. However, the flow rates in both the primary and secondary loops, while comparing closely initially, start deviating after pony motor speeds are attained. Two factors may account for these differences: (1) DEMO uses a constant K-loss factor for pressure losses, while SSC used both a K-loss factor and a flow rate dependent friction factor, and (2) DEMO uses a box-type, pure transport delay model which also does not include heat transfer to the pipe walls, while SSC-L uses a model which includes turbulent coolant mixing and wall heat conduction effects. The relative importance of these effects on the flow rate calculations are being investigated further.

4. Verification of Pump Model (I. K. Madni)

The homologous pump model in SSC is being further validated by comparisons with some new head and torque data in the published literature. Attempts are also being made to obtain the data from prototype pump testing in Japan.

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