ATTACHMENT

MODIFICATION OF GE THERMAL LIMIT EVALUATION

I. INTRODUCTION

The SCAT (Single Channel Analysis of Transients) computer program was developed and implemented into transient thermal-hydraulic design analysis over a decade ago by the General Electric Co. A development effort was undertaken by General Electric to improve its ability to respond to low flow and large pressure rate conditions, improve user convenience and to provide a new version of the program for implementation as the standard analysis method for operational transients.

II. MODEL DESCRIPTION

The revised version of the program solves the continuity and energy equations for the mixture and for individual phases. The energy distribution between the phases, one of which can be in thermal non-equilibrium, is treated through the use of an interfacial heat transfer coefficient calibrated to steady state data. The conservation equations are solved using an explicit prediction scheme followed by an implicit correction technique. This procedure is consistent with the procedure used in the ODYN code which has been reviewed extensively by the NRC staff. However, as in the previous version, the mixture momentum equation is decoupled from the other conservation equations and is solved after the other equations have converged.

Although the principal changes in the code are associated with the formulation and solution of the hydraulic equations, other changes have been made to utilize updated methods for the solution of the heat conduction equation in the fuel and cladding and to include models for direct non-fuel energy spatial heating distribution and leakage flow paths.

The revised version of the program has been extensively verified against analytical transient hydraulic solutions and against independent steady state solutions for such parameters as pressure drop and thermal margin.

Qualification, as with SCAT in the past, included comparisons against ATLAS and BDHT test data for simulations of turbine trip and loss-of-coolant-accident transients. As in earlier versions of the program, the prediction of time to boiling transition during these transients was earlier than the data. The results from the revised version of the code compared quite closely with the original results, except that the new version is capable of handling the rapid pressure rate changes and low flow conditions which created problems with the earlier version.

III. IMPACT ON SYSTEM EVALUATIONS

The application of the revised version of the code for evaluation of operating limit minimum critical power ratios will not entail any procedural changes. That is, the revised version will just be substituted for SCAT in these evaluations.

Studies demonstrate that in cases where SCAT exhibits stable behavior, both versions produce very comparable results. This is shown in Table 1* which compares results using input from REDY. Table 2* provides a similar comparison with input from ODYN. Both Tables 1 and 2 provide comparisons using similar nodal structures for the two versions of the code. The revised version provides capability for increased noding to determine the sensitivity of the calculated results to the number of nodes.

When driven by ODYN, the SCAT code can exhibit numerical instabilities which, unless accommodated by the user, result in spurious Δ CPR calculations. Rapid pressure changes rate can result in a numerically produced flow discontinuity in time which can in turn result in both positive and negative spikes in the CPR. Since the procedure for determining MCPR is to use the lowest calculated value of CPR during the transient, these spikes could result in an artificially low CPR for a transient. In general, the new version closely matches the mean of the SCAT Δ CPR versus time results when the SCAT results show stable characteristics. Table 2 results for SCAT are determined using the raw input from ODYN. These values, due to numerical instabilities, are artifically large and are presented to indicate the potential error due to the instabilities. Licensing submittals with SCAT would not use these inputs but would be based on user adjusted pressure traces which results in stable SCAT performance.

In summary, the new version will be used as a replacement for SCAT in the evaluation of operating limit minimum critical power ratios. Based on the studies performed, both versions produce similar results for those cases in which SCAT performs in a stable manner.

*The results presented are not intended to imply a degree of accuracy to four significant figures on CPR evaluations. This presentation is intended to illustrate the differences between the two versions of the code.

KWC:vm/1242-1243
7/19/79

TABLE 1

Δ CPR COMPARISIONS
(REDY INPUT)

PLANT	EVENT	SOURCE OF INPUT	Δ CPR SCAT RESULTS	Δ CPR REVISED VERSION RESULTS
BWR 3	TTNBT	REDY	0.2912	0.2964
	FWCF	REDY	0.3284	0.3250
BWR4/218/560 PLANT A	LRNBT	REDY	0.2795	0.2787
	FWCF	REDY	0.2399	0.2393
BWR4/218/560 PLANT B	LRNBT/RPT	REDY	0.0996	0.1064
BWR4/251/764 PLANT C	TTNBT	REDY	0.3337	0.2356
	FWCF	REDY	0.0737	0.0720
BWR4/218/560 PLANT D	TTNBT	REDY	0.1780	0.1881

TABLE 2

Δ CPR COMPARISONS
(ODYN INPUT)

PLANT	EVENT	SOURCE OF INPUT	Δ CPR SCAT RESULTS*	Δ CPR REVISED VERSION RESULTS
BWR4/218/560 PLANT 1	LRNBT	ODYN	0.271	0.226
	TTNBT/RPT	ODYN	0.1765	0.1243
	LRNBT/MST	ODYN	0.221	0.185
BWR4/183/368	TTNBT	ODYN	0.2522	0.226[illegible]
BWR4/218/560 PLANT 2	LRNBT	ODYN	0.2798	0.2[illegible]
	FWCF	ODYN	0.2487	0.2[illegible]

LRNBT - Load rejection without bypass transient
TTNBT - Turbine trip without bypass transient
RPT - Recirculation pump trip
MST - Measure scram time of insertion
FWCF - Feedwater Controller Failure
PLANT - Plant type/vessel size/No. fuel bundles

*Results are based on raw input data without user adjustments

KWC:vm/1244
7/19/79

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