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International Agreement Report

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Lih-Yih Liao, Song-Feng Wang, Yi-Bin Chen

Institute of Nuclear Energy Research
P.O. Box 3, Lung-Tan 32500
Taiwan, Republic of China

Office of Nuclear Regulatory Research
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ABSTRACT

Comprehensive analysis with RELAP5/MOD2 is performed to predict the LOFT transient thermal-hydraulic responses for the LOCE L2-5 test. Experiment L2-5 is planned to simulate a hypothetical LOCA which results from a 200% double-ended offset shear break in a cold-leg of a typical pressurized water reactor. The test simulation begins with break initiation and subsequent blowdown, and continues through lower plenum refill, core reflood, and terminates with corewide quench. The nominal best estimate calculation results indicate that the cladding temperature continuously increases during blowdown phase without an early fuel-rod rewet (blowdown quench). A peak cladding temperature of 1,112 K, which is very close to the experimental data, is calculated at 7.0 s, and fuel rods are predicted to be quenched at 57 s after the break initiation. Sensitivity analyses of the test simulation with respect to various code input uncertainties, including broken loop initial temperature, cross-flow junction, discharge coefficient, accumulator condition, reflood fine mesh number, form loss coefficient, fuel gap dimension, and reflood option are performed to investigate their impacts on the calculation results. Scenario study on the pump behavior is analyzed to see whether the blowdown quench could be resulted from the RELAP5/MOD2 model. The effect of the uncertainty of Biasi CHF on the cladding temperature response is also studied.

SUMMARY

This report documents the results and conclusions of the RELAP5/MOD2 code assessment in the analysis of LOCE test L2-5. Sensitivity studies of the L2-5 simulation with respect to various modeling options are performed as well to investigate their impacts on the calculation results.

LOCE L2-5 is performed to simulate a hypothetical LOCA which results from a 200% double-ended offset shear break in the cold-leg of a typical pressurized water reactor. A specific purpose of L2-5 test is to establish conditions which will result in a large break blowdown without early quench that occurred during previous large break LOCA tests. RELAP5/MOD2 is an advanced, one-dimensional, two fluid, six-equation, thermal nonequilibrium reactor transient and accident analysis program. The objective of this assessment study is to provide systematic assessment of the RELAP5/MOD2 code relative to code development, code improvement, and the enhancement of user guidelines.

In this study, the test simulations using RELAP5/MOD2 begin with break initiation and subsequent blowdown, and continue through lower plenum refill, core reflood, and terminate with corewide quench. Major events and their timings of the large break LOCA test L2-5 are well predicted by the RELAP5/MOD2 model. According to the hydraulic process (pump behavior) set up in L2-5, the RELAP5/MOD2 calculation gives no early quench phenomenon. Important parameters, such as pressure, break flow,

and cladding temperature, are calculated with reasonable agreement in the comparison to the test data. Noticed differences between the calculation results and the test data including hot-leg break flow at initial period, cladding temperature during reflood, pressurizer pressure response, cladding temperature responses at upper and lower elevations of the fuel rod, fuel quench temperature etc., are discussed with possible reasons in this report. On the other hand, the calculated peak cladding temperature (the most critical parameter concerned in a large break LOCA) of 1,112 K is in excellent agreement with the test data of 1,077 K.

Sensitivity analyses of the test simulation with respect to various code input uncertainties, including broken loop initial temperature, cross-flow junction, discharge coefficent, accumulator condition, reflood fine mesh number, form loss coefficient, fuel gap dimension, and reflood option are performed to investigate their impacts on the calculation results. Scenario study on the pump behavior is analyzed to see whether the blowdown quench could be resulted from the RELAP5/MOD2 model. The effect of the uncertainty of Biasi CHF on the cladding temperature response is also studied.

Calculated PCTs are quite insensitive to the selected parameters and their variations in the sensitivity studies except in the cases of the fuel gap dimension and the CHF correlation. With the doubled fuel gap dimension used in the code calculation, the resulted PCT is increased by 130 K in the comparison to that of the base case. In the sensitivity study of the Biasi CHF correlation, the reduction of the CHF does not yield improvement in the cladding temperature predictions at upper and lower elevations of the fuel rod. At the hottest location, significant reduction of the time-to-CHF is calculated with the reduction of the CHF, which leads to an overestimation of the PCT by more than 500 K.

From the results of the scenario study, it is learned that the present RELAP5/MOD2 model does not calculate the blowdown quench phenomena even at the assumption of connected flywheel system during the pump coastdown.

Excessive precursory cooling of the fuel rod is calculated during the reflood period. It is seen that discontinuities of the cladding surface heat flux and the vapor temperature are calculated at the moment of the reflood model actuation. Without using the reflood model in RELAP5/MOD2, the calculated cladding temperatures during the reflood period are in good agreement with the test data. These results may indicate that either the criteria used in RELAP5/MOD2 for the actuation of the reflood model calculation are inadequate or the heat transfer package in the reflood model is improper.

CONTENT

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1. INTRODUCTION

The assessment study documented in this report contributes to the overall code assessment effort, which is coordinated within the International Code Assessment and Applications Program (ICAP) sponsored by the U.S. Nuclear Regulatory Commission (NRC). The objective of the ICAP is to provide qualitative assessment of the major thermal-hydraulic computer codes relative to code development, code improvement, and the enhancement of user guidelines. This report contains results from the best estimate experiment prediction analysis performed using the RELAP5/MOD2[1] Version 36.04 computer code to simulate the system thermal-hydraulic responses of the Loss-of-Fluid Test (LOFT) during Loss-of-Coolant Experiment (LOCE) L2-5.

LOCE L2-5, in conjunction with previously conducted LOCE L2-2 and L2-3, is intended to evaluate the system responses during a large break loss-of-coolant accident (LOCA). These tests are conducted to address conservatisms in licensing criteria defined in the U.S. code of Federal Regulations (10CFR50 Appendix K). Current licensing criteria limit fuel rod cladding temperatures to 1,477 K (2,200 F). For most plants limited by this criteria, the peak cladding temperature occurs during reflood portion of the licensing calculation. While there are other limits that determine the maximum power a plant can operate at, the majority of plants are limited by the LOCA analysis.

Experiment L2-5 uses nominally the same system configuration as the previously performed Experiment L2-3. The essential differences between L2-5 and L2-3 are the post-break pump operation and ECCS actuation times. Experiment L2-2 and L2-3 unexpectedly show that during blowdown phase (with pump left running), a surge of coolant through the core occurs when flow from the pumps exceeds flow out of the cold-leg break. This coolant surge caused an "early rewet" of the nuclear fuel rods, effectively halting the rapid increase in cladding temperature that is typically predicted to occur in large break LOCAs. One purpose of Experiment L2-5 is to establish conditions which will result in a large break blowdown without "rewet". Therefore, in Experiment L2-5, the primary coolant pumps (PCPs) are unpowered quickly and then coast down while disconnected from their flywheel system. Such a coastdown during Experiment L2-5 is nontypical since the LOFT pumps would normally coast down while connected to their flywheel system to simulate the normal coastdown of the PCPs in a commercial PWR. The reason of having this nontypical PCP coastdown is the intention of producing core hydraulic conditions which would most likely prevent the early fuel-rod rewet that occurred during Experiment L2-3.

A RELAP5/MOD2 model used in the simulation of Experiment L2-5 is developed for the base case study according to the information provided by the Idaho National Engineering Laboratory (INEL). These information include description of the LOFT facility [2], L2-5 test conditions [3], RELAP5/MOD1 input deck [4], and data report [5]. Except the base case study, sensitivity analyses with respect to various code input uncertainties are also performed to investigate their impacts on the calculation results, and to provide information in setting user guidelines of the RELAP5/MOD2 code. Scenario study on the pump coastdown behavior and simple modification of the CHF correlation in the code are made as well. In these studies, the experiment simulations using RELAP5/MOD2 begin with break initiation and subsequent blowdown, and continue through lower plenum refill, core reflood, and terminate with corewide quench.

This report is organized as follows: section 2 gives brief descriptions of the test facility and conditions. The RELAP5/MOD2 model used to simulate the experiment is described in section 3. In section 4 the calculation results compared to the test data are presented and discussed. Computational efficiency of RELAP5/MOD2 is given in section 5. Finally, some conclusions obtained from this study are drawn in section 6. A listing of the RELAP5/MOD2 input deck for the Experiment L2-5 simulation is provided in Appendix A.

2. FACILITY AND TEST DESCRIPTIONS

2.1 LOFT Facility

The LOFT facility is a 50-MWt pressurized water reactor system with instruments that measure and provide data on the system thermal-hydraulic and nuclear core behavior during postulated LOCAs and anomalous transients. The LOFT facility consists of five major systems: reactor system, primary coolant system, blowdown suppression system, emergency core cooling system, and secondary coolant system.

The LOFT primary-coolant-system (PCS), shown in Figure 1.1, is volume-scaled to a typical four-loop commercial PWR. The general philosophy in scaling coolant volumes and flow areas in LOFT is to use the ratio of the LOFT core power (50 MWt) to a PWR core power (3,000 MWt).

The nuclear core of the LOFT facility is 1.68 m high and 0.6 m in diameter and contains 1,300 fuel rods and 4 control assemblies. A top view of the core arrangement is shown in Figure 1.2. The postulated broken loop and three unbroken loops of a four-loop PWR are simulated by a single broken loop and intact loop, respectively. The broken loop is connected to a suppression tank that holds the effluent and simulates the back pressure in a PWR containment building. The ECCS is designed functionally the same as commercial plant system but has additional flexibility in injection flow rates and locations.

The LOFT system response may not be identical to that of any specific commercial plant for a LOCA or operational transient. However, the LOFT design incorporates the same physical processes and general boundary conditions important to the transient so that results can be used to qualify the accuracy of the analytical models used for predicting accident behavior. The safety of commercial plants can then be assessed by these qualified models.

2.2 Experiment L2-5

LOCE L2-5 is the third experiment conducted in LOFT Power Ascension Experiment Series L2. The purpose of the LOFT L2 experiment series is to provide thermal-hydraulic and fuel behavior data during double-ended cold-leg break experiments at various ECCS conditions. These data are to be used to evaluate and verify models in computer codes to predict large PWR LOCA response.

The major conditions achieved in Experiment L2-5 are: (1) the reactor has been operating at steady state power long enough to establish near equilibrium fission product concentrations; (2) there has been a loss of offsite power coincident with the LOCA, thus the primary coolant pump will be tripped off at break initiation and ECC injection will be delayed for a period of time corresponding to the delay until the commercial plant's emergency diesel is delivering power; (3) the minimum ECC action takes place, which requires that the High Pressure Injection System (HPIS), and Low Pressure Injection System (LPIS) flow rates be scaled to represent only one of the two pumps available for each system; and (4) The PCP will coast down without connection to its flywheel system in order to establish hydraulic condition which would prevent the occurrence of early rewet for this experiment.

2.2.1 Initial conditions Initial reactor criticality occurred about 54 hours prior to experiment initiation. The power level reached 36.0 + 2.0 MW 28 hours prior to Experiment L2-5 initiation, and was maintained at approximately that level until the experiment began. Prior to blowdown, the conditions in the intact loop were established to provide a flow of 192.4 + 7.8 kg/s, with temperature and pressure in the hot-leg of 589.7 + 1.6 K and 14.94 + 0.06 MPa, respectively.

2.2.2 Experiment procedure The experiment was initiated by opening the Quick Opening Blowdown Valves (QOBVs) in the broken loop hot-leg and cold-leg. The reactor scrammed on low pressure at 0.24 + 0.01 s. Following the reactor scram, the operators tripped the PCPs at 0.94 + 0.01 s. Accumulator injection was actuated when the system pressure dropped below 4.2 MPa. Delayed ECC injection from the HPIS and LPIS were actuated at 23.90 + 0.02 and 37.32 + 0.02 s, respectively. The LPIS injection was stopped at 107.1 + 0.4 s, after the experiment was considered complete.

3. CODE AND MODEL DESCRIPTIONS

3.1 Computer Code

The RELAP5/MOD2 Version 36.04 computer code is used to simulate the transient thermal-hydraulic response of the LOFT system during Experiment L2-5. RELAP5/MOD2 is a one-dimensional, two fluid, six-equation, thermal nonequilibrium reactor transient and accident analysis program. This computer code is developed at the INEL for the U.S. Nuclear Regulatory Commission. Specific application of the code to the Experiment L2-5 simulation is discussed in the following sections.

3.2 Model Descriptions

The RELAP5/MOD2 model of the L2-5 simulation is shown in Figure 3.1. The nodalization used in this study is based on the nodalization presented in Reference 4 with changes where necessary to convert the RELAP5/MOD1 model into the RELAP5/MOD2 model and to make simplifica' based on experience obtained in usin- of the code. This mo consists of 128 volumes, 145 junctions, and 77 heat structures to describe the LOFT systems including reactor vessel, b--ken loop, intact loop, pressurizer, steam generator, and ECCS. Brief descriptions of the RELAP5/MOD2 model of the LOFT facitily are presented as follows.

3.2.1 Reactor vessel The reactor core is represented by two parallel six-volume channels --- hot and average channels. The geometry of the hot channel represents that of the center fuel assembly in the LOFT core; the average channel is used to simulate the remaining eight fuel assemblies. Crossflow junctions with appropriate flow areas and resistances between volumes are employed to represent the interconnections of these assemblies. A three-section pipe in parallel with fuel channels is used in modeling the bypass channel.

Modeling of the reactor vessel downcomer is one area of major importance in a large-break LOCA analysis because of ECC water injection phenomena. Conventionally, the downcomer was modelled by a single series of vertically stacked control volumes. The inadequacy of this model was demonstrated in the LOFT large-break LOCA simulations in which strong azimuthal asymmetries were measured, especially during ECC injection. The conventional downcomer model apparently is unable to calculate these phenomena. This deficiency can be improved by modeling the downcomer as a two-channel downcomer interconnected with crossflow junction. In this study, the downcomer is split into two equal parts (with equal flow area and volume) associated with the intact loop and broken loop, respectively. Each part is represented by six stacked annulus components. The connections between the parallel downcomers are represented by crossflow junctions.

The lower plenum and upper plenum are divided into several control volumes and simulated by branch or single-volume components in the RELAP5/MOD2 model.

Cylindrical heat structures are included to represent high-powered fuel rods (4 rods in the core center) and average fuel rods in the hot channel, and average fuel rods in the average channel. These heat structures representing the fuel rods are each divided vertically into six geometrical structures to allow different radial nodalization dimensions of the fuel rods at different axial locations associated with different power levels. The best estimate values of the dimensions of the fuel pellet, gap, and cladding corresponding to the Experiment L2-5 power levels are used in order to obtain the best estimate initial stored energy. Reflood option is chosen for the fuel rod heat structures, and reflood calculation will be turned on when the connected hydrodynamic volume is nearly empty. A maximum number of axial fine mesh intervals of 8 is specified for axial length of 0.28 m during reflood calculation.

Other heat structures representing the flow ducts and reactor vessel are also modelled to describe the appropriate heat transfer between different flow channels, and ambient.

3.2.2 <u>Broken loop</u> Modeling of the broken loop deserves careful attention since the accuracy of the break flow calculation is of major importance in the predictions of the system responses of a large break LOCA. In this study, the broken loops (hot-leg and cold-leg) are simulated by a series of branch and pipe components, and the QOBVs are represented by trip valves to simulate the break junctions. Downstream of the break junctions, the broken loops are connected to time-dependent volumes where the pressure boundary conditions of the blowdown suppression tank (BST) are provided. Flow areas and flow resistances of the junctions along the broken loops are specified to simulate the pump simulator, steam generator simulator, and broken loop piping. Choked-flow model is applied to the junctions wherever the junction flow area is restricted.

