Px 2215

INFORMATION

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

To
C. D. Morgan, Manager, Technical Staff

cc: C. E. Parks
B. H. Dunn

From
J. J. Cudlin/N. H. Shah, LOCA Methods, Technical Staff

BDS 663-3

Cust.

File No.
or Ref.

Subj. ANALYSIS CODE REQUIREMENTS AND VERIFICATION PROJECT:
ACTION ITEM 5

Date 9/4/79

This letter is to cover one customer and one subject only.

INTRODUCTION

A review of four prominent features of the B&W small break evaluation model has been completed as specified in Action Item 5 of the Analysis Code Requirements and Verification Project. This review was aimed at the following elements of CRAFT2 simulations of small break transients: (1) the dual flow path technique employed to prevent phase "pancaking" in vertically-stacked control volumes, (2) the use of a multiplier in conjunction with the Wilson bubble rise model to account for void distributions in large, vertically-oriented control volumes, (3) simulation of steam generator heat transfer, particularly that attributable to auxiliary feedwater, and (4) pressurizer modeling within the present capabilities of CRAFT2. It was originally presumed that the investigation would establish the sensitivity of the small break evaluation model to these selected features. Early on, however, it became obvious that the analysis results are strongly case-dependent, and that the emphasis should be shifted toward a confirmatory review. The results of that review are summarized below.

SUMMARY

1. Dual Flow Path Modeling

The small break evaluation model utilizes parallel dual flow paths between nodes to allow for counter current flow and also to reduce steam "pancaking" between vertically stacked nodes during phase separation. In this model, a vertical flow path is divided into two equal area paths staggered by about one foot and assigned opposite directions at the node interface. The present study indicates that the dual flow path concept as used adequately describes the mixture height in the top node. However, a staggered length of about 0.5 feet was found to provide optimum results in the test case used in this review.

2. Bubble Rise Velocity Multiplier

The Wilson bubble rise velocity model is used to calculate phase separation rates in the reactor core and RCS piping. A factor of 2.38 is applied in the core volume to account for the effects of the nonuniform void fraction distribution largely attributable to the axial variation in core power. This approach is well-documented in ECCS Analysis calculation files and is supported by both FOAM2 analyses and level swell test data. In other vessel control volumes a multiplier of 2.0 is used, again to account for nonuniform void distribution, primarily because of steam production of flashing in conjunction with primary metal heat. In this case, however, the multiplier has been established also using FOAM2 analyses wherein additional heat sources were introduced to approximate the flashing process. This procedure assumed an equivalence between heat addition at constant pressure and an irreversible expansion. The present study concentrated upon confirming, with a more defensible analysis, that the value used for the bubble rise multiplier is reasonable for its intended application. This objective was met via CRAFT2 depressurization cases in which the mixture level behavior of a single volume was compared to that of multinode model of equal total volume. Wilson bubble rise multipliers of 2.2 and 1.6 applied to the single volume were found to "bracket" the level behavior of the multinode model in which multipliers of 1.0 were used in each control volume. This indicates that the bubble rise multiplier used in small break analyses is reasonable. It should be noted, however, that the effects of spatial variations in void fraction can only be approximated by this technique. Accurate best estimate results will likely require a finer discretization or, at least, a more sophisticated method for phase separation within large control volumes.

3. Steam Generator Heat Transfer

The evaluation model uses, for each steam generator, one control volume to represent the secondary side and two control volumes to represent the primary side. The top primary node generally comprises the hot leg after the "U" bend, SG inlet plenum and half the tube lengths. The steady state heat load in each generator is equally distributed between the two primary volumes. The overall heat transfer conductance is calculated based on the initial heat load and the initial temperature difference across the corresponding primary and secondary volumes. The UA value thus calculated is generally kept constant during the transient if auxiliary feedwater is actuated and maintained. An examination of the Davis Besse 1 natural circulation data (Memorandum, R. W. Winks to R. C. Jones, "Description of Natural Circulation Test Conducted at Davis Besse 1", NSS-14/T3.5, January 15, 1979.) indicates that, subsequent to reactor and RCP trip, the bulk of the heat transfer in the SG occurs within the secondary mixture height even when the auxiliary FW is injected near the top of the tube bundle. The conductance value for the bottom node during a low flow (~ 5% initial flow) drops to about 20% of the initial value. In the top half of the tube bundle, the heat transfer would seem to take place only in tubes near the outer periphery, containing about 10 to 15% of the tubes, which are directly impinged upon by the AFW spray. The primary fluid in the remaining tubes will only be cooled below the secondary mixture level. A more accurate simulation of this behavior would require that a multichannel SG model be used. It is at least clear, from the Davis Besse 1 data, that the generator heat demand assumed in small break analyses is optimistic.

4. Pressurizer Modeling in CRAFT2

In the ECCS evaluation model, the pressurizer behavior is typically simulated using a single equilibrium control volume. Thus, during a transient, the steam and liquid regions remain at equal temperatures corresponding to saturation states at the pressurizer pressure. Obviously, the effect of this limitation upon results is entirely case-dependent; the direction and rate of surge flow, hence the interaction between the pressurizer volume and the RCS, will vary according to both break size and location and the time during the transient. In short, the deficiencies associated with an equilibrium volume simulation of pressurizer behavior cannot be concisely determined. For a specific transient, say an insurge subsequent to LOFW, the shortcomings which are intuitively expected are borne out by analyses: the equilibrium pressurizer model underpredicts the rise in system pressure and will either delay or entirely miss the attainment of high pressure setpoints and trips. To a certain extent, this limitation can be overcome by using a multivolume model for the pressurizer as in the TMI simulation performed by ECCS Analysis. That case study was carried out using both single equilibrium volume and multivolume pressurizer models. Predicted system pressure and pressurizer level were in excellent agreement, differing, as would be expected, in the early pressure rise following the loss of generator heat demand.

DETAILED RESULTS

Specific case studies and calculations performed for Action Item 5 have been assembled in a calculation file retained by LOCA Methods.

JCudlin
J. J. Cudlin

NHShah
N. H. Shah

JJC-NHS/kpb