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ANALYSIS OF SHORT-TERM REACTOR CAVITY TRANSIENT

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INTRODUCTION

Following the transient of a hypothetical loss-of-coolant accident (LOCA) in a nuclear reactor, peak pressures are reached within the first 0.03 s at different locations inside the reactor cavity. Due to the complicated multidimensional nature of the reactor cavity, the short-term analysis of the LOCA transient cannot be performed by using traditional containment codes, such as CONTEMPT.[1] The advanced containment code, BEACON/MOD3,[2] developed at the Idaho National Engineering Laboratory (INEL), can be adapted for such analysis. This code provides Eulerian, oneand two-dimensional, nonhomogeneous, nonequilibrium flow modeling as well as lumped parameter, homogeneous, equilibrium flow modeling for the solution of two-component, two-phase flow problems. The purpose of this paper is to demonstrate the capability of the BEACON code to analyze complex containment geometry such as a reactor cavity.

Reactor Cavity Experiment

A reactor cavity blowdown experiment[3] conducted by Battelle-Frankfurt was simulated using BEACON/MOD3. The test configuration of this experiment, C8, is shown in Figure 1. The blowdown was initiated by mechanically breaking a rupture disk on the end of an exhaust duct located at the bottom of the pressurized vessel. The blowdown mass flow rate, temperature, pressure, and flow densities were obtained through appropriate measurements. The pressure transient within the annulus between the vessel and the biological shield was monitored through a series of pressure sensors.

Model Description

The C8 reactor cavity was modeled using an unwrapped two-dimensional (2-D) slab nodalization with 230 fluid cells. The flow area in the upward flow direction at various locations around the spherical shell bottom is preserved by progressively decreasing the depth of the slab toward the bottom of the cavity. The nodalization scheme is shown in Figure 2. The exterior boundary conditions imposed at the top of the 2-D region were a constant pressure and temperature for the short-term transient calculation. The flow into the cavity was modeled by using sources located at the bottom cells of the 2-D region. Flow rates and corresponding specific enthalpies in the exhaust duct were input to describe the source conditions for the problem.

RESULTS AND CONCLUSIONS

For data comparisons, two BEACON cells were selected, which correspond to the location of two pressure sensors identified as OPS000A2 and OPS134A13. Figure 3 shows that the BEACON calculated pressure transients at the two locations follow the experimental data very well. The initial pressure spikes were successfully predicted. The maximum error for the calculated pressure is less than 10% during the initial 0.05-s transient period. Improved results might be obtained by including modeling of Room 1, which is connected to the top of the reactor cavity region. It is concluded that for reactor cavity problems, such as in the Battelle-Frankfurt Test C8 where the circumferential velocity components are small relative to the upward components, the two-dimensional Cartesian mesh of the BEACON modeling yields a good simulation.

REFERENCES

1. L. J. Metcalf et al., "CONTEMPT4/MOD2, A Multicompartment Containment System Analysis Program," TREE-NUREG-1202, EG&G Idaho, Inc. (February 1978).

2. C. R. Broadus et al., "BEACON/MOD3: A Computer Program for Thermal-Hydraulic Analysis of Nuclear Reactor Containments," NUREG/CR-1148, EG&G Idaho, Inc. (April 1980).