Definition of the break geometry is also of importance in accurately calculating the break flow. A discharge coefficient is required to account for multi-dimensional effects at the break that cannot be calculated using one-dimensional computer codes. A recommended discharge coefficient of 0.84 [6,7] is applied in the broken loop cold-leg break for both subcooled and saturated choked flow. However, a discharge coefficient of 1.0 is used for the broken loop hot-leg break.

3.2.3 Intact loop The intact loop modeling includes the hot-leg, loop seal, PCP, and cold-leg which are simulated by branch, single-volume, pipe, and pump components. Pump characteristics (head curves and torque curves) are provided for single-phase conditions. A set of two-phase difference curves are input, in conjunction with the single-phase curves to calculate the two phase pump performance. The moment of inertia of the pump rotor shaft (1.43 kg-m) is used to characterize the coastdown behavior of the PCP.

3.2.4 Pressurizer The pressurizer model is not expected to be sensitive to the calculated peak cladding temperature in a large break LOCA analysis, therefore, simplification with neglecting the water spray and heater is made in order to save computation effort. The pressurizer surge line is nodalized with three control volumes and related junctions. The pressurizer tank is represented by a seven-section pipe with PORV simulated by a trip valve connecting to a time-dependent volume with atmospheric pressure at the top.

3.2.5 Steam generator The steam generator primary side is represented by two branch components in modeling of the inlet and outlet plena, and an eight-section pipe (with four sections direct vertically upward and four sections direct downward) in simulating the steam generator U-tubes. In the secondary side, it is represented by a series of feedwater system, downcomer, boiler, seperator, riser, and mist extractor simulations based on various components available in the RELAP5/MOD2 code. At the exit of the secondary side, a time-dependent volume is used to provide the pressure boundary conditions of the air-cooled condenser. Cylindrical heat structures representing the tubes are added to permit the heat exchange between the primary and the secondary sides of the steam generator. Additional heat structures are also used to simulate the heat loss to the environment.

3.2.6 ECCS The emergency core cooling systems, including the accumulator, HPIS and LPIS are simulated in the RELAP5/MOD2 model. The accumulator is represented by an ACCUMTOR component with back pressure of 4.2 MPa. The HPIS and LPIS are modelled by time-dependent junctions with injected coolant flow controlled by the system pressure. In order to simulate delayed HPIS and LPIS established in L2-5 test, the HPIS and LPIS are initiated in the calculation model at given times (23.9 and 37.32 s, respectively). The accumulator flow is, however, actuated when the calculated system pressure drops below its back pressure, and the accumulator flow rate is determined by the pressure difference and given flow resistance. All emergency coolant injections are conducted to a common volume (volume 600) before being injected to the intact loop cold-leg.

Downstream of the accumulator, a TRPVLV component (junction 603) is used in simulating the accumulator check valve. This component will be used to shutoff nitrogen injection after the accumulator is empty in order to avoid the numerical problem of the RELAP5/MOD2 calculation.

3.3 Initialization Process

The RELAP5/MOD2 model of the L2-5 experiment simulation is initialized to a steady-state corresponding to the test initial conditions before it is utilized for the large break LOCA transient analysis. During initialization, the following processes are taken:

(1) In order to achieve pressure condition, a time-dependent volume with system initial pressure (14.94 MPa) is connected to the top of the pressurizer tank.

(2) In order to obtain correct pressurizer water level (i.e. primary water inventory), a time-dependent volume is connected to the bottom of the pressurizer tank by a time-dependent junction. The flow rate (including both insurge and outsurge flows) of the time-dependent junction is controlled by the difference between

the calculated water level and desired water level. Thermodynamic properties of the water inventory provided by the time-dependent vol me are specified according to the properties of the water in the pressurizer tank.

(3) In the primary coolant system, minor adjustments of the flow resistances at certain locations are made in order to achieve the flow condition and core T.

(4) At the steam generator secondary side, a pressure lower than the measurement is used in the RELAP5/MOD2 model in order to obtain the primary coolant temperature closing to the test data. This requirement shows a possible deficiency of RELAP5/MOD2 in describing heat transfer between the primary and the secondary sides. However, the conditions of the steam generator secondary side is not sensitive in determining the system response of a large break LOCA type of transient, minor adjustment of the secondary side pressure is acceptable.

The initial conditions of the RELAP5/MOD2 model obtained by the initialization process are listed in Table 3.1 in comparison to the test data.

4. RESULTS AND DISCUSSIONS

Results of the experimental simulation of the thermal-hydraulic responses of L2-5 test are assessed through comparison of experimental data. The comparisons presented in this report are representative key parameters of the L2-5 large break LOCA transient.

4.1 Base Case Analysis

Following the test procedure in L2-5 simulation with transient calculation initiated by the opening of break valves, the timings of major events calculated by RELAP5/MOD2 compared to the test data are listed in Table 4.1. There is no significant difference between the calculated transient scenario and the test result.

The calculated pressure response upstream of the cold-leg break (volume 345) compared to the test data are shown in Figure 4.1. An extremely rapid system depressurization commences with the opening of the QOBVs. Figure 4.1 shows that both the calculated and measured pressures drop from 14.94 MPa to 10.0 MPa immediately after the test initiation. As the pressure decreases, the temperature of the liquid in the vessel reaches saturation and flashing phenomenon occurs. Consequently, the depressurization rate is reduced by the voiding in the vessel as shown in both the calculation result and test data. The calculated pressure closely follows the test data at the first five seconds. After that, the pressure is underpredicted by RELAP5/MOD2 with little difference to the measurement. In Figure 4.2, the comparison of the pressurizer pressure is shown. It can be seen that the differences between the calculated and measured pressures are large with lower pressurizer pressure being calculated by RELAP5/ MOD2. This could be resulted from the overprediction of the outsurge flow and the neglect of the pressurizer heat structure in the calculation model. The inflection point of the pressurizer pressure response at the mom nt of pressurizer empty occurs earlier in the calculation than that of measurement. According to the pressurizer water level response shown in Figure 4.3, the calculated pressurizer empty occurs at 10.0 s after the test initiation, which is about four seconds earlier than the test data.

In Figure 4.4, calculated interfacial water levels of the core region, the downcomer region near intact loop, and the downcomer region near broken loop are shown with level zero referring to the bott n of the reactor vessel. Based on the calculated water level in the core region, the L2-5 large break LOCA transient is divided into three periods: blowdown phase (0 to 21 s), refill phase (21 to 30 s), and reflood phase (30 to 54 s). According to the void asurements of L2-5 test, lower plenum refill starts at 22 s and ends with the begining of core reflood at 31 s; and core reflood sequentially completes at 55 s. These events and their timings are well predicted by RELAP5/MOD2. During the blowdown phase, the calculated water level at the downcomer near broken loop declines much faster than that of the downcomer near intact loop. This result emphasizes the necessity of the downcomer modeling used in this study. In the core region, an even faster water level decrease is calculated with minimum water level reaching 0.623 m below the bottom of the active fuel at 21.3 s. At this time, the blowdown phase of the transient ends and the refill phase begins as liquid from the accumulator reaches the lower plenum. The lower plenum is then refilled when the calculated water level reaches the bottom of the active fuel at 30.5 s. The end of the core reflood is calculated when the water level reaches the top of active fuel at 54.0 s. During the reflood period, the calculated water level rises with a rate of 70 mm/s.

Figure 4.5 shows calculated mass flow rates from the accumulator, HPIS, and LPIS. Calculated HPIS and LPIS flow rates shown in this figure are 1.585 kg/s and 6.42 kg/s, respectively. Compared to the test data, calculated HPIS and LPIS flow rates are overpredicted (measured HPIS and LPIS flow rates are 0.75 kg/s and 6.0 kg/s, respectively) because of the underprediction of the system pressure by RELAP5/MOD2. Since the major portion of the ECC flow is provided by the accumulator, the differences found in HPIS and LPIS flow rates can be neglected. The calculated accumulator flow initiated at 15.7 s goes up to 50.0 kg/s at 27.7 s, and then decreases linearly to 30.0 kg/s at the end of the calculation (90.0 s). However, the accumulator flow is, unfortunately, failed to be measured in L2-5 test. After the actuation of the accumulator recorded at 16.8 s, the only available measurement regarding to the accumulator is the accumulator water level, which gives an indication that the

Accumulator flow ends at 50.0 s because the water level drops below the inlet of the variable standpipe at that time. In L2-5 test, the inlet of the variable standpipe is located at 0.95 m above the bottom of the accumulator tank. Therefore, certain amount of water (about 1,200 kg) stored below the variable standpipe inlet would not be injected into the reactor vessel. This condition is not included properly in the calculation model of the base case study which consequently leads to a continuous accumulator flow after 50.0 s in the calculation result. This error may not be significant in calculating the L2-5 transient since major events are almost complete at that time. A sensitivity study with accumulator tripped off at 50.0 s will be performed to investigate whether it is important or not in calculating the L2-5 transient.

According to the test data, single-phase blowdown ends and two-phase blowdown begins at the cold-leg break 3.4 s after the experiment initiation. While in the calculation, break flow transition from subcooled to saturated condition occurs at 2.0 s. Calculated cold-leg break flow rates compared to the test data are shown in Figure 4.6. It is seen that RELAP5/MOD2 gives good result in the prediction of the cold-leg break flow during the blowdown period. In general, subcooled break flow is slightly underpredicted while saturated break flow is overestimated by the RELAP5/MOD2 model. During the refill and reflood periods, RELAP5/MOD2 calculates an almost zero break flow while the test data shows a bunch of water slugs periodically rush out of the cold-leg break. The cold-leg break flow observed during the refill and reflood periods of L2-5 test may be attributed to the ECC bypass which is not calculated by the RELAP5/MOD2 model. Certainly, the underprediction of the system pressure shown in Figure 4.1 could be the reason of the underestimation of the break flow during these periods. After 70.0 seconds, increased cold-leg break flow rates are calculated because the calculated downcomer water level increases to the level of the cold-leg break by the excessive accumulator flow.

For the hot-leg break flow comparison shown in Figure 4.7, significant differences are found during the blowdown period. However, the calculated break flow shows excellent agreement with the test data later on. During blowdown, the measured flow rate shows a hump shape response while the calculated break flow monotonically decreases from its initial peak value. It is seen that the measured flow rate drops from an initial flow of 210 kg/s to a minimum flow of 30 kg/s at 4.0 s, and then increases to a maximum flow of 70.0 kg/s at 8.0 s. During this period, the break flow is significantly overpredicted by the RELAP5/MOD2 model. In the test data, the reason for the break flow to increase during system depressurization is very difficult to identify without other detailed measurements. The break flow can be increased with the increasing density (or with the decreasing void fraction) near the break. Probably, the break flow increase as observed in L2-5 is due to "loop clearance" occurred at the top of the steam generator simulator. During the blowdown period, bubbles are generated by flashing flow upward along the U-tube (0.367 m ID pipe) of the steam generator simulator. Because the broken loop flow is restricted by the critical discharge at the break, the flowing bubbles could be momentarily accumulated in the region of the U-tube bend which results in a vertical stratification pattern in the U-tube pipe. At the moment when the broken loop cold-leg starts voiding, the cold-leg break flow rate is suddenly reduced which produces a perturbation to push the upstream liquid in the broken loop hot-leg over the U-tube bend. This liquid push over will yield consequently a syphon phenomenon which leads to void reduction near the break and therefore the hot-leg break flow increases. Calculated void fractions near the breaks are shown in Figure 4.8. From this figure, it is noted that the broken loop hot-leg starts voiding immediately after the break initiation. Small oscillation of the hot-leg void are calculated during the period of 4.0 to 8.0 s resulted from the occurrence of significant void in the broken loop cold-leg. The hot-leg void oscillation leads to oscillation of the hot-leg break flow without having flow increase in the calculation results. The failure in the prediction of the hot-leg break flow increase during blowdown with the RELAP5/MOD2 code could refer to its capability in the modeling of the phase seperation and loop clearance phenomena.

The mass flow rate of the intact loop cold-leg is shown in Figure 4.9. Before the accumulator flow initiation, the cold-leg flow calculated by RELAP5/MOD2 agrees reasonably well with the test data. Flow oscillation observed in L2-5 after ECC injection due to direct contact condensation is also calculated by RELAP5/MOD2 with smaller oscillation magnitude than the test data.

The comparison between calculated and measured results of the intact loop hot-leg flow is shown in Figure 4.10. Significant discrepancies of the flow rates during the blowdown period are found in this figure. In order to understand the differences, a more detailed comparison of the hot-leg flow during the blowdown period is presented in Figure 4.11 with zero flow indication. It clearly shows that calculated flow rates are lower than the test data at the first few seconds of the initial period. After four seconds of the transient, negative flow rates (water runback) caused by the PCP stop are calculated with similar magnitudes of the positive flow rates shown by the test data. It is known [5] that as the result of partial failure of the flow measurement in test L2-5, the test data provides only the magnitude of the intact loop hot-leg flow without indication of the flow direction. However, the differential pressure measurement across the intact loop hot-leg indicates the existence of reverse flow during the blowdown period because the measured differential pressure changes sign from an initial positive value to a negative value at 5.0 s, and maintains negative pressure difference to the end of the blowdown period.

Calculated core flow rates during the blowdown period are shown in Figure 4.12. It shows that the core inlet flow changes direction immediately after the break initiation from a positive (upward) flow of 195 kg/s to a negative (downward) flow of 250 kg/s, while a positive flow is sustained at the core outlet for 0.5 s. This bidirectional flow configuration results in the reducing of water inventory in the core region, flow stagnation somewhere in the core, and the occurrence of transient CHF. Core flow oscillation induced by direct condensation during ECC injection is also calculated and presented in Figure 4.13.

Calculated cladding temperatures of the hot channel hot rod at different axial elevations (with level 1 corresponding to the bottom node) are shown in Figure 4.14. It is seen that significant temperature rises are calculated for the fuel rod cladding at levels 2, 3, and 4 when CHF conditions are predicted at 0.3 s. At the level 1 position, temperature spikes occur with relatively small magnitudes during the blowdown and refill periods. At higher portions of the fuel rod (levels 5 and 6), calculated cladding temperatures keep going down without departure from saturation temperature during the whole transient. However, the cladding temperature measurements located at various axial positions from the bottom to the top of the hottest fuel rods indicate that the whole fuel rods experience CHF during L2-5 test. Inaccurate predictions of the cladding temperature responses at the upper and lower parts of the fuel rod could be resulted from inaccurate prediction of the CHF. The present model used in RELAP5/MOD2 for CHF calculation is the Biasi correlation which overpredicts the CHF by 60% in the comparison to the dryout experiment conducted at the Royal Institute of Technology in Sweden [8]. A sensitivity study with reduced Biasi CHF will be performed to see whether the cladding temperature prediction can be improved.

In test L2-5, a peak cladding temperature (PCT) is recorded at one third of the full length of the fuel rod from the bottom which corresponds to the elevation at the middle of the level 2 and level 3 positons in the calculation model. However, differences in calculated cladding temperatures between the level 2 and level 3 positions are small. Therefore, calculated cladding temperatures of the level 3 elevation shown in Figure 4.15 are used in the comparison to the test data. According to the calculated cladding temperature response, the CHF occurrence is predicted at 0.3 s after the break initiation. The calculated cladding temperature reaches a peak value of 1,112 K at 7.0 s and sustains at that level to the end of the blowdown period without the occurrence of the early fuel rod rewet. An enhanced cooling is calculated after the reflood model is turned on at 26.0 s, which depresses the cladding temperature to a calculated quench temperature (T) of 530 K at 57.2 s. In test L2-5, the cladding temperature drops before the CHF occurs at 0.9 s. After that, a severe heatup of the fuel rod cladding is detected, and the cladding temperature increases from 600 K to 1,000 K in six seconds. A slower temperature increase is then measured to the end of the refill period with the PCT of 1,077 K reached at 28.5 s after the experiment initiation. Early quenching phenomena observed in test L2-3 does not occur in test L2-5 because different hydraulic conditions achieved in these tests. At the begining of the reflood period, the measured cladding temperature starts declining with slower decreasing rate than that of the calculated temperature. Fuel rod quench occurred at 54.0 s is detected when the cladding temperature drops to 820 K which is about 300 K higher than the RELAP5/MOD2 calculation. The underestimation of the fuel rod quench temperature by RELAP5/MOD2 is also found in the comparison to FLECHT-SEASET data [9]. It is caused by a simplified formula in computing quench temperature currently used in the reflood heat transfer package which gives an almost constant quench temperature of 520 K [1]. Based on the observation of the quench temperature in test L2-5, the calculation model should be reexamined.

