Enclosure

TOPICAL REPORT EVALUATION

REPORT TITLE:	FIESTA, A One Dimensional, Two Group Space-Time Kinetic Code for Calculating PWR Scram Reactivities
REPORT NUMBER:	CEN-122(F)
REPORT DATE:	November, 1979
ORIGINATING ORGANIZATION:	Combustion Engineering
REVIEWED BY:	Core Performance Branch/Reactor Physics Section
DATE OF EVALUATION:	February 26, 1981

Summary of Topical Report

This report describes the FIESTA space-time kinetics computer code which was developed by CE for PWR scram reactivity calculations which account for the axial space-time variations in the neutron flux. The one-dimensional two-group time dependent neutron diffusion equation is solved by a space-time factorization method which divides the neutron flux into a time-dependent amplitude function times a time-dependent shape function. The flux amplitude is calculated by the point kinetics equations using very small time steps. These time steps are automatically expanded or reduced by the code as needed in order to achieve a converged point Kinetics solution. The point kinetics approximation is appropriate since the flux shape between relatively small time intervals may be assumed to be constant. The flux shape, which varies more slowly than the amplitude, is calculated by the shape equation using a much larger time step size which is specified by the user. Therefore, although the space-time factorization method introduces an additional variable and an additional equation (point kinetics equation), an overall saving is realized since the shape equation, which is the most time consuming calculation, may be evaluated less frequently than with normal space-time calculational procedures.

Verification calculations have been performed and are summarized in this report. Both a subcritical and a supercritical transient were analyzed from the Argonne National Laboratory report of benchmark problems (ANL-7416). An additional comparison was made between FIESTA and the NRC approved three-dimensional neutron kinetics code HERMITE in calculating scram reactivities.

Scram reactivities for a typical cycle using space-time calculations are compared to static calculations in this report. The impact of using the space-time approach on the results of analyses of design basis transients is also presented.

A description of the code input is also included as an appendix.

Summary of Review

We have reviewed the subject report, including the mathematical models and analytical procedures and methods. Although the FIESTA code incorporates a thermal hydraulic model and is capable of analyzing a variety of transients with the inclusion of feedback effects, the code description and verification calculations presented in this report were limited and intended only to validate the use of FIESTA for scram reactivity calculations without feedback effects. Therefore, a detailed description of the feedback modules were not included in the topical report and were not reviewed or approved by the staff.

The FIESTA code is verified by comparison with two benchmark problems which have been distributed by the Argonne National Laboratory Code Center in ANL-7416 Supplement 1 dated December, 1972. The first benchmark problem consists of a subcritical transient in a three region infinite slab reactor model where the thermal absorption cross section in one of the regions is linearly increased by three percent in one second. The second benchmark problem consists of a supercritical transient using the same geometry as the previous problem but with the thermal absorption cross section decreased by one percent in one second. The results of both benchmark problems obtained by FIESTA are in excellent agreement with the results obtained by four other widely used and acceptable space-time kinetics codes; RAUMZEIT, WIGLE, QX1, and HERMITE. This validation procedure as well as the results obtained are acceptable.

Additional comparisons are performed between FIESTA and the HERMITE code, which has been previously approved by the staff. The analysis is representative of a reactor scram in which control rods are inserted into the core in three seconds. The excellent agreement between the results obtained with the one-dimensional FIESTA code and the three-dimensional HERMITE code confirm to the staff that FIESTA is acceptable for calculating scram reactivities.

Comparisons of space-time (FIESTA) scram reactivities with static scram reactivities show the FIESTA calculations result in greater reactivity insertions at intermediate CEA positions. This is due to the fact that in the space-time calculation, the delayed neutron precursors are distributed according to the initial flux shape. The neutron precursors provide a source of delayed neutrons which tends to tilt the neutron flux shape toward the CEAs compared to static methods, leading to greater CEA reactivity worth at intermediate CEA positions. At full CEA insertions both methods yield nearly the same reactivity. Although the space-time results are less conservative than those of the previous static method of calculating scram reactivities, they are more realistic since delayed neutron effects are accounted for and are, therefore, acceptable.

Evaluation Procedure

The review of topical report CEN-122(F) has been conducted within the guidelines provided by the Standard Review Plan, Section 4.3, NUREG 75/087. Sufficient information is presented to permit a knowledgeable person to conclude that the calculational procedures and techniques used in the FIESTA code are state-of-the-art and acceptable for the calculation of PWR scram reactivity worth. This conclusion is reinforced by the fact that comparison of FIESTA results with results of other widely-used and acceptable space-time kinetics codes for scram type calculations produce similar results.

Regulating Position

On the basis of our review of topical report CEN-122(F) we conclude that it is acceptable for reference in licensing actions in regard to PWR scram reactivity calculations for various design basis events which require a trip.

The thermal-hydraulic model which is available in the FIESTA code was not included in the topical report because it is not used in the scram reactivity calculations. The feedback modules in FIESTA have, therefore, not been reviewed or approved.

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