3. Technischer Bericht RS 50-32-C8-1, Vorlaufiger Versuchsbericht C8 (August 1975).

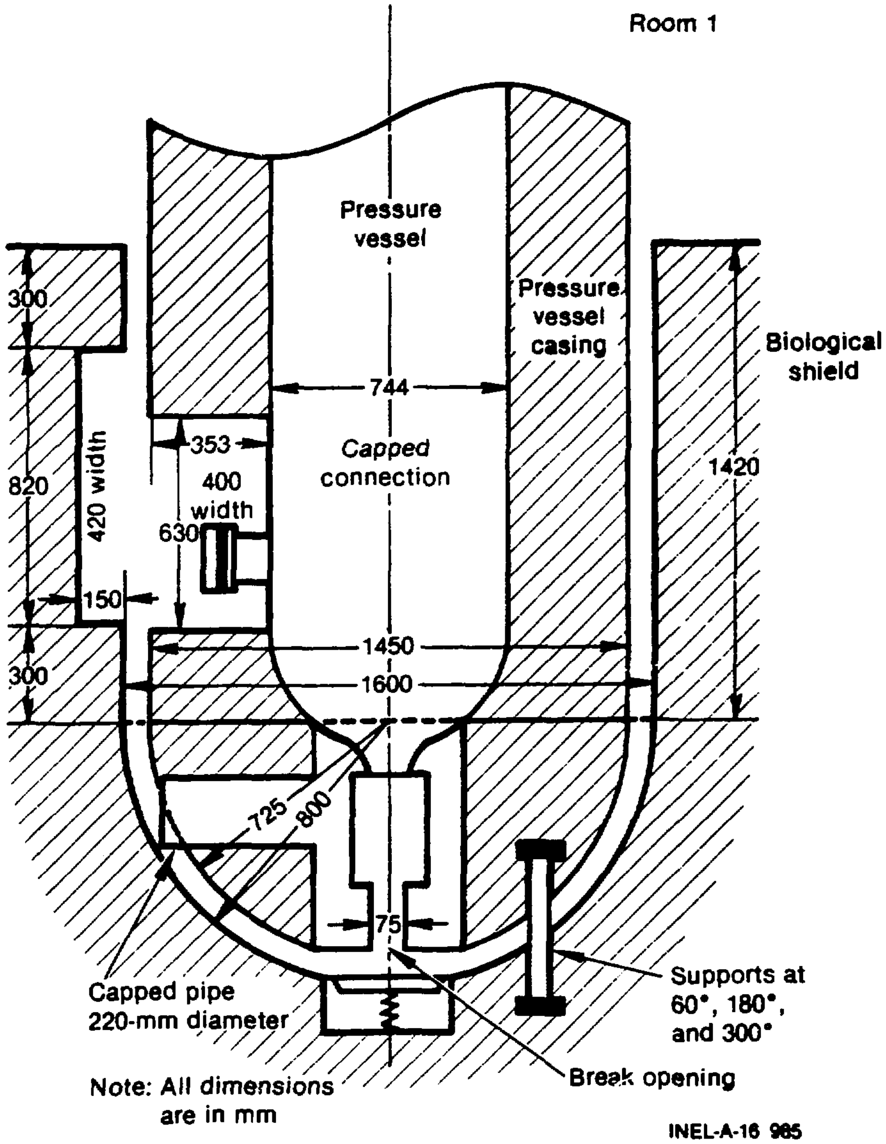

Figure 1. Experiment C8 reactor cavity configuration.