The underprediction of the cladding temperature before quench caused by an excessive cooling is calculated with the reflood model of RELAP5/MOD2. Currently, the reflood model uses a correlation for the dispersed-flow film boiling heat transfer based on Dougall and Rohsenow's modifications to the single phase flow Dittus-Boelter correlation. It is known that the correlation does not account for nonequilibrium effect, therefore, tends to overpredict the film boiling heat transfer coefficients [10,11].

The excessive precursory cooling of the fuel cladding by the RELAP5/MOD2 calculation could also be caused by excessive interfacial drag with its present model [12,13]. Too much liquid is entrained from the lower plenum to the core region. In the hydraulic volumes next to the fuel where post-dryout condition occurs, the flow regimes predicted by RELAP5/MOD2 are mist (dispersed) flow during the refill and reflood periods. Increased liquid droplet entrainment will increase interface heat transfer area between the liquid and vapor, which in turn will reduce the degree of vapor superheating in rod bundles and lead to a higher driving potential for energy removal. In addition, the vapor superheating could be also underpredicted by RELAP5/MOD2 with its present interfacial heat transfer model at high void flow conditions [14,15]. Moreover, steep increase of the wall heat flux is calculated at the moment of the reflood model actuation, which contributes also to the excessive precursory cooling. Detailed discussions of the reflood model calculation can be seen in the following section.

Evidence of RELAP5/MOD2 underpredicting the vapor superheating can be observed from the comparison of fluid temperatures at the upper plenum and hot-leg. Calculated fluid temperatures at the upper plenum (volume 240) compared to the test data are shown in Figure 4.16. The temperature measurements indicate the existence of superheated steam while calculated temperatures show that both the liquid and vapor stay saturated during the refill and reflood periods. At the end of the reflood period, subcooled ECC water reaching the upper plenum region is calculated. Superheated vapor is also observed in the hot-leg region during L2-5 test. Fluid temperature responses at the intact loop and broken loop are shown in Figures 4.17 and 4.18, respectively. Again, the comparison clearly indicates that RELAP5/MOD2 fails in calculating the extent of vapor superheating of the L2-5 transient.

In the intact loop cold-leg, near the ECC injection point, subcooled liquid temperatures are calculated at the moment of the accumulator flow initiation. According to the measurements shown in Figure 4.19, the thermocouple could be surrounded by vapor space at the initial period of the accumulator injection, subcooled temperature is detected with several seconds delay. Temperature oscillation measured during the accumulator injection can be caused by the alternate contact of the liquid and vapor phases with the thermocouple. However, measured fluid temperature in the intact loop cold-leg is higher than the RELAP5/MOD2 prediction. The underprediction of the liquid temperature could be resulted from underestimation of the condensation with the RELAP5/MOD2 model.

In the downcomer region, calculated liquid temperatures of the upper portion (volume 202 and 282) and the lower portion (volume 210 and 290) are shown in Figures 4.20 and 4.21, respectively. It is seen that calculated temparatures near the intact loop where ECC water is injected are different from that near the broken loop. At the intact side, the delivery of the subcooled ECC water to the downcomer is calculated with few seconds delay after the accumulator flow initiation. At the broken side, subcooled liquid temperature is calculated in the downcomer when the liquid level increases during the refill and reflood periods. In test L2-5, downcomer fluid temperature measurements are located at an azimuthal angle of 155 away from the intact loop cold-leg. The fluid temperature responses measured at various axial locations in the downcomer region are shown from Figures 4.22 to 4.25 for the comparison to the calculated temperatures in the downcomer near the broken loop. The temperature underprediction shown in these figures could be caused by the underprediction of the heat transfer between the vessel hot wall and the ECC liquid. Of course, the downcomer liquid temperature could be also underpredicted if the ECC condensation is underestimated with the RELAP5/MOD2 model.

The comparison of the fluid temperatures of the broken loop hot-leg is shown in Figure 4.26. Significant differences found fter 60.0 s are caused by the excessive accumulator injection in the calculation model.

The comparisons of the fluid densities of the intact loop cold-leg, intact loop hot-leg, and broken loop cold-leg are presented in Figures 4.27, 4.28 and 4.29, respectively. Calculated fluid densities in the intact loop cold-leg agree well with the measurements before the actuation of the accumulator. Increased densities with ECC injection are noted in the test data with significant variations resulted from local measurement. In the calculation results, the volume-averaged densities are shown with smooth changes. Density overprediction in the RELAP5/MOD2 calculation after 60.0 s is due to overfill of the downcomer by excessive accumulator flow. Excessive carryover of the core liquid to the intact loop hot-leg is illustrated by the high density fluid present after 45.0 s (see Figure 4.28). The cause of this carryover lies in the interfacial drag model used in the RELAP5/MOD2 code. In the broken loop cold-leg (volume 345), calculated densities shown in Figure 4.29 are in good agreement with the test data during early period of the transient. After about 10.0 s, calculated densities in general are higher than the measurements. It is interesting to note that the calculated density in the broken loop cold-leg is high while the calculated cold-leg break flow shown in Figure 4.6 is almost zero during the ECC injection period. The questions turn out to be where the high density fluid comes from and where it goes during the refill and reflood periods. In Figure 4.30, calculated mass flow rates of the BLCL junction (vessel outlet junction from volume 282 to volume 335) and the cold-leg break junction are shown. From this figure, it is seen that fluid periodically flows into the broken loop cold-leg and back to the reactor vessel without exiting flow through the break during 25.0 to 42.0 s. However, whether the flow is provided by the carryover from the downcomer or resulted from the ECC bypass phenomena in the calculation model remains unknown. Calculated flow rates of the BLCL junction are compared to that of junction 272 and junction 283 in Figure 4.31. A positve flow of the junction 272 represents bypass flow from the intact side (volume 202) to the broken side (volume 282); while a negative flow of the junction 283 indicates the amount of carryover from downcomer to the broken loop. It is seen from Figure 4.31 that in general the junction 272 flow is less than zero, i.e. reverse flow is calculated on the flow path of the ECC bypass. It is known that the ECC bypass phenomena will occur when the ECC water can flow downward the annulus downcomer by gravity and be swept out through the break by the escaping upward steam flow, that is, due to the counter-current flow limitation (CCFL) phenomenon. However, there is no direct modeling of the CCFL in RELAP5/MOD2, and the existing model of the interfacial drag is not good enough in retarding the downflow of the ECC water [16]. Therefore, it can be concluded that the RELAP5/MOD2 model does not calculate ECC bypass in the L2-5 simulation. High density fluid of the broken loop cold-leg during ECC injection is resulted from excessive carryover with the present RELAP5/MOD2 models.

4.2 Sensitivity Studies

In addition to the base case calculation, sensitivity studies are performed to explore the effects of input modeling and code options. Scenario study and simple model modification, specifically speaking, the pump coastdown behavior and the Biasi CHF correlation are also analyzed in elucidating the code performance. The identifications of the cases analyzed in this study are listed in Table 4.2 with the conditions which are different from that of the base case. The purpose and the results of the sensitivity studies are discussed in the following sections.

4.2.1 ACCUM50 This case study is used to identify the influences of the thermal-hydraulic response predictions resulted from the excessive accumulator flow of the base case. Calculated accumulator flows compared to the base case are shown in Figure 4.32. The water level comparisons are presented from Figure 4.33 to 4.35. Major differences of the water level responses can be seen when the accumulator flow is tripped off at 50.0 s in the ACCUM50 case. The cold-leg break flow shown in Figure 4.36 indicates similar results except some flow spikes after 70.0 s are calculated. Calculated fluid densities of the broken loop cold-leg are compared in Figure 4.37. Simulation with correct accumulator flow stop can improve the prediction of the density at later period. However, the calculated density of the ACCUM50 case is still higher than the test data. In Figures 4.38 and

4.39, calculated cladding temperatures are shown. It is seen that there is no significant difference in the cladding temperature prediction resulted from the difference in the accumulator simulation. With lower accumulator flow simulated in the ACCUM50 case, the fuel rod quench is delayed by 2.0 seconds compared to the base case.

4.2.2 BLHL-HT In the base case study, it is found that the hot-leg break flow is overpredicted during the blowdown phase. Considering the possible uncertainties in the temperature measurements, higher initial temperatures of the broken loop hot-leg are used in the BLHL-HT case to see if the hot-leg break flow prediction can be improved.

Reduced hot-leg break flow with the increasing of the initial temperature is shown in Figure 4.40. However, the hump shape of the break flow response shown by the test data is still failed to be calculated. With reduced hot-leg break flow, increasing of the cold-leg break is expected. Figure 4.41 shows that the calculated cold-leg break flow of the BLHL-HT case is higher than the base case in the first two seconds. Cladding temperature responses at various axial locations are compared in Figure 4.42. Significant difference is seen in the cladding temperature at level 2 position. This could be resulted from the relocation of the stagnation point. Higher flow resistance can be induced by the higher initial temperature in the broken loop hot leg, which moves the stagnation point upward in the core region and introduces an increased reverse flow in the level 2 node immediately after the opening of the QOBVs. The increased reverse flow will then prevent the deviation from saturation at that location. However, the calculated PCT at the hottest location (level 3) of the BLHL-HT case is only 20 K lower than that of the base case (see Figure 4.43).

4.2.3 BLHL-DC The calculated flow can be reduced with reducing of the discharge coefficent specified in the RELAP5/MOD2 input. In the BLHL-DC case, the hot-leg break dischage coefficent is reduced from 1.0 in the base case to 0.8.

It is seen from Figure 4.44 that the calculated hot-leg break flow is decreased by this input change, but with limited difference from the base case. The other parameters, including the pressure, cold-leg break flow, and cladding temperature responses, shown in Figures 4.45 to 4.48 indicate minor effects of the hot-leg break discharge coefficent on the L2-5 simulation.

4.2.4 BLHL-5K Regarding the uncertainty of the form loss coefficient during flow transient condition, a sensitivity study is needed to investigate the possible impacts in the large break LOCA calculation. In the BLHL-5K case, the form loss coefficents of the junctions in the broken loop hot-leg specified in the RELAP5/MOD2 input are five times of the base case.

Calculated pressures of the broken loop cold-leg and pressurizer compared to the test data are shown in Figures 4.49 and 4.45, respectively. It is seen that the system pressure increases with increased form loss coefficient in the broken loop hot-leg. During the blowdown period, the calculated pressure of the broken loop cold-leg is higher than the test data with increased form loss coefficient, however, the calculated pressure of the pressurizer is still much lower than the test data. Significant reduction of the hot-leg break flow is seen in the BLHL-5K case (see Figure 4.51). In general, better agreement on the hot-leg break flow is seen in the BLHL-5K case, but the initial break flow is apparently underestimated. Because of the increasing of the system pressure, the calculated cold-leg break flow shown in Figure 4.52 is increased with the increasing of the form loss coefficent. The comparisons of the cladding temperatures are presented in Figures 4.53 and 4.54. The major difference is found in the temperature response of the level 2 position as resulted from the relocation of the stagnation point. The fuel quench time is delayed by 8.0 seconds while the PCT is compatible in the comparison to the base case.

4.2.5 PV-X-PL The RELAP5/MOD2 numerical scheme is generally formulated using one-dimensional elements. However, there are several applications where an approximate treatment of crossflow provides an improved physical simulation. One major application of the crossflow junction is to provide a tee model. In the L2-5 base deck, the pressure vessel outflow junctions connecting to broken loops are considered to be normal junctions. In reality, the momentum flux in the reactor vessel is perpendicular to the momentum flux in the broken loop. Therefore, crossflow junctions instead are chosen in the PV-X-BL case to identify the difference with this option in the L2-5 simulation.

Important parameters with respect to the large break LOCA transient, including the break flows and cladding temperatures, are shown in Figures 4.55 to 4.58. It is interesting to see the calculated break flows, both in the hot-leg break and the cold-leg break, with crossflow junction modeling are equal to the base case. The effects of the crossflow option on the cladding temperature responses are calculated with limited differences. The PCT calculated in the PV-X-BL case is the same as that of the base case.

4.2.6 MESH#32 A fine mesh-rezoning scheme is implemented to efficiently use the two-dimensional conduction solution for reflood calculations. It is suggested in the RELAP5/MOD2 manual that appropriate user-specified maximum number of axial fine mesh intervals is 8 to 32 with the length of hydrodynamic volumes ranged from 0.15 m to 0.6 m. In the analysis of the MESH#32 case, the number of fine mesh intervals increases from 8 used in the base case to 32.

The results of this study are presented in Figures 4.59 to 4.62. It is seen that important paramters calculated with increased number of fine mesh intevals are identical to those in the base case, except a little differenco of the fuel quench time.

4.2.7 FUEL-GAP It is well known that fuel gap distance (or gap conductance) is an extremely important parameter in determining the PCT during a large break LOCA. In the L2-5 base deck, varied fuel gap distances are used for various axial and radial locations of the fuel rods in accordance with different power levels. At the hottest section, the fuel gap distance specified in the base deck is 0.04944 mm. In the FUEL-GAP case, a mominal fuel gap distance of 0.0953 mm [2] is universally used for fuel rod modeling at various locations. The increase of the fuel gap distance will reduce the gap conductance and, consequently, increase the initial rod temperature and the initial stored energy.

Radial profiles of calculated rod temperatures at the hottest location are presented in Figure 4.63. It is seen that the initial fuel rod centerline temperature of the FUEL-GAP case is 270 K higher than the base case. The effect of the increased stored energy on the cladding surface temperature can be seen in Figures 4.64 and 4.65. The PCT calculated for the FUEL-GAP case is 130 K higher than that of the base case in the L2-5 simulation. This disparity emphasizes the importance of fuel-rod modeling for the large break LOCA transient analysis. Calculated break flows presented in Figures 4.66 and 4.67 are, however, not affected by the increasing of the fuel gap distance.

4.2.8 PUMP-FW The major difference observed between the LOCE L2-3 and L2-5 tests is the early rewet phenomena as a result of different operations of the primary coolant pumps during the transients. In the base case study, no early rewet of the fuel rod is calculated according to the pump operation of L2-5. In a sensitivity study [4] performed with earlier version RELAP5/MOD1, it is found that the early rewet of the fuel rod can be predicted in the L2-5 simulation if the pumps coast down with their flywheel system. In this study, the same assumption on the pump behavior is used to see whether the RELAP5/MOD2 code can predict early quenching.

Figure 4.68 shows the coolant mass flow rate of the intact loop cold-leg provided by the surge flow from the coastdown pump. It is seen that with the assistance of the flywheel system the cold-leg flow of the PUMP-FW case is sustained for a longer period than the base case. Because of the higher coolant flow in the intact loop cold-leg of the PUMP-FW case, a positive core flow is re-estabilished at earlier time and results in a higher core flow between 5.0 to 10.0 s in the comparison to the base case (see Figure 4.69). However, calculated cladding temperature shown in Figure 4.70 indicates no early rewet even though the pumps coastdown with their flywheel is assumed in the calculation. Calculated cladding temperatures of the PUMP-FW case deviate from the base case after 7.0 s with small difference. The calculated PCT of the PUMP-FW case is almost the same as that of the base case. Calculated break flows shown in Figures 4.71 and 4.72 can be used to illustrate the insignificant effect of the pump coastdown behavior on the break flow calculation in the L2-5 simulation.

