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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WAS INGTON, D. C. 20555

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MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER NO. 40 THE COMPUTER CODE BRENDA (BREEDER REACTOR NUCLEAR DYNAMIC ANALYSIS) A COMPUTER PROGRAM FOR THE DYNAMIC SIMULATION OF A LIQUID METAL FAST BREEDER REACTOR PLANT

This Research Information Letter describes the BRENDA code. BRENDA is a fast running systems code intended to provide NRC with the capability of doing parametric surveys and scoping studies of normal operating as well as accidental transients in LMFBR plants. It was originally designed to evaluate the CRBR plant, and is currently being modified to make it applicable to the preoperational and start-up tests in FFTF.

Introduction

A research program to develop methodology for the computer simulation of full-scale breeder reactor power-plant systems has been in progress at the Nuclear Engineering Department of the University of Arizona since January 1975. The work is being funded by the USNRC under University of Arizona Contract No. AT(49-24)-0250. The code BRENDA (Breeder Reactor Nuclear Dynamics Analysis) simulates a loop-type LMFBR power-plant system of the proposed Clinch River Project design. It is written to utilize the "DARE-P" (Differential Analyzer Replacement) program. This program was developed by Granino Korn and John Wait of the Electrical Engineering Department of the University of Arizona under National Science Foundation funding. The DARE system is a user-oriented simulation package based on Continuous System Simulator Language (CSSL) specifications. The systems code BRENDA, in conjunction with the DARE-P interface is operational on the BNL CDC-7600 computer and can be accessed through the terminals at the Phillips and Willste Buildings.

Results

A series of typical transients of interest have been analyzed by the RSR staff. The code simulates the behavior of an LMFBR plant and realistically predicts short-range operating transients with or without the plant responding to system controllers. A separate simulator module emphasizing examination of the capability of the auxiliary decay heat-removal system is used for long term transient after scram.

The response of the BRENDA uncontrolled transient model to a 10¢ reactivity increase is shown in the enclosed report BNL-NUREG-25099. In this report the BRENDA results are compared to calculations of the same case with the Super Systems Code (SSC-L) four channel model being developed at BNL.

In general, the agreement was good. Because of slight differences in initial conditions the response curves are slightly displaced but the response shapes are very similar. The BRENDA calculation used 23 seconds of CDC-CYBER-175 CPU time for 200 seconds of real time vs. 231 seconds of CDC-7600 CPU time for 900 seconds of real time using SSC-L. Correcting for the difference in computer speeds. BRENDA takes about 1/5 as much time as SSC-L. Primarily this can be attributed to the simpler modeling in BRENDA.

Discussion

At a meeting of the Fast Reactor Systems Code Review Group on June 10, 1977, a presentation on the BRENDA code modeling structure and input requirements was made by the project director, Professor D. L. Hetrick of the University of Arizona. The group was satisfied with the structure and ease of input preparation, and recognized that the relatively simple component modeling and one-dimensional structure of the code limit its use for some accident analysis. Its primary application will be for use as a fast running inexpensive tool for making parametric surveys and scoping studies. For example, the magnitude and frequency of rapid temperature changes in a component could be investigated over a wide range of assumed typical operating histories. A scoping study by the investigators at the University of Arizona has demonstrated that the design of the process control systems can influence the stability of the plant.

The BRENDA Code is of the same order of sophistication as the currently available vendor codes, such as DEMO, and its primary virtue is that it provides NRC with an independently derived tool for safety assessment. BRENDA is also projected to be used to define the parameter space for detailed investigation with more sophisticated codes as SSC-L.

The comparison between BRENDA and SSC-L discussed above demonstrates that BRENDA can be used to study the response of system variables such as loop temperatures and flows with approximately the same results as SSC-L. Because of the simplicity of some of the modeling the code has limitations. The single channel core modeling does not handle flow redistribution and transition to natural circulation. Hence, it cannot be expected to give reasonable estimates of fuel and cladding temperatures during a loss-of-forced circulation accident. No modeling is provided for a pipe break accident.

The BRENDA code has been documented (NUREG-0110) and a users manual (NUREG/CR-0244) prepared. Copies of these documents are enclosed. BRENDA will be made available through the Argonne code center. A users manual for the auxiliary program DARE-P has been published as a book.[(1)] A computer tape with the DARE-P program is available to the public at a nominal cost from the University of Arizona. For further information on using the code contact Phillip M. Wood of the RES staff.

Saul Levine, Director
Office of Nuclear Regulatory Research

Enclosures:

1. M.A.M. Shinaishin
   "Dynamic Simulation of a Sodium-Cooled Reactor Power Plant" NUREG-0110, September 1976

2. D. L. Hetrick and G. W. Sowers "BRENDA: A Dynamic Simulator for a Sodium-Cooled Fast Reactor Power Plant" NUREG/CR-0244, July 1978

3. K. E. St. John, A. K, Agrawal, and J. G. Guppy "A Comparison between SSC-L and BRENDA System Codes" BNL-NUREG-25009, November 1978

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(1) Korn, G.A., and J.V. Wait, "Digital Continuous System Simulation," Prentice-Hall, Inc., 1978.