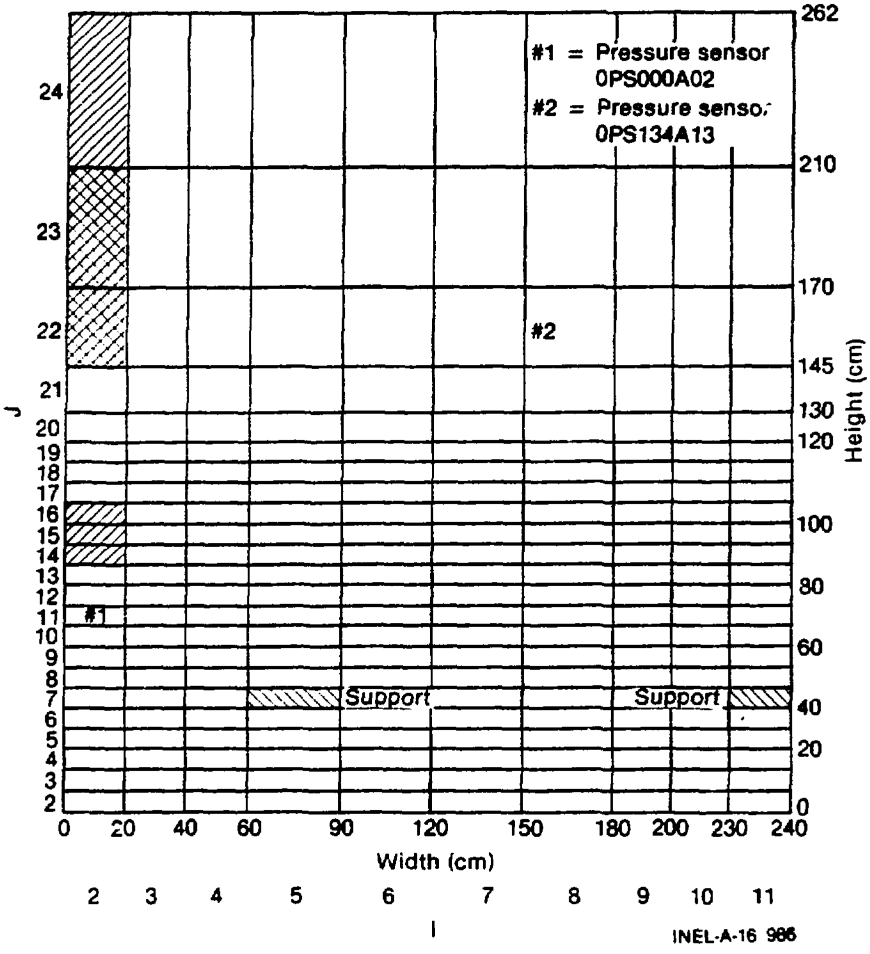

Figure 2. Unwrapped reactor cavity nodalization using 2-D Cartesian cells, where I and J are the cell imdices of the 2-D mesh.

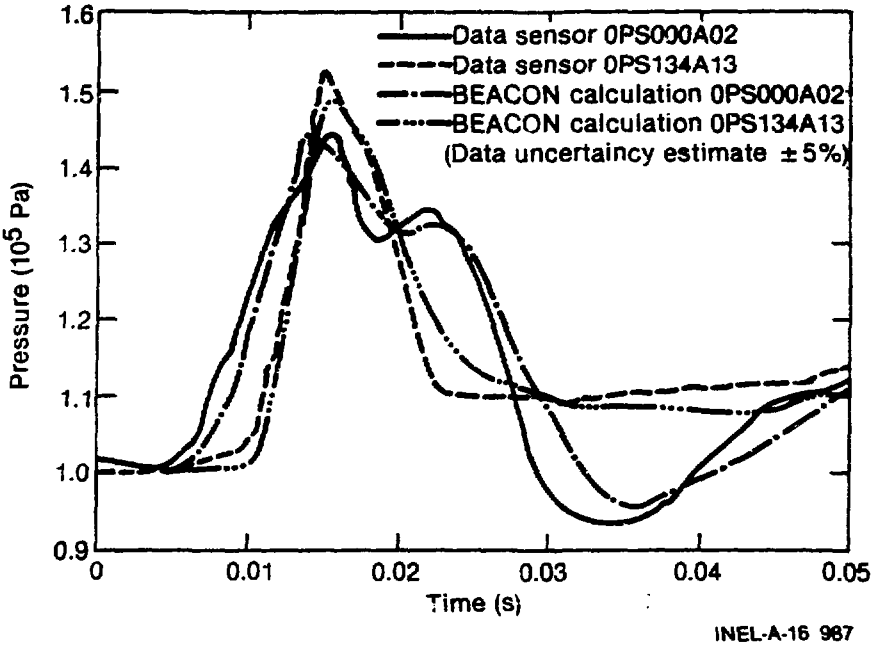

Figure 3. Experiment C8 pressure history comparisons.