4.2.9 CHF*0.6 Regarding the failure of the cladding temperature predictions at the upper and lower portions of the hottest fuel rods in the base case study, the accuracy of the Biasi CHF correlation used in RELAP5/MOD2 is questioned. This sensitivity study is performed with a modified Biasi correlation (simply multiply by a factor of 0.6) to see whether the cladding temperature prediction can be improved.

Results of the cladding temperatures are shown in Figures 4.73 to 4.75. It is learned that the discrepancies of the cladding temperature responses at the upper portion of the fuel rod found in the base case still exist in the CHF*0.6 case. The calculation model still fails in predicting CHF at low power sections. Moreover, the predictions of the cladding temperatures of the hottest portion are even worse with the CHF reduction. In Figure 4.73, it is seen that the time-to-CHF is reduced from 0.3 s in the base case to almost time zero with the reduction of the CHF, and the associated PCT is calculated to be 500 K higher than the test data. Therefore, a solid statement on the Biasi correlation can not be made, and the reason for the failure of the cladding temperature prediction is unknown.

4.2.10 NORFLOD Different heat transfer correlations are used in RELAP5/MOD2 for post-dryout condition between the calculations with and without reflood model option [1]. The reflood model calculation is actuated when the system pressure is lower than 1.0 MPa, when the mass flux is less than 200 kg/m s, and when the connected hydrodynamic volume is nearly empty. In view of the failure of the cladding temperature prediction resulted from the excessive precursor cooling during the reflood period of the base case analysis, an experimental simulation is performed without the actuation of the reflood model in the RELAP5/MOD2 calculation.

Calculated void fractions in the hot channel of the NORFLOD case compared to the base case are shown in Figure 4.76. In general, the calculated void fraction without using reflood model is a little higher than that of calculation with reflood model. In Figure 4.77, calculated cladding temperatures at various axial elevations of the NORFLOD case are shown. It is seen that high cladding temperatures are sustained for the rest of the reflood period without significant precursory cooling before quench because lower heat fluxes are calculated for the NORFLOD case in the comparison to the base case (see Figure 4.78). Discontinuity of the heat flux calculation is exhibited in the base case at the moment of the reflood model actuation. The calculated vapor temperature comparison shown in Figure 4.79 indicates also a significant vapor temperature increase with the heat transfer package switching. These discontinuities should be further studied to see whether they are real situations.

The comparisons of the cladding temperatures are shown in Figures 4.80, 4.81, and 4.82 for various axial elevations. Significant improvement in the cladding temperature prediction at the hottest section results in the NORFLD case study. In Figure 4.80, it is seen that not only the cladding temperatures before quench but also the fuel rod quench temperature and its timing calculated without the reflood model are in good agreement with the test data. These results may indicate that either the criteria used in RELAP5/MOD2 for the actuation of the reflood model calculation are inadequate or the heat transfer package in the reflood model is improper. However, the suggestion of not using reflood model in the L2-5 simulation can not be justified because the accuracy of the RELAP5/MOD2 model in predicting local hydraulic conditions (quality, droplet size, interfacial area, and two phase velocities) is still an open question. It would be almost impossible to evaluate separately the heat transfer correlations and hydraulic models in calculating the cladding temperature response during post-dryout dispersed flow conditions.

5. RUN STATISTICS

The computational efficiency of the RELAP5/MOD2 simulations are summarized in Table 5.1. The simulations are conducted on a FACOM M200 computer which is compatible to an IBM MVS system.

6. CONCLUSIONS

In this study, the large break LOCA test L2-5 is analyzed by the RELAP5/MOD2 model. The test simulations begin with break initiation and subsequent blowdown, and continue through lower plenum refill, core reflood, and terminate with corewide quench. Major events and their timings of the large break test L2-5 are well predicted by the RELAP5/MOD2 model. Important parameters, such as pressure, break flow, and cladding temperature, are calculated with reasonable agreement in the comparison to the test data. Especially, the most critical parameter in the large break LOCA, the peak cladding temperature, is very well calculated by the RELAP5/MOD2 model. Noticed differences and code deficiencies found in the L2-5 test simulation and various major findings of the sensitivity studies are described in the following:

1. The broken loop pressure is well predicted (slightly underestimated) while the pressurizer pressure is significantly underpredicted. The underprediction of the pressurizer pressure is caused by the overprediction of the outsurge flow during blowdown.
2. Significant differences in the water level responses between the downcomer near the intact loop and the downcomer near the broken loop are calculated. It indicates that the downcomer modeling employed in this study is quite important in a large break LOCA analysis.

3. The effect of the excessive accumulator injection after 50.0 s found in the base case calculation is insignificant in determining the transient behaviors of the L2-5 simulation. Since L2-5 failed to measure the accumulator flow rate, the calculated result according to the accumulator model used in the RELAP5/MOD2 calculation can not be verified. However, according to the comparison of the major event timing, the calculated accumulator flow rate could be a close resemblance to the test condition.
4. The hot-leg break flow is overpredicted by RELAP5/MOD2 during early stages of the transient. The measured hot-leg break flow rate shows a hump shape response while the calculated break flow monotonically decreases from its initial peak value during the blowdown period. The break flow increase during blowdown observed in L2-5 could be resulted from momentarily accumulation of the bubbles in the U-tube bend and sequentially the occurrence of the "loop clearance" by the liquid push over. These phenomena could be out of the RELAP5/MOD2 calculation capability. In the sensitivity studies, no improvement in the hot-leg break flow is calculated with various input modifications.
5. Flow oscillation observed in L2-5 after ECC injection due to direct contact condensation is calculated by RELAP5/MOD2 with smaller oscillation magnitude than the test data. In the comparison of the fluid temperatures in both the cold-leg and

the downcomer regions, it is found that RELAP5/MOD2 underpredicts the fluid temperature during ECC injection period. These differences indicate a possible deficiency in the condensation model of the present RELAP5/MOD2 code.

6. During ECC injection, high density fluid is calculated in the broken loop cold-leg. However, the high density liquid in the calculation is provided by the carryover from the downcomer region instead of the ECC bypass. Compared to the measured density, it is found that the carryover is overpredicted with the interfacial drag model of RELAP5/MOD2.
7. According to the cladding temperature measurements located at various axial elevations, the hottest fuel rods from the bottom to the top experience CHF conditions during L2-5 test. The RELAP5/MOD2 calculation, however, shows that only the middle high power portions of the fuel rods suffer from dryout while the lower and upper elevations of the fuel rods stay cooled in the transient analysis. In the sensitivity study with the reduction of the Biasi CHF by a factor of 0.6, the calculation results do not give better predictions of the cladding temperatures at the low power elevations. Moreover, the calculated cladding temperatures at the high power elevations significantly deviate from the test data with the reduction of the CHF.
8. With the reflood model calculation, excessive precursor cooling of the fuel rod results which leads to the underesti-

mation of the cladding temperature during the reflood period. Calculation without using the reflood model, not only the calculated cladding temperatures but also the quench temperature and its timing are in very good agreements with the test data. However, the exciting results of this special calculation could be caused by wrong reasons, because the accuracy of the RELAP5/MOD2 model in predicting local hydraulic conditions is still an open question. However, the results may indicate that either the criteria used in RELAP5/MOD2 for the actuation of the reflood model calculation are inadequate or the heat transfer package in the reflood model is improper. In any case, the discontinuities of the calculated rod surface heat flux and vapor temperature indicate a discontinuous heat transfer coefficient before and after the actuation of the reflood model. Further review is required for these discontinuity.

9. In the sensitivity studies of the large break LOCA test L2-5, the calculated PCTs of various cases are obtained during the blowdown period. The calculated PCTs are quite insensitive to different input modifications including (1) adjusted accumulator modeling; (2) initial temperature distributions in the broken loop hot-leg; (3) flow resistances of the broken loop hot-leg; (4) discharge coefficient of the critical flow at the hot-leg break; (5) cross-flow junction used for the linkage between the broken loop and the reactor

vessel. However, significant differences in the PCT calculations are found in the studies of the fuel gap dimension and the CHF correlation.

10. With the assumption of having flywheel connected during pump coastdown, the calculation results show that the present RELAP5/MOD2 model does not yield blowdown quench phenomena.

Table 3.1 Initial Conditions of LOCE Test L2-5

Parameter	L2-5	RELAP5/MOD2
Power level (MW)	36.0 ± 1.2	36.0
Primary colant system mass flow (kg/s)	192.4 ± 7.8	194.97
Hot-leg pressure (MPa)	14.94 ± 0.06	14.935
Intact loop hot-leg temperature (K)	589.7 ± 1.6	589.71
Intact loop cold-leg temperature (K)	556.6 ± 4.0	556.24
Core ΔT (K)	33.1 ± 4.3	33.47
Broken loop hot-leg temperature (K)	561.9 ± 4.3	565.44
Broken loop cold-leg temperature (K)	554.3 ± 4.2	554.31
S.G. secondary side pressure (MPa)	5.85 ± 0.06	5.548
S.G. secondary side flow (kg/s)	19.1 ± 0.4	18.86
Pressurizer water level (m)	1.14 ± 0.03	1.14

Table 4.1 Sequence of Events in LOCE Test L2-5

Event	Time (s) L2-5	Time (s) RELAP5/MOD2
Experiment initiation	0.0	0.0*
CHF occurred	0.9	0.3
Primary coolant pump trip	0.94	0.94*
Liquid level drops below top of core	3.2#	1.7
Liquid level drops below bottom of core	5.4#	5.0
Peak cladding temperature reached	30.0	7.0
Pressurizer empty	14.0	10.0
Accumulator flow initiation	16.8	15.7
End of blowdown	22.0#	21.3
HPIS flow initiation	23.9	23.9*
Lower plenum refill	31.0#	30.5
LPIS flow initiation	37.3	37.3*
Core reflood	55.0#	54.0
Final core quench	62.0	57.2
Transient ended	120.0	90.0

* Boundary conditions

\# Rough estimate from void measurements in the core region

Table 4.2 Cases Analyzed in the Sensitiuity Study of the LOCE Test L2-5 Simulation

Case	Conditions different from the base case
ACCUM50	Smaller accumulator volume (67% of the base case) and accumulator flow tripped-off at 50.0 s
*BLHL-HT	Initial temperature of 590 K (25 K higher than the base case) is specified in the broken loop hot-leg
BLHL-DC	Discharge coefficient of 0.8 (instead of 1.0 in the base case) is used in the hot-leg break
BCHL-5K	Junction form loss coefficents used in the broken loop hot-leg are five times of the base case
PV-X-BL	Cross-flow junction is used in connecting the broken loop to the pressure vessel
MESH#32	Number of reflood fine mesh intervals increases from 8 to 32
*FUEL-GAP	Nominal fuel gap distance of 0.0953 mm (about twice larger than the base case) is assumed without considering possible fuel swelling effect
PUMP-FW	Pump coastdown with 316.04 kg-m^2 inertia (instead of 1.431 kg-m^2 in the base case) produced by its flywheel system
CHF*0.6	CHF calculated by the Biasi correlation is reduced by a factor of 0.6
NORFLOD	Calculation without the actuation of the reflood heat transfer model

*Initialization process is performed before transient calculation

Table 5.1 Run Statistics of the LOCE Test L2-5 Simulation

Case	Transient Time(s)	CPU(s)	Number of Time Step	Number of Volume Cell	*Performance Number
BASE	90	3277.13	6284	128	4.074
BLHL-HT	60	2301.99	4394	128	4.093
BLHL-DC	60	2280.81	4335	128	4.110
BLHL-5K	90	2761.04	5220	128	4.132
PV-X-BL	60	2310.41	4436	128	4.069
MESH#32	60	2423.19	4494	128	4.213
FUEL-GAP	80	2969.44	5825	128	3.983
PUMP-FW	60	2330.01	4452	128	4.089
CHF*0.6	90	3068.71	5992	128	4.001
NORFLOD	80	2685.07	5503	128	3.812

*Performance Number=

CPU x 10^3/ [Number of Time Step] / [Number of Volume Cell]

