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INTERIM REPORT

Project Highlights

for

February 1983

PROGRAM: A. SSC Development, Validation and Application (FIN No. A-3015)
B. CRBR Balance of Plant Modeling (FIN No. A-3041)

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This is the monthly highlights letter for (A), the Super System Code (SSC) Development, Validation and Application Program and (B) the CRBR Balance of Plant (BOP) Modeling Program for the month of February 1983. These programs are covered under the budget activity number 60-19-03-01.

A. SSC DEVELOPMENT, VALIDATION AND APPLICATION (J.G. Guppy)

The prime activity of this program is to provide independent licensing tools to simulate plant-wide transients in liquid metal fast breeder reactors (LMFBRs). A series of computer codes, denoted by the prefix SSC (Super System Code), is being developed. Versions of SSC presently under development include: 1) SSC-L for the simulation of transients in loop-type LMFBRs, 2) SSC-P for pool-type LMFBRs and 3) SSC-S for the simulation of long-term shutdown transients. The SSC Development, Validation and Application Program is currently focused to provide direct support to the on-going CRBRP licensing activities within NRC.

I. SSC-L Code (M. Khatib-Rahbar)

1. CRBRP Accident Analysis

- Natural Circulation Transient (J.G. Guppy)

With the completion of the independent analysis using SSC to assess the calculations reported by the CRBR Project on the natural circulation transient, attention has now turned to the assessment of the conservatisms represented in the Project's analysis. A work plan to accomplish the necessary sensitivity analysis is being addressed.

- Pipe Break Analysis (J.G. Guppy, W.C. Horak)

More detailed information was requested and received from the CRBR Project regarding the results from DEMO analyses of three postulated large pipe breaks in the primary sodium piping. This information is being utilized in the independent pipe break assessment analysis being conducted using SSC.

2. Intra-Assembly Flow Redistribution (M. Khatib-Rahbar, E. G. Cazzoli)

The subassembly temperature peaking factor was calculated as a function of the modified Grashof number to inlet Reynolds number ratio at various transverse heat flux gradients. The results indicate that the transition from forced convection to mixed convection is independent of the radial power skew; and occurs at a critical Gr/Re value. Furthermore, a similar transition from mixed to free convection regime occurs at another critical Gr/Re value. These calculations confirm the experimentally measured behavior of the heat transfer regime changes in the W-ARD blanket test model, and thus provide valuable insight into the heat transfer mode for LMFBR rod bundles.

II. SSC-P Code (E.G. Cazzoli)

1. Code Maintenance (E.G. Cazzoli)

Due to the continued focus of this program to provide direct support for the CRBRP licensing activities, work on the pool version of SSC (SSC-P) has been slowed. However, modification of SSC-P to maintain its compatibility with the latest cycle of the SSC program library is continuing, but on a reduced level.

III. SSC-S Code (B.C. Chan)

1. Improved Upper Plenum Modeling (B.C. Chan)

A 2-D cylindrical channel flow representation has been modeled to test the behavior of the momentum equations. The fluid enters with uniform velocity. The calculations show how the velocity profile changes to fully developed as it proceeds downstream. The following three cases have been tested.

Case 1; zero viscosity

Case 2; 8 x 48 variable mesh with different Reynolds No. (500, 400, 300, 200, 100)

Case 3; 8 x 15 variable mesh, Reynolds No. = 200

Results are in good agreement with other computational codes.

IV. SSC Validation (W.C. Horak)

1. EBR-II Data Deck (W.C. Horak)

Work has started on the in-vessel data deck for use on the upcoming EBR-II natural circulation tests. Because the actual core configuration will not be known until shortly before the tests, a detailed core model is not useful for the pre-test predictions. A 9 channel core model is being developed which explicitly models the XX09 and XX10 subassemblies; hot and average driver fuel, reflector, and blanket assemblies; and an average control assembly. It is hoped that the effect of the remaining experimental assemblies and the safety rods can be accounted for in the appropriate average assembly. Currently, we are waiting for more information on the various types of assemblies from the EBR-II Project.

