# Project Highlights

for

January 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 January 1983. These programs are covered under the budget activity number 60-19-01-40.

## 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 Analyses

- Loss-of-Heat-Sink Study (M. Khatib-Rahbar, E.G. Cazzoli)

SSC was used to simulate loss-of-heat-sink events in CRBRP. The first series of transients analyzed included the impact of Direct Heat Removal Service (DHRS) on the sodium mixing inside the upper plenum. Comparison of the simulated results, with the Project's base case F-2 event, showed excellent agreement in the peak temperature achieved.

Additional calculations were made to determine the consequences of failure to activate the DHRS, leading to a complete loss-of-heat-sink (LOHS) accident. Calculated results show that, due to the significantly lower pressure in the reactor upper plenum, the sodium saturation temperature is about 50 degrees lower than in the reactor core assemblies. Therefore, sodium flashing inside the upper plenum began at about 11.5 hours following LOHS, nearly two hours prior to boiling in the core regions. Furthermore, due to stable low quality sodium boiling inside the subassemblies, fuel pin dryout can be precluded until the entire inventory of sodium inside the upper plenum is boiled-off, leading to fuel pin uncovery at about 18 hours after LOHS.

These results indicate that the timing of events following LOHS is significantly prolonged as a result of stable low quality sodium boiling in the reactor. Therefore, coolable geometry can be maintained for several hours as compared to previously estimated time scales in the order of minutes.

- CRBR Natural Circulation Transient (W.C. Horak, J.G. Guppy, R.J. Kennett, G.J. Van Tuyle)

Upon initial comparison with the Project's results reported in WARD-D-0308, two additional changes were made in the SSC input data for the natural circulation transient:

1) The intermediate piping lengths and elevations were selected to match those of the DEMO code. Information on the intermediate piping was incomplete in the PSAR and isometrics had not yet been obtained from the Project.

2) The gap conductances were those used by the Project (obtained using the LIFE code) and were held constant throughout the transient.

The transient was simulated for a total of 600(s) with and without interassembly flow redistribution. In general, the hot channels without flow redistribution were in good agreement with the Project's results, although the radial blanket temperature was slightly higher using SSC due to a higher power level being used in SSC. The results with flow redistribution were all lower than the Project's predictions. Some discrepancy still exists between the SSC results for the average radial blanket channel and those obtained by the Project using the DEMO code. Efforts are underway to resolve these differences.

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

The simple porous-body model was used to study the temperature flattening effect due to flow redistribution in the Westinghouse 61 pin blanket assembly experiments. Calculated results are in excellent agreement with the experimental measurements in the conservative direction. Furthermore, the calculated results were compared to the existing calculations using the COTEC, ENERGY II and COBRA IV computer codes. It was seen that, in general, most of the calculations (with the exception of COBRA IV), over-predict the data in the high Reynold's number flow regime. However, as the flow rate is reduced to natural convection level, the comparisons improve and all of the codes are in excellent agreement.

The impact of flow regime change on flow redistribution was also studied and found to be quite significant.

A draft report describing the model and its applications is in preparation.

3. User Support (W.C. Horak, R.J. Kennett, J.G. Guppy, G.J. Van Tuyle)

CY-41, along with appropriate documentation, has been sent to the Argonne National Laboratory for use by the EBR-II Project.

Several plots were made of the SSC results for the CRBR natural circulation and DHRS events to assist the NRC in an upcoming ACRS presentation.

4. Color Graphics (R.J. Kennett)

Several test programs have now been made operational on the VAX computer system, which support the higher level DISSPLA 9.0 system.

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 buoyancy dominated flow model has been tested using the upper plenum 8 x 10 mesh 60 degree sector representation. The initial temperature of the sodium is 950°K. The sodium temperature from the core is assumed to instantaneously decrease to 900°K. During steady-state testing with different inlet velocities, the results show that when inlet velocity is high, the flow in the upper plenum is separated into two regions: an upflow in the center and a downflow in the outer annular region. The temperature results show that the sodium in the plenum mixes very well. When inlet velocity decreases, the flow divides into two zones. The flow velocity becomes nearly zero in the upper zone, and the downflow in the outer annular region, generated by the outward radial flow at the location of the inlet flow, has a maximum penetration. The temperature remains high in the upper zone and low in the lower zone, which shows that mixing is very poor. These results agree with the J.S. Turner experiment, which used heavy salt injected into a tank with fresh water.

IV. SSC Validation (W.C. Horak)

1. Release of New Cycle (W.C. Horak, R.J. Kennett)

CY-41 of SSC/MINET is now operational. The cycle was validated on four separate test problems and performed well on all of them. Listings of CY-41, along with results of the four sample problems, have been made available to SSC group members.

## 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 Models (G.J. Van Tuyle)

The large set of MINET code modifications, needed to represent balance of plant components and configurations, is now undergoing testing. Heat transfer correlations for condensing steam and air will be added shortly.

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

Updates that were used to create CY-41 of SSC were factored into the stand-alone version of MINET. Several sections of SSC, providing some minor functions to MINET, previously included in the MINET library have been eliminated in favor of data statements or smaller functions or subroutines.

The large set of revisions to the steady-state and transient calculations has been undergoing testing. The scope of these tests has been limited thus far by the lack of a compatible input processor, which is still under development. Even so, the tests completed to date have been very encouraging, particularly with regard to the heat exchanger model.

Revisions to the data handling input processor functions are nearly complete, and will be tested shortly. The principal input processor routines will be written next, which will use the revised data handling functions to process the new input data.

A new utility package, GCM (Global Container Manager) has been introduced. Its purpose is to assign and manage variably-dimensioned global container storage. Several enhancements are provided over a similar method used in SSC:

- Full recovery is provided for assignment parameter errors. This allows completion of the allocation process before executing an error abort, thereby flagging the maximum number of errors possible.

- Container overflow recovery is provided to allow completion of the allocation process. A full container map, including error messages, is printed before executing the overflow error abort. This is useful in cases where the container size must be increased to accommodate large input data sets.

- Provision is made for container segmentation. This allows sharing of storage by mutually-exclusive segments which reside in secondary storage when they are not being accessed.

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

MINET decks C4 and C5 are currently the standard input decks for one- and two-loop analysis of CRBRP, using CY-41 of SSC/MINET. As the stand-alone version of MINET is undergoing extensive revisions, we do not plan to standardize any of the new test input decks for some time.

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

The version of MINET in CY-41 of SSC is being used extensively in licensing applications for CRBRP. This practice is expected to continue while the stand-alone version of MINET is extended.

The CY-41 version of MINET is also planned for use in our analysis of the EBR-II facility. Our current objective is to test our EBR-II representation using a previous test transient, and then to make pre-test predictions for an upcoming natural circulation test series. We have requested additional information on the EBR-II reactor and data from previous test transients. EBR-II support staff at ANL has sent us data from test series 8A, and are currently preparing the reactor data we requested.

The stand-alone version of MINET is being tested on several simple problems while necessary modifications to the input processor are being made. Several of the new capabilities have been tried, and all functions tested thus far are working correctly.

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

The EBR-II staff at Idaho and at ANL are interested in SSC and MINET, particularly the helical coil heat exchanger model in MINET. A CDC compatible program library of CY-41 of SSC/MINET, along with supporting documentation and test problems, have been sent to them for use on their CDC system in Idaho. They have also requested an IBM compatible library for their system at ANL, and we are preparing to provide such a version.

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