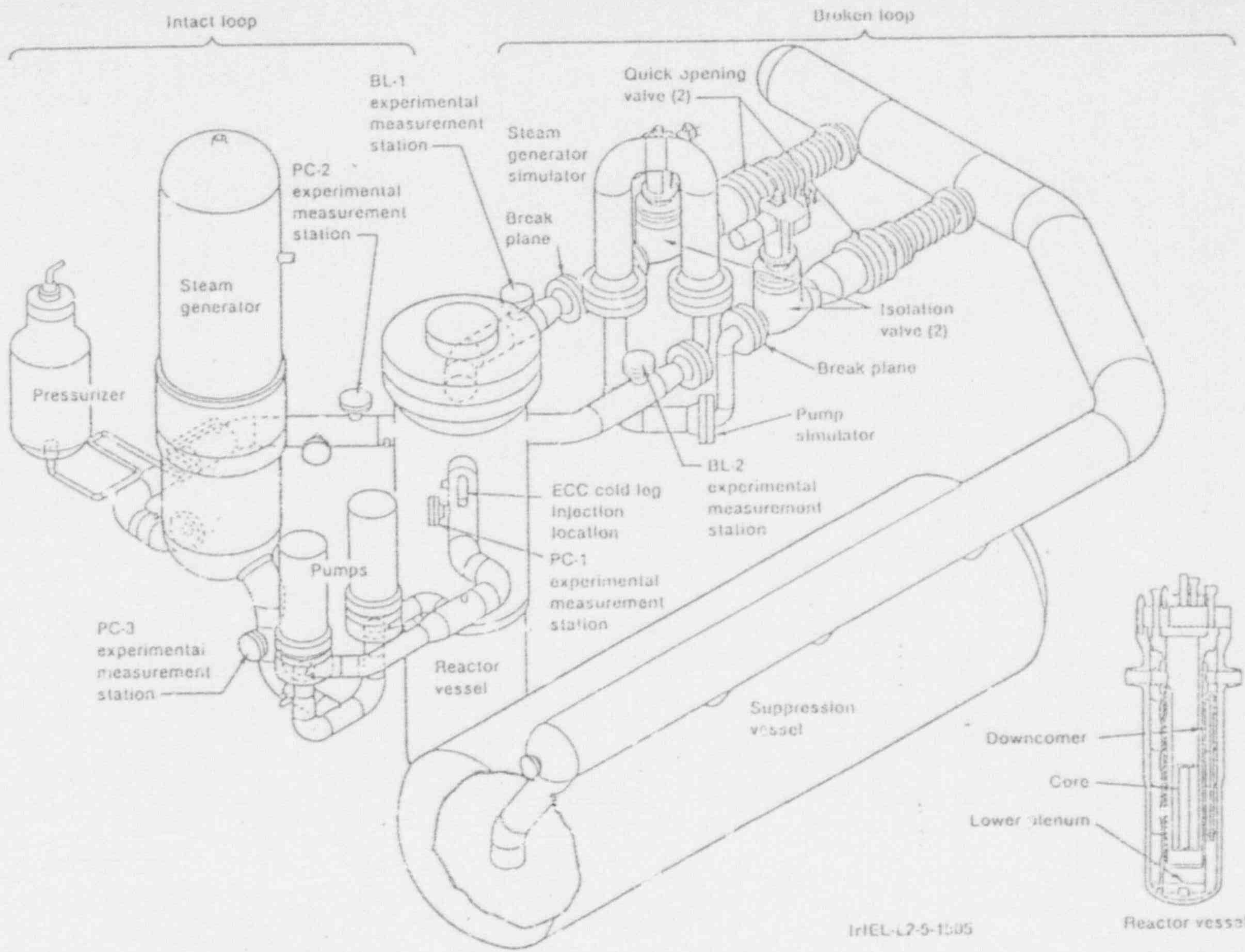


Figure 1.1 LOFT Facility Major Components

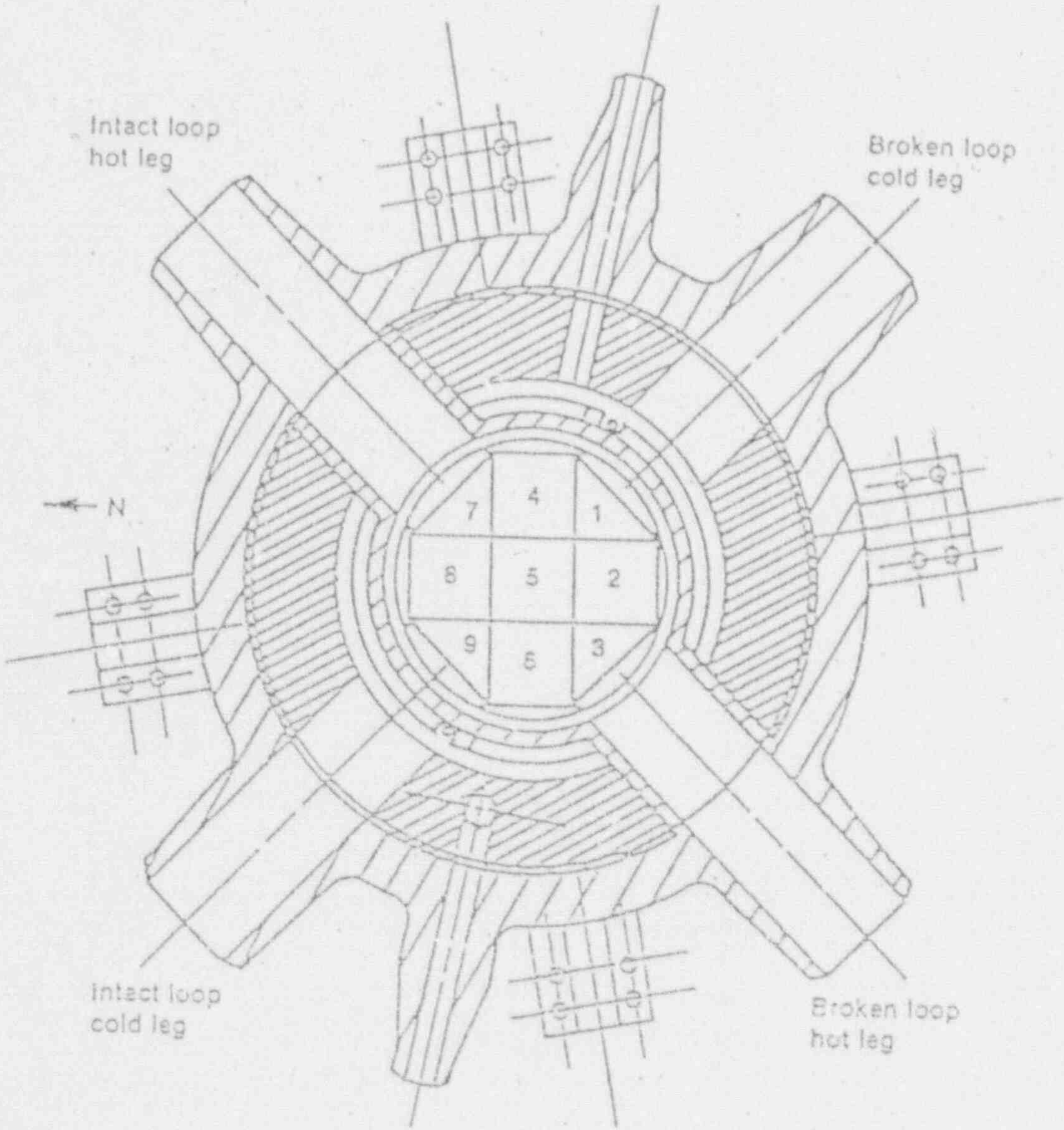


Figure 1.2 LOFT Facility Core Arrangement

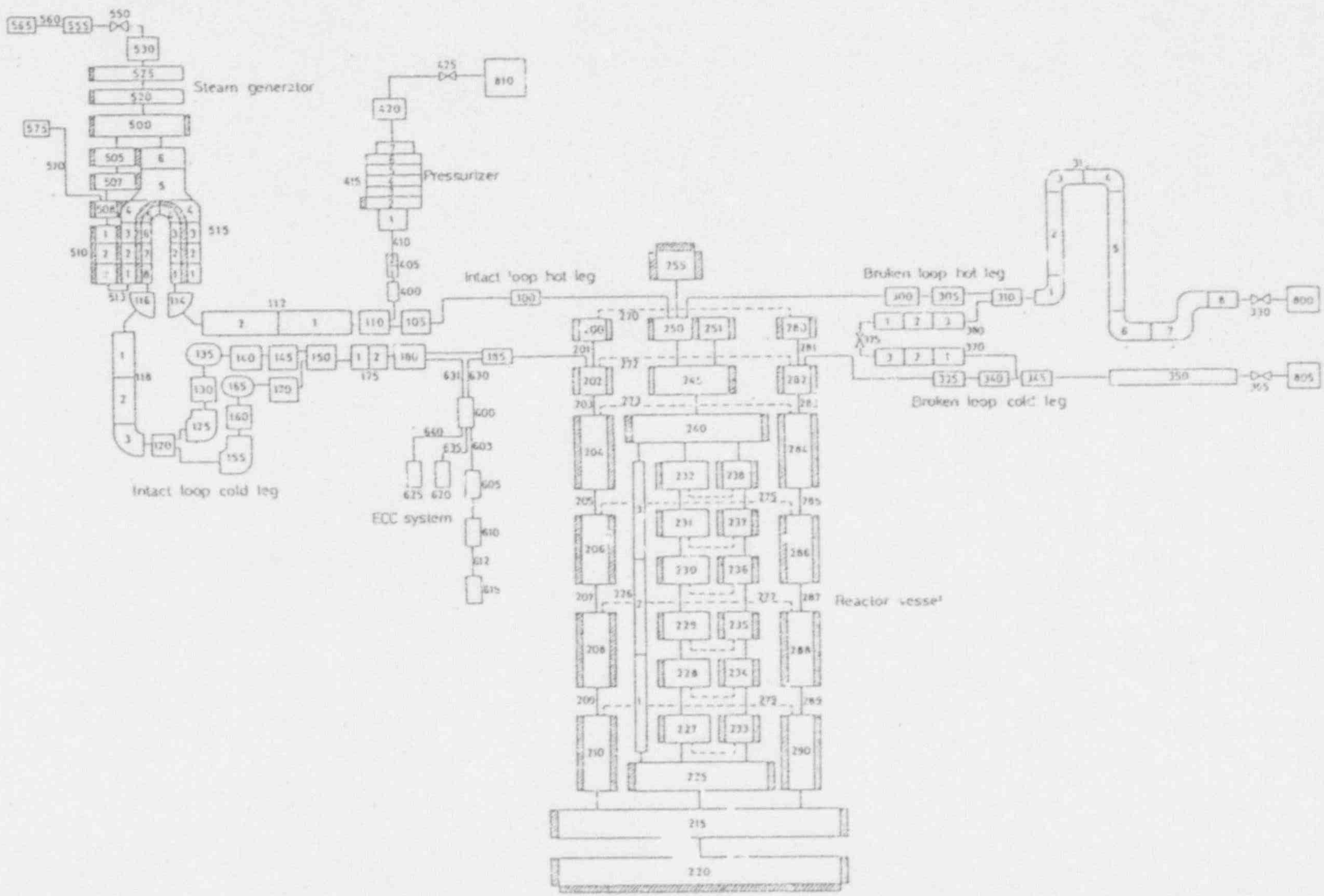


Figure 3.1 RELAP5/MOD2-LOFT Large Break Model Nodalization for Experiment L2-5

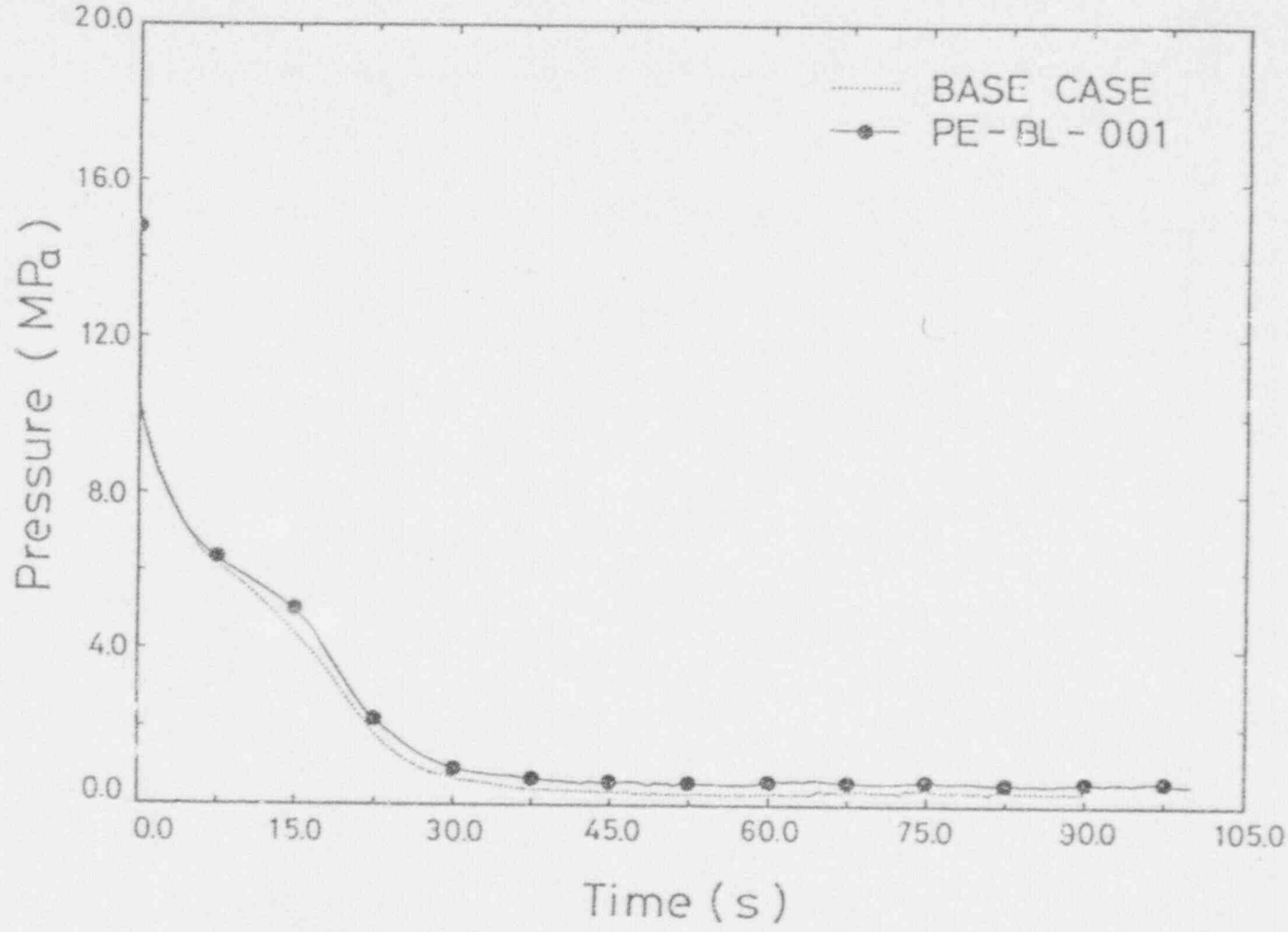


Figure 4.1 Comparison between the Calculated and Measured Broken Loop Cold-Leg Pressures of Test L2-5

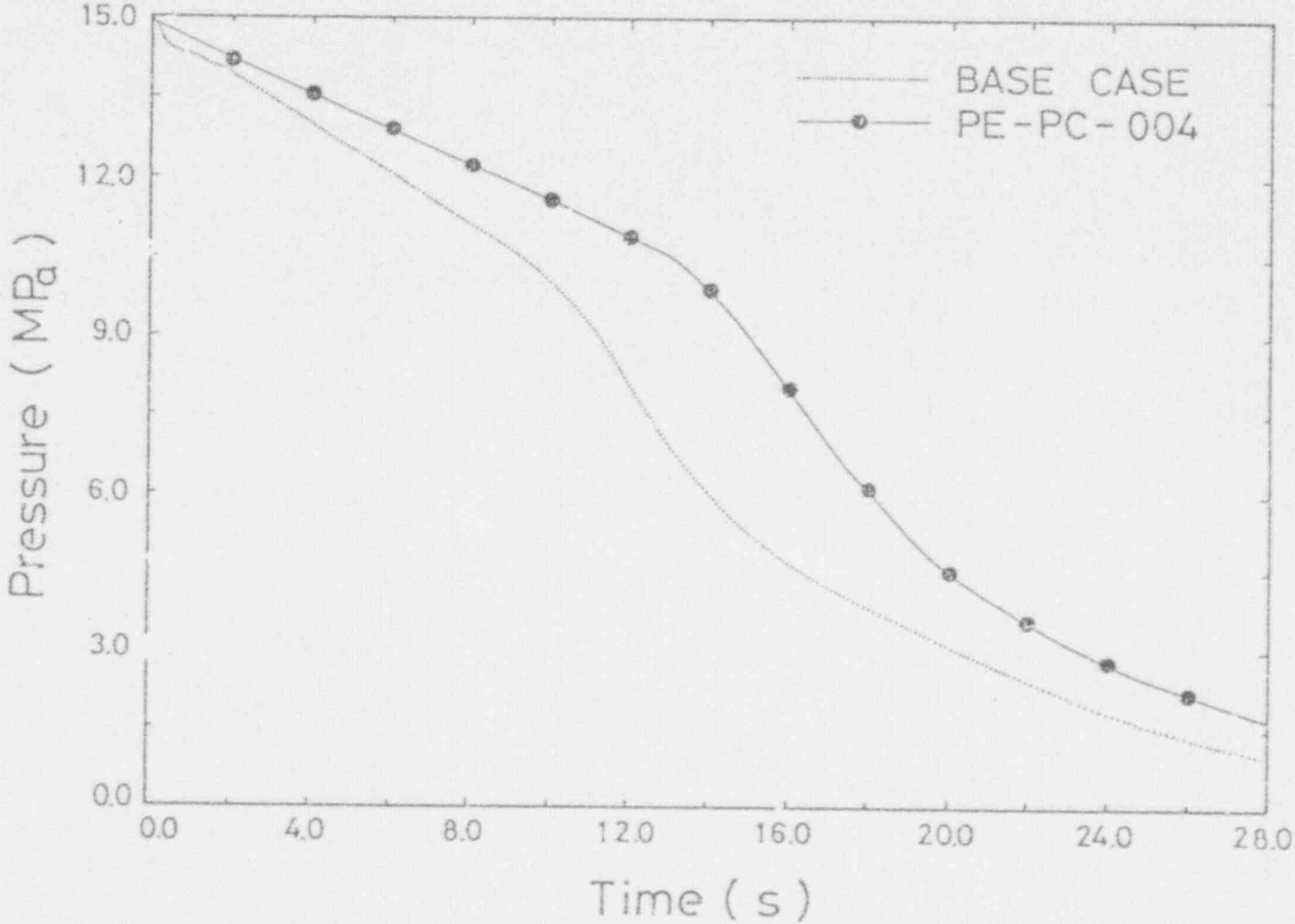


Figure 4.2 Comparison between the Calculated and Measured Pressurizer Pressures of Test L2-5.