2. FFTF Natural Circulation Transients (W.C. Horak, R.J. Kennett)

Efforts this month concentrated on the modeling of the secondary outlet plenum in the IHX to investigate the differences in the predicted vs. experimental secondary hot leg temperature responses. It was found that replacement of the present one-node model, with a 10 node, donor-cell differenced scheme increased the residence time in the plenum by a factor of 2. This, however, was still inadequate to account for the time delay seen in the secondary hot leg temperature experimentally. A cell centered difference scheme is now being tested to see if this method can accurately predict the hot leg temperature.

B. CRBR BALANCE OF PLANT MODELING (J.G. Guppy)

The CRBR Balance of Plant (BOP) Modeling Program deals with the development of safety analysis tools for system simulation of nuclear power plants. It provides for the development and validation of models to represent and link together BOP components (e.g., steam generator components, feedwater heaters, turbine/generator, condensers) that are of direct application for the CRBRP, but at the same time are also generic to all types of nuclear power plants. This system transient analysis package is designated MINET to reflect the generality of the models and methods, which are based on a momentum integral network method.

1. Balance of Plant Modeling (G.J. Van Tuyle)

The basic modeling changes needed to represent feedwater heaters and condensers are now in the stand-alone version of MINET. These changes have been undergoing testing while the input processor is being revised. Recently, we have added a heat transfer "correlation" for filmwise condensation, air properties, and a heat transfer correlation for air crossing the outer surface of heated tubes.

2. MINET Code Improvements (G.J. Van Tuyle, T.C. Nepsee)

Work continues on revising the input processor for the stand-alone version of MINET. All data management functions appear to be working correctly, and the coding for reading the revised input data is well along.

Installation and testing of ISU (Input Specification Utility) in the Input Processor have been completed. During this process several minor enhancements were installed to provide flexibility in handling variable length data records such as those needed for defining function lookup tables. Enhanced data type error tests have also been installed. These place appropriate error messages in both the formatted and unformatted input data listings immediately following the occurrence of the error.

The DMU (Data Management Utility) has been revised to eliminate the MODULE data area allocation function as an external feature. Allocation is now performed implicitly with the first PUTDATA reference to a named data area.

While the input processor is being revised, a limited processor is being used to test the steady-state and transient parts of stand-alone INET. Recently, several properties have been added and, to a limited degree, tested. These additions include:

a. A "correlation" for filmwise condensation of steam, needed for representing condensers and feedwater heaters.

b. Materials property functions have been coded for MINET. (The equivalent functions exist in SSC, and are borrowed for use in the MINET version coupled to SSC).

c. Sodium properties were added to stand-alone MINET. (In the version of MINET linked to SSC, the SSC sodium properties are borrowed.) The new functions are optimized for MINET usage. Sodium is now treated as thermally expandable in MINET, and a non-zero flow gradient across a node is allowed (unlike SSC). The heat transfer correlations for flow inside and outside a heat exchanger tube were also adopted for MINET use.

d. Air properties were added in parallel to properties for water/steam and sodium. A heat transfer correlation for air flowing across heated tubes was also incorporated.

e. Properties and heat transfer correlations for NaK (eutectic) were added in parallel to those for water/steam, sodium, and air.

In addition to the various fluid properties and correlations being added, the model for calculating the pump head is being improved. The model is a variation on the homologous pump curves used in SSC.

3. MINET Standard Deck (G.J. Van Tuyle)

MINET standard decks C4 and C5 are the current standard decks for one- and two-loop analysis of CRBRP, using CY-41 of SSC/MINET. There are no standard decks for stand-alone MINET, as it continues to be in a developmental phase.

4. MINET Applications (G.J. Van Tuyle)

Recent efforts have been directed primarily toward incorporating various fluid properties and correlations into the stand-alone version of MINET. On-going analysis related to the licensing of CRBR is performed exclusively with the use of the MINET version coupled to SSC.

5. User Support (G.J. Van Tuyle, R.J. Kennett)

An IBM compatible library for CY-41 of SSC/MINET has been sent to EBR-II support staff at ANL. They now have versions compatible with their IBM facility at ANL and their CDC facility in Idaho.

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