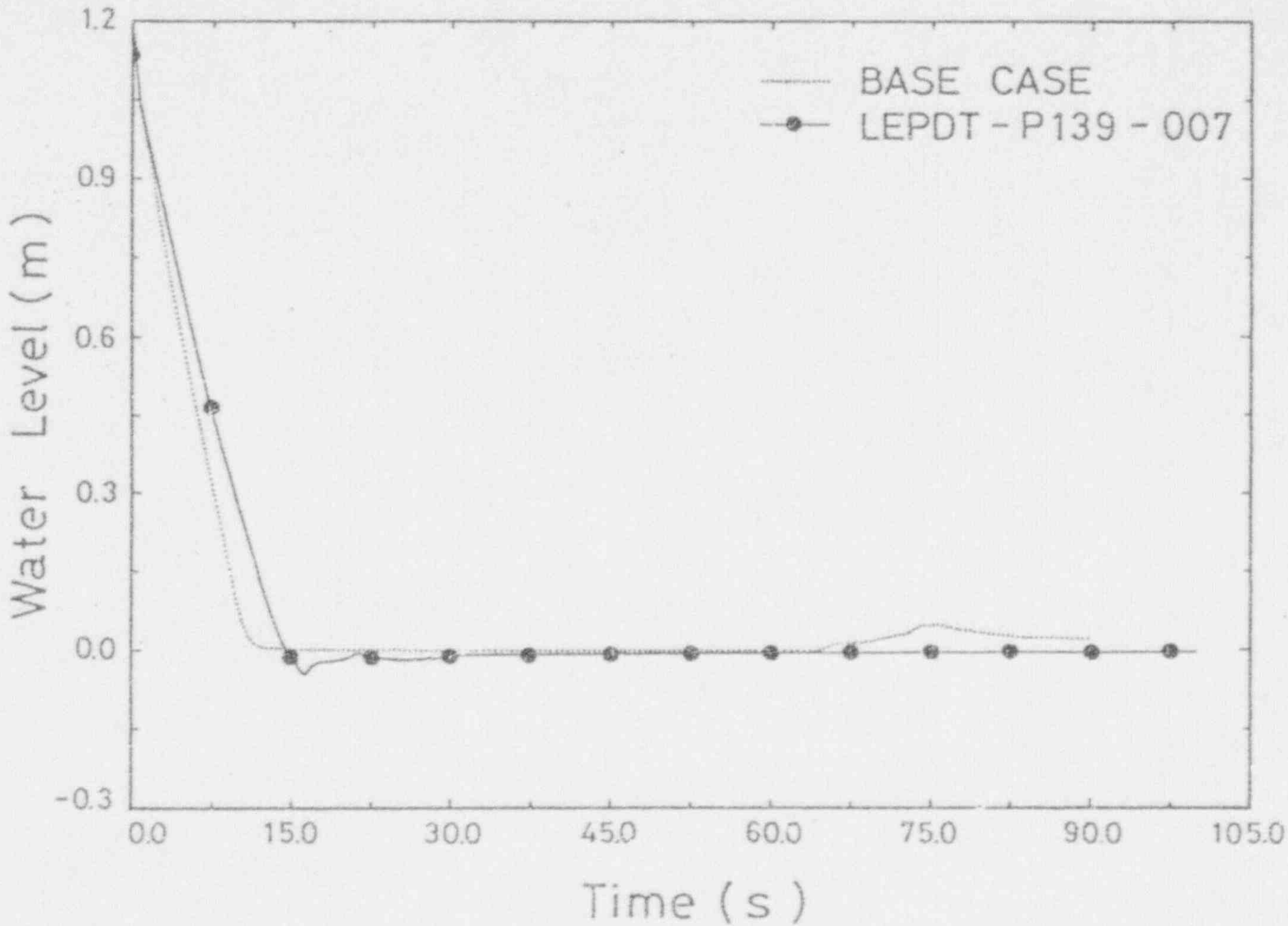


Figure 4.3 Comparison between the Calculated and Measured Pressurizer Water Levels of Test L2-5

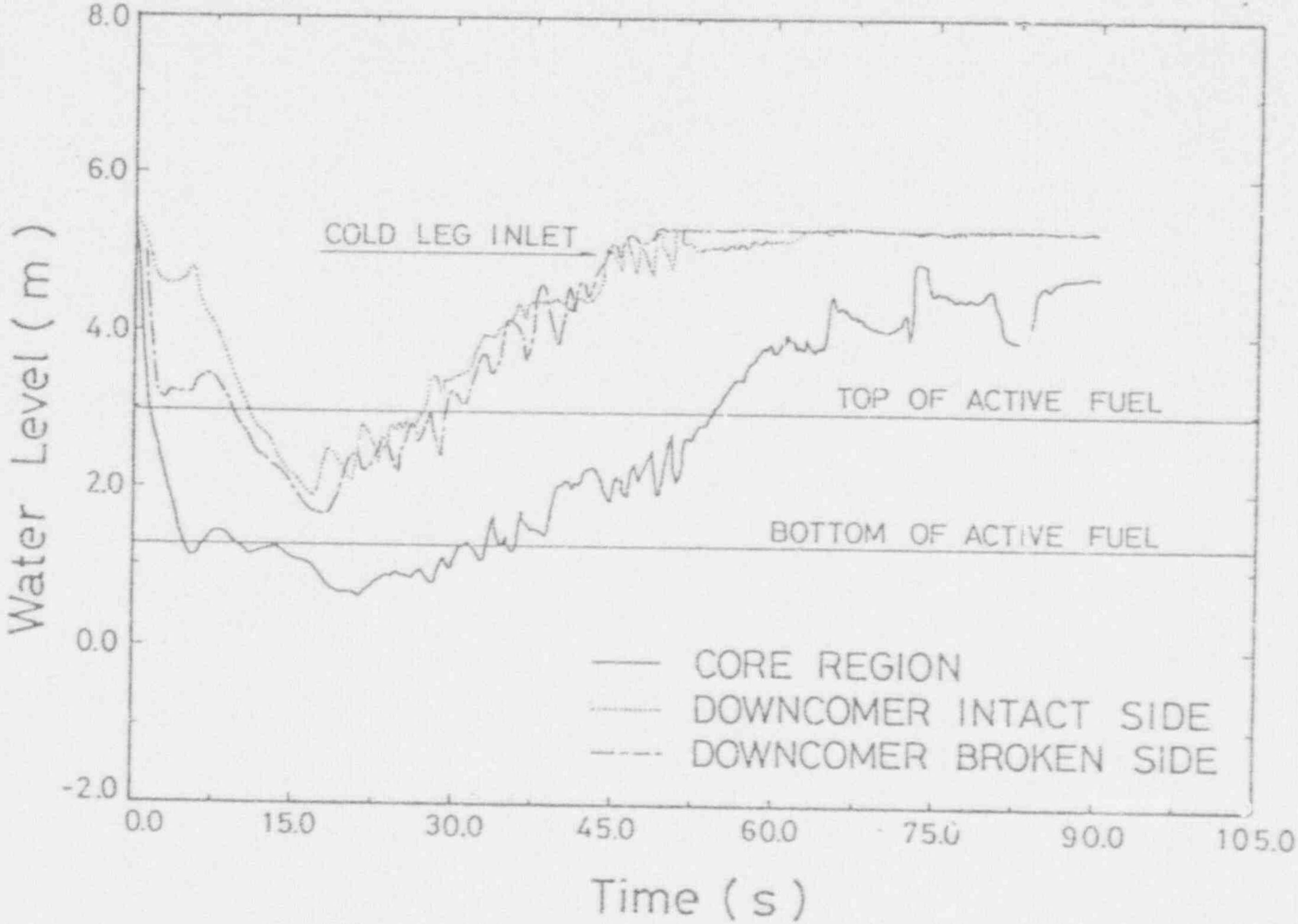


Figure 4.4 Calculated Water Levels in Reactor Vessel of Test L2-5 Simulation

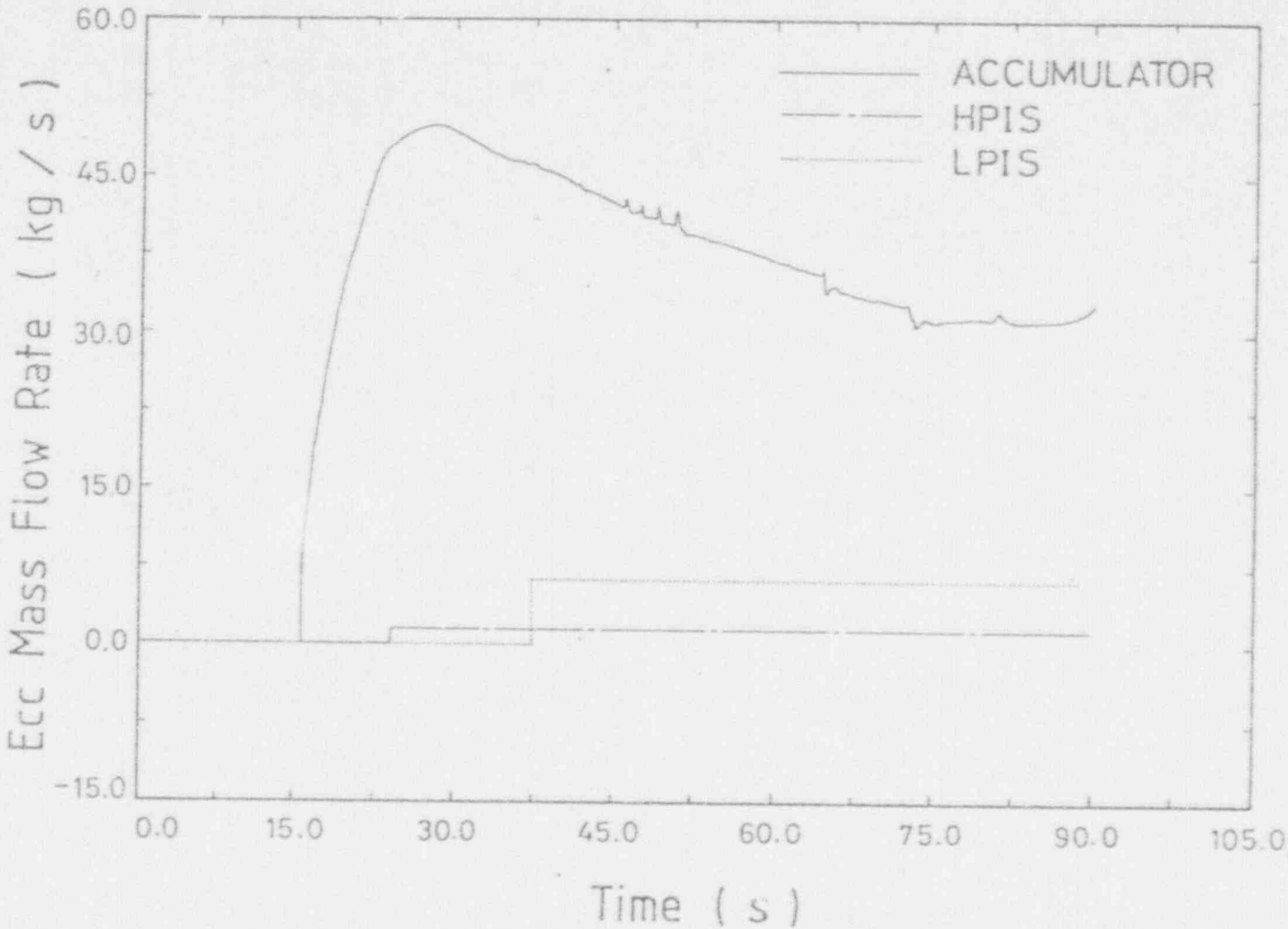


Figure 4.5 Calculated ECC Flow Rates of Test L2-5 Simulation

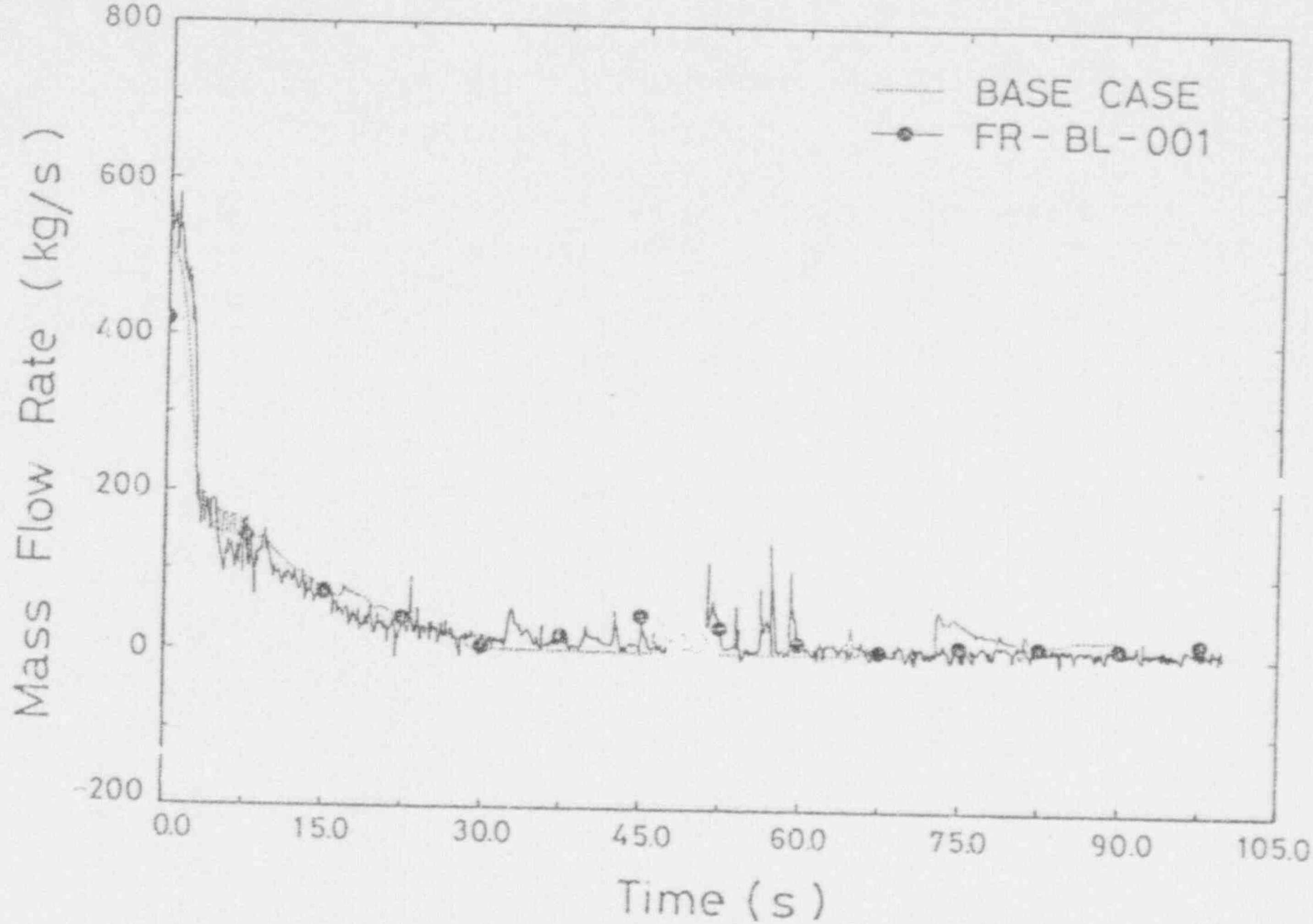


Figure 4.6 Comparison between the Calculated and Measured Cold-Leg Break Flow Rates of Test L2-5

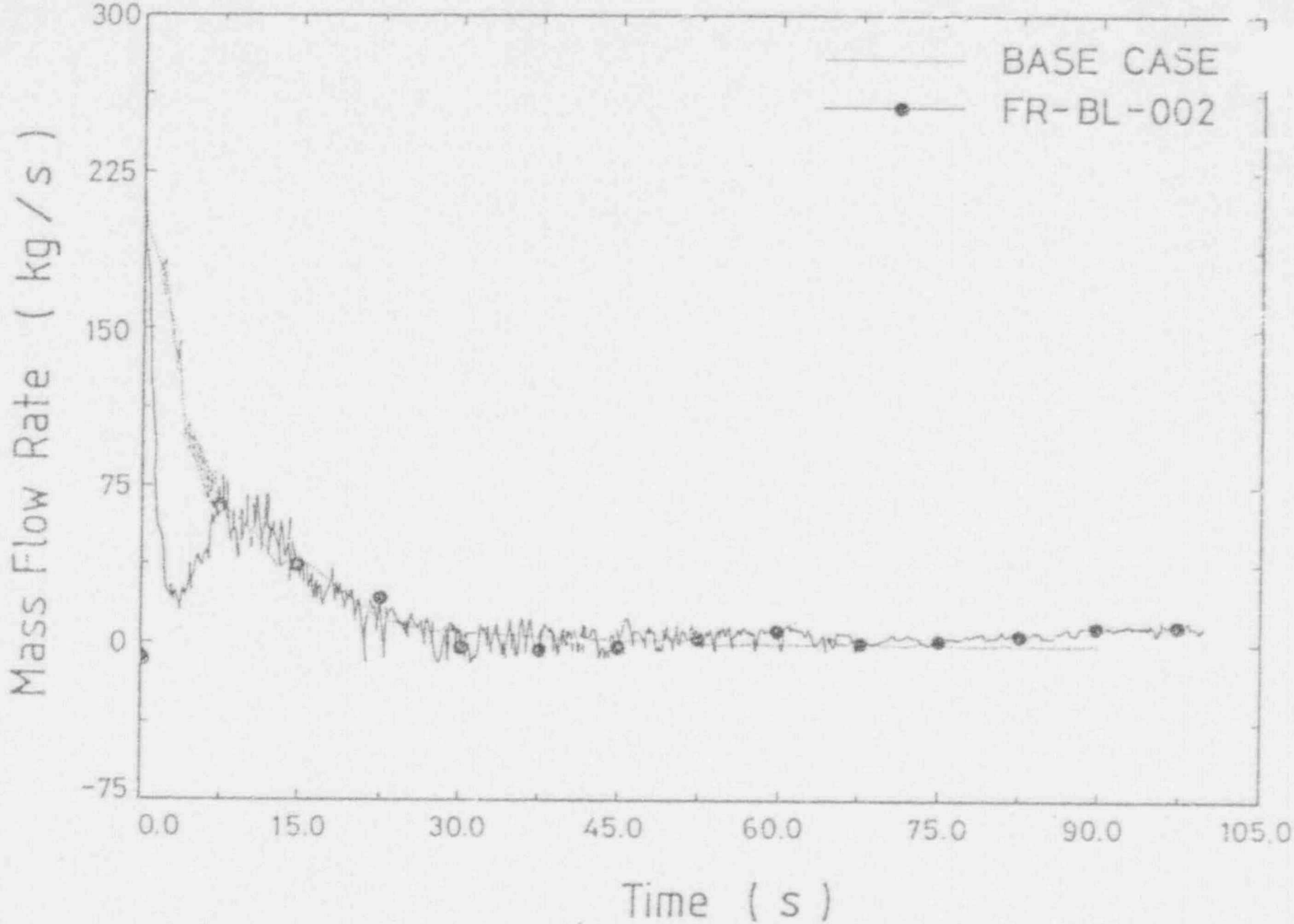


Figure 4.7 Comparison between the Calculated and Measured Hot-Leg Break Flow Rates of Test L2-5

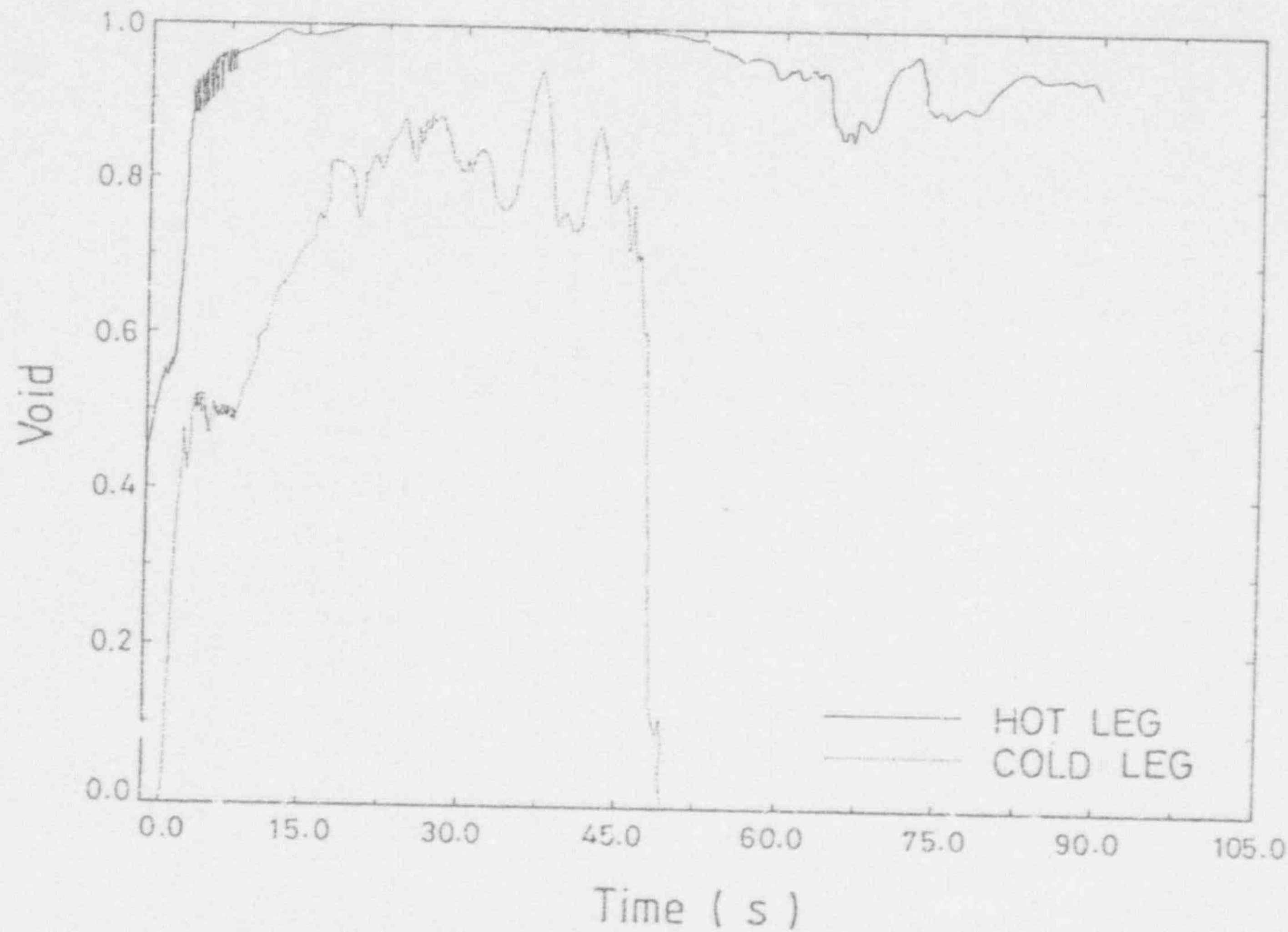


Figure 4.8 Calculated Void Fractions Upstream the Break Junctions of Test L2-5 Simulation

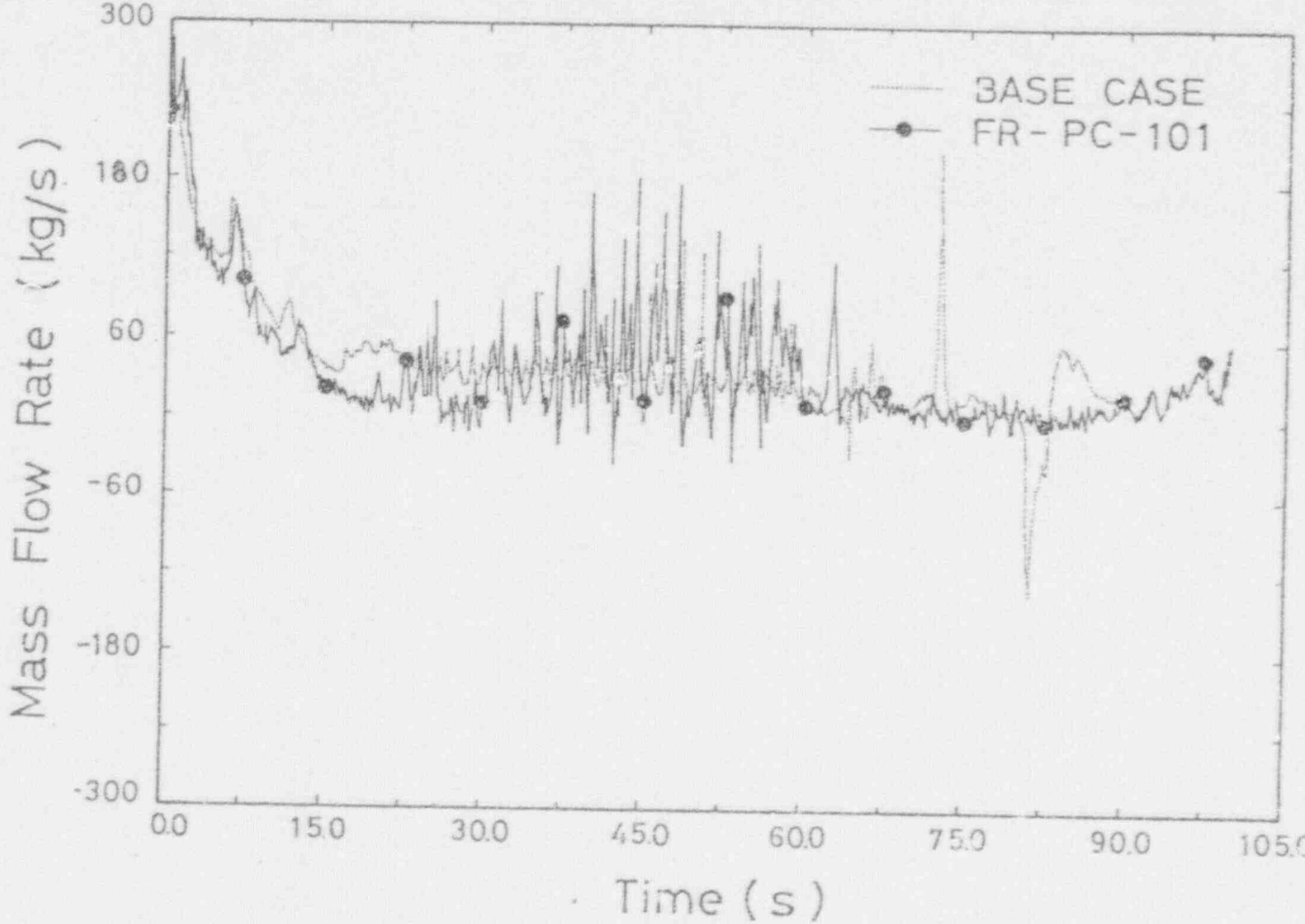


Figure 4.9 Comparison between the Calculated and Measured Intact Loop Cold-Leg Flow Rates of Test L2-5

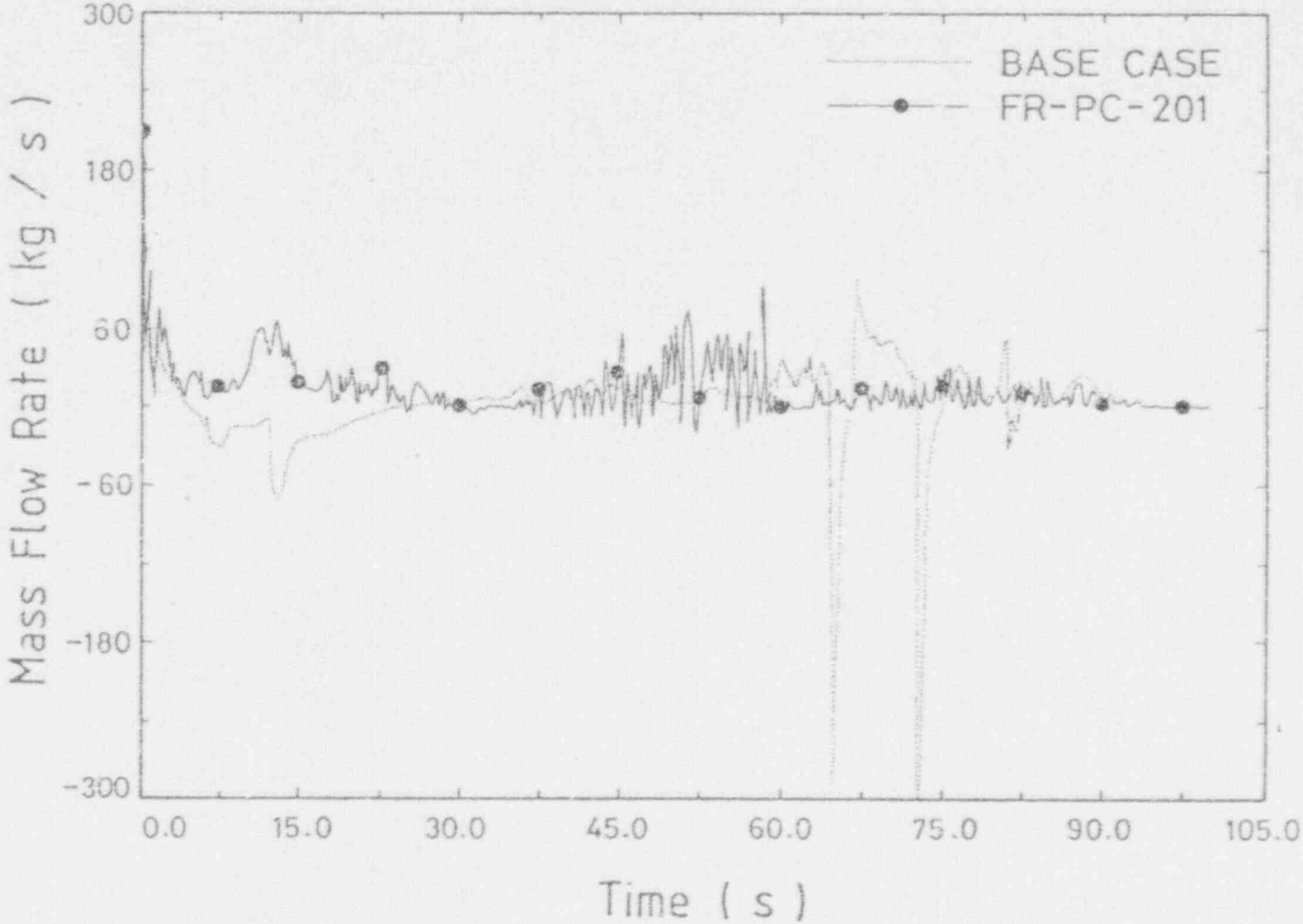


Figure 4.10 Comparison between the Calculated and Measured Intact Loop Hot-Leg Flow Rates of Test L2-5

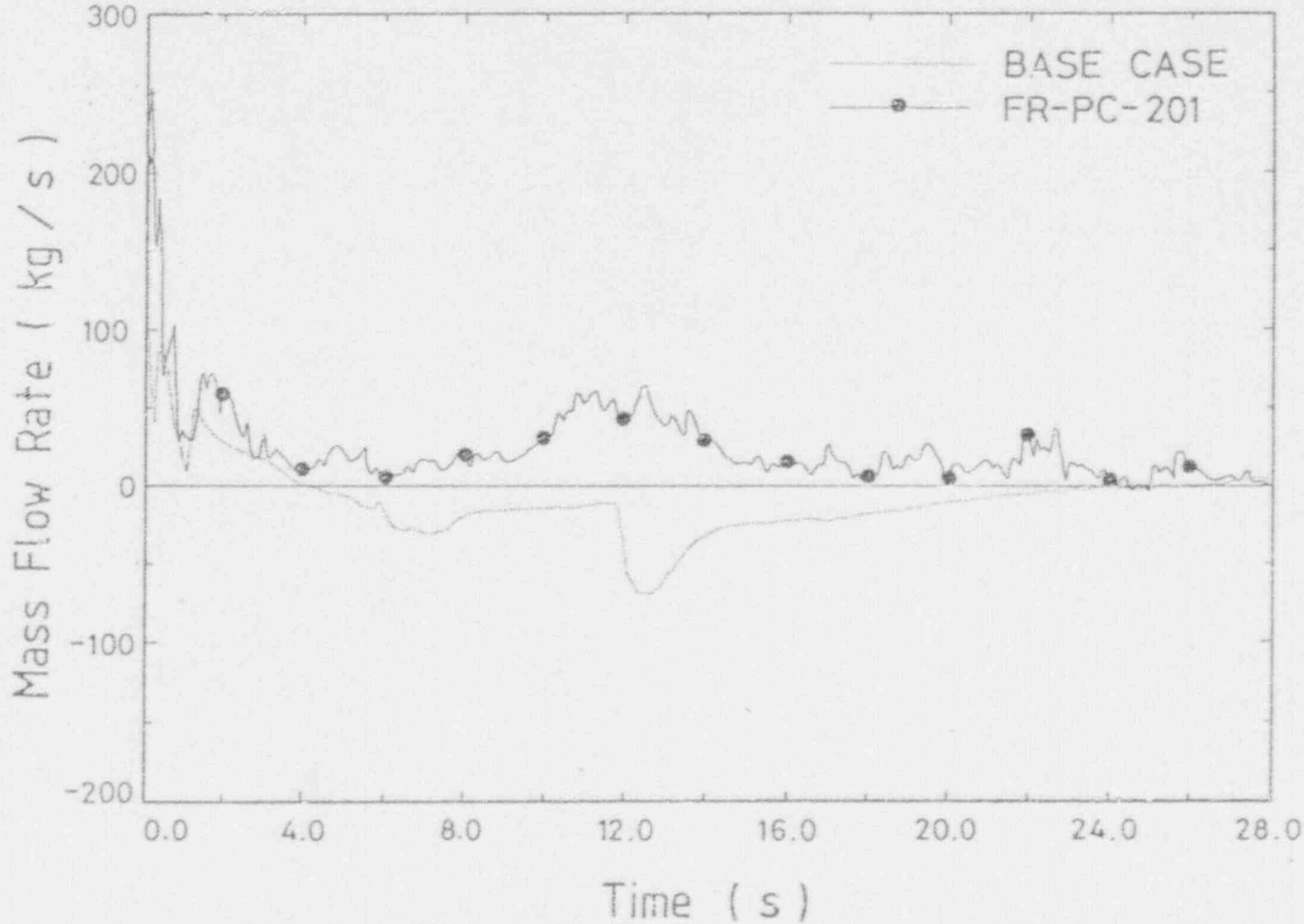


Figure 4.11 Comparison between the Calculated and Measured Intact Loop Hot-Leg Flow Rates During the Blowdown Period of Test L2-5

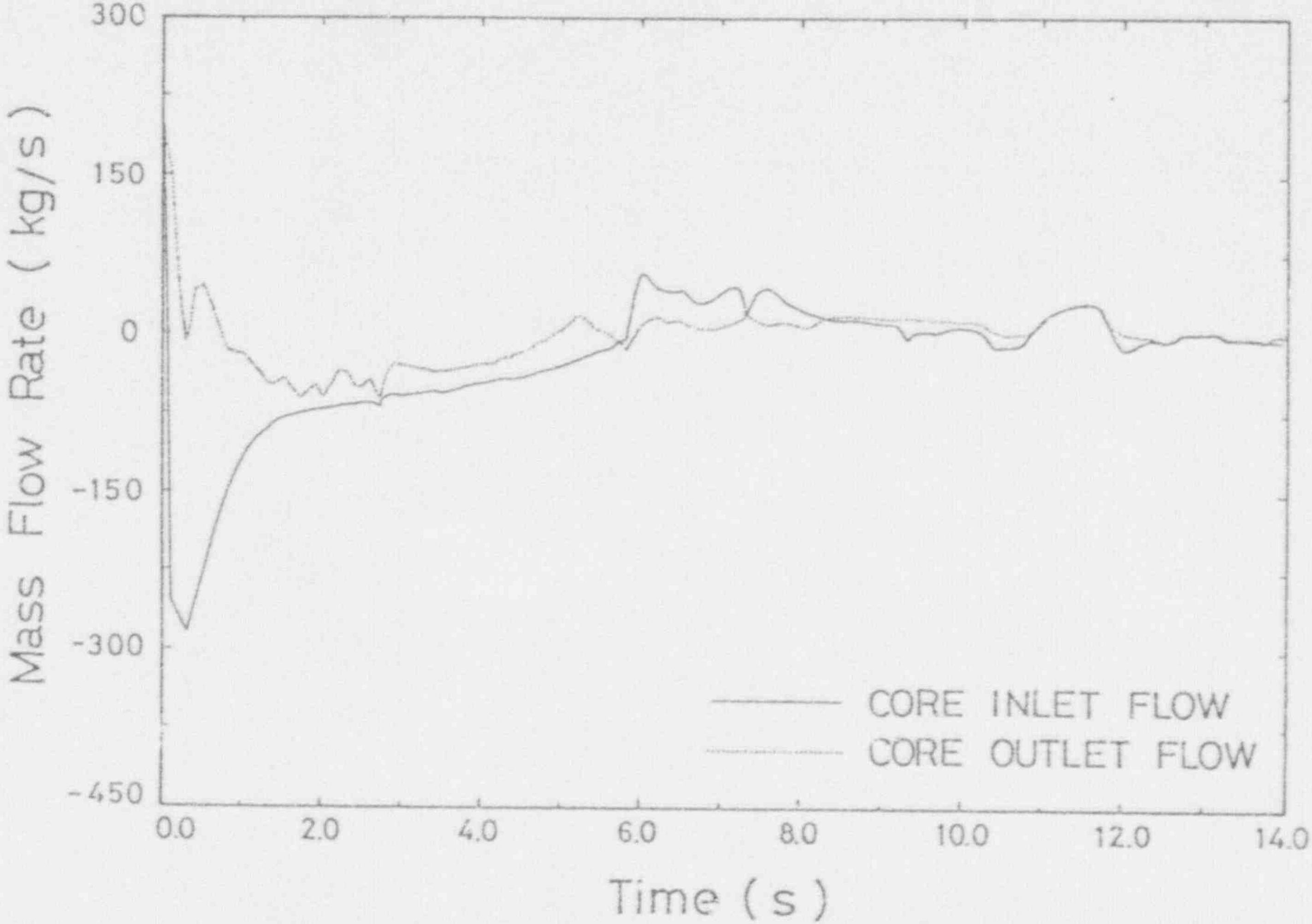


Figure 4.12 Calculated Core Flow Rates During the Blowdown Period of Test L2-5 Simulation

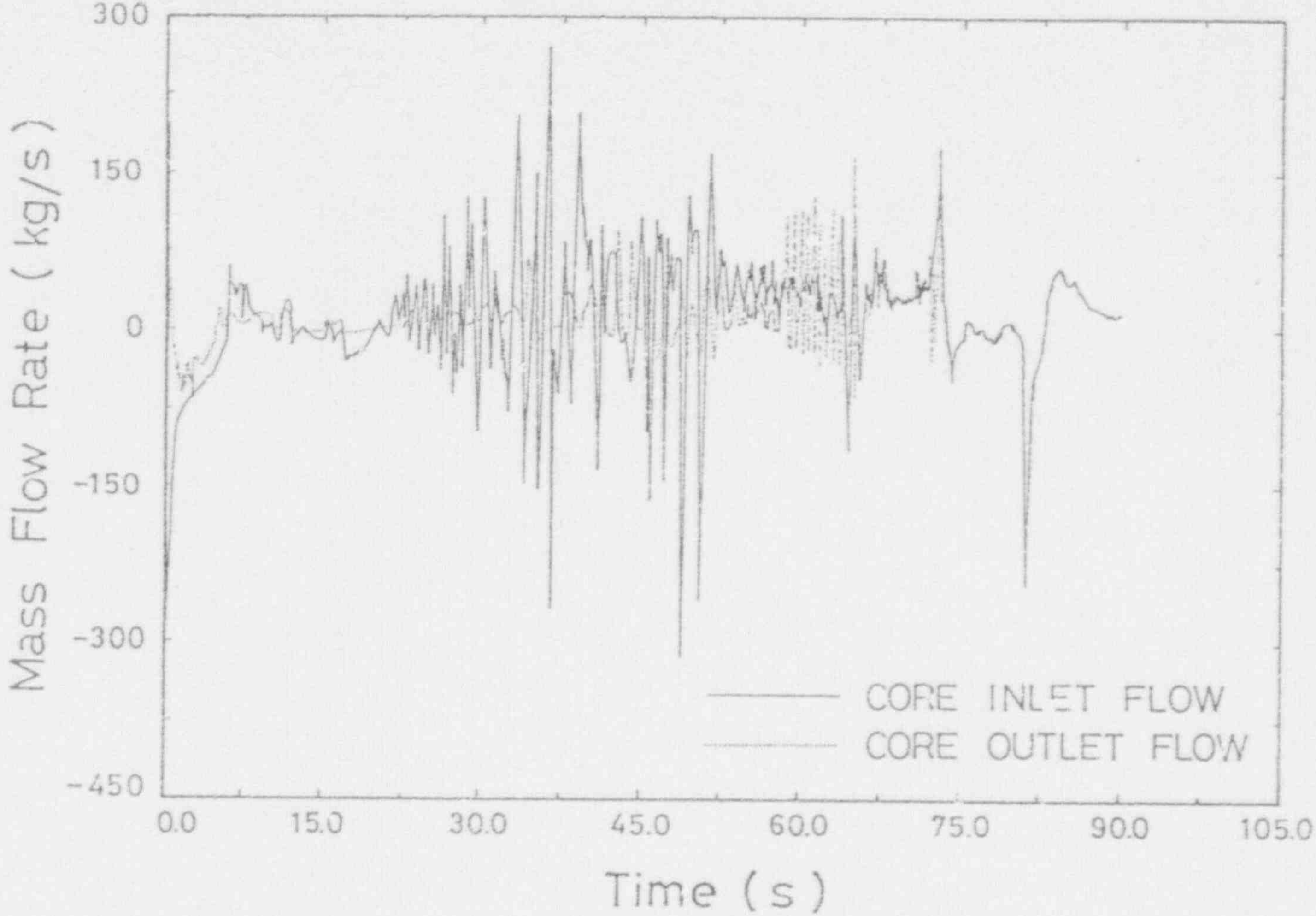


Figure 4.13 Calculated Core Flow Rates of Test L2-5 Simulation

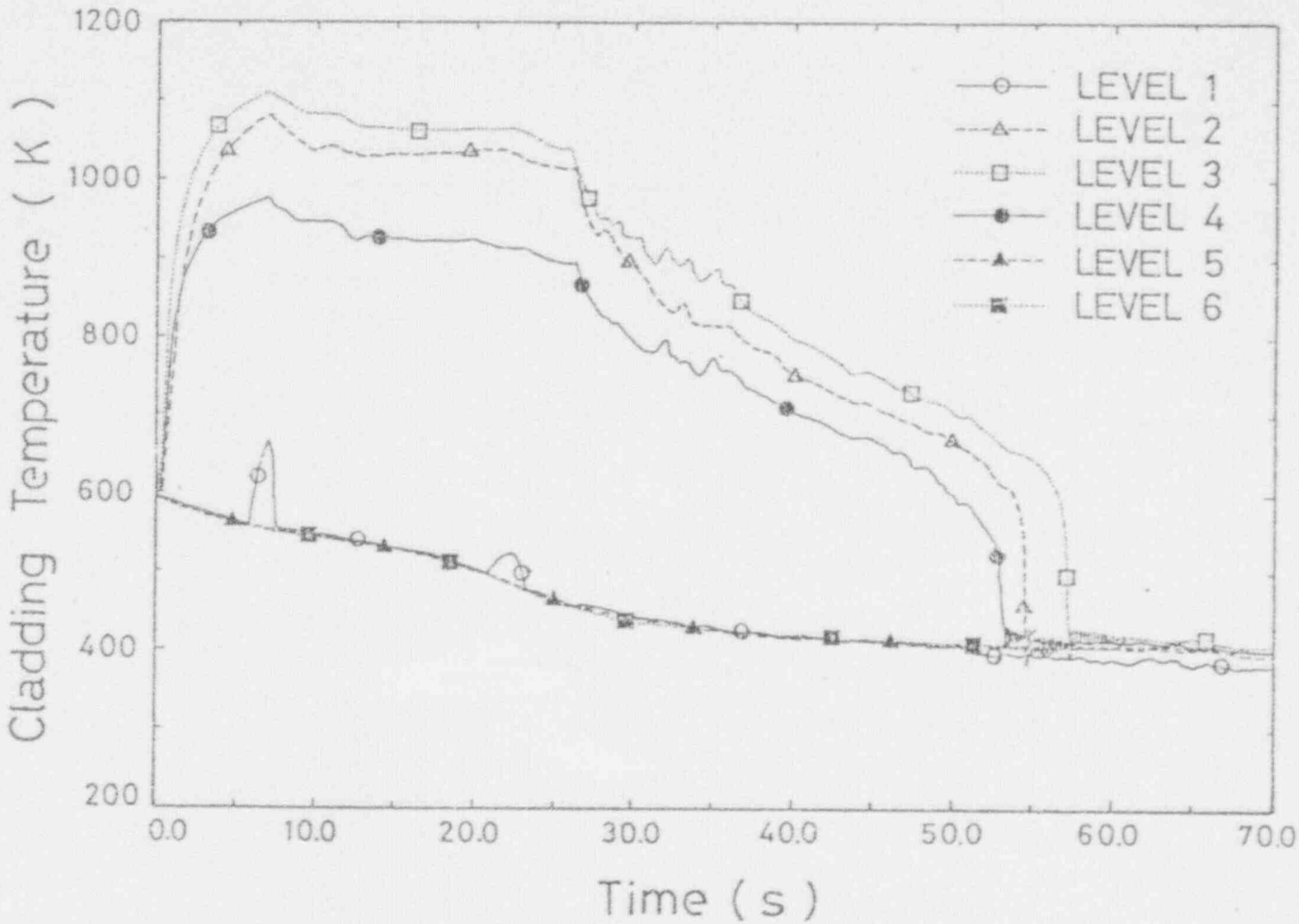


Figure 4.14 Calculated Cladding Temperatures at Hot Channel Hot Rod of Test L2-5 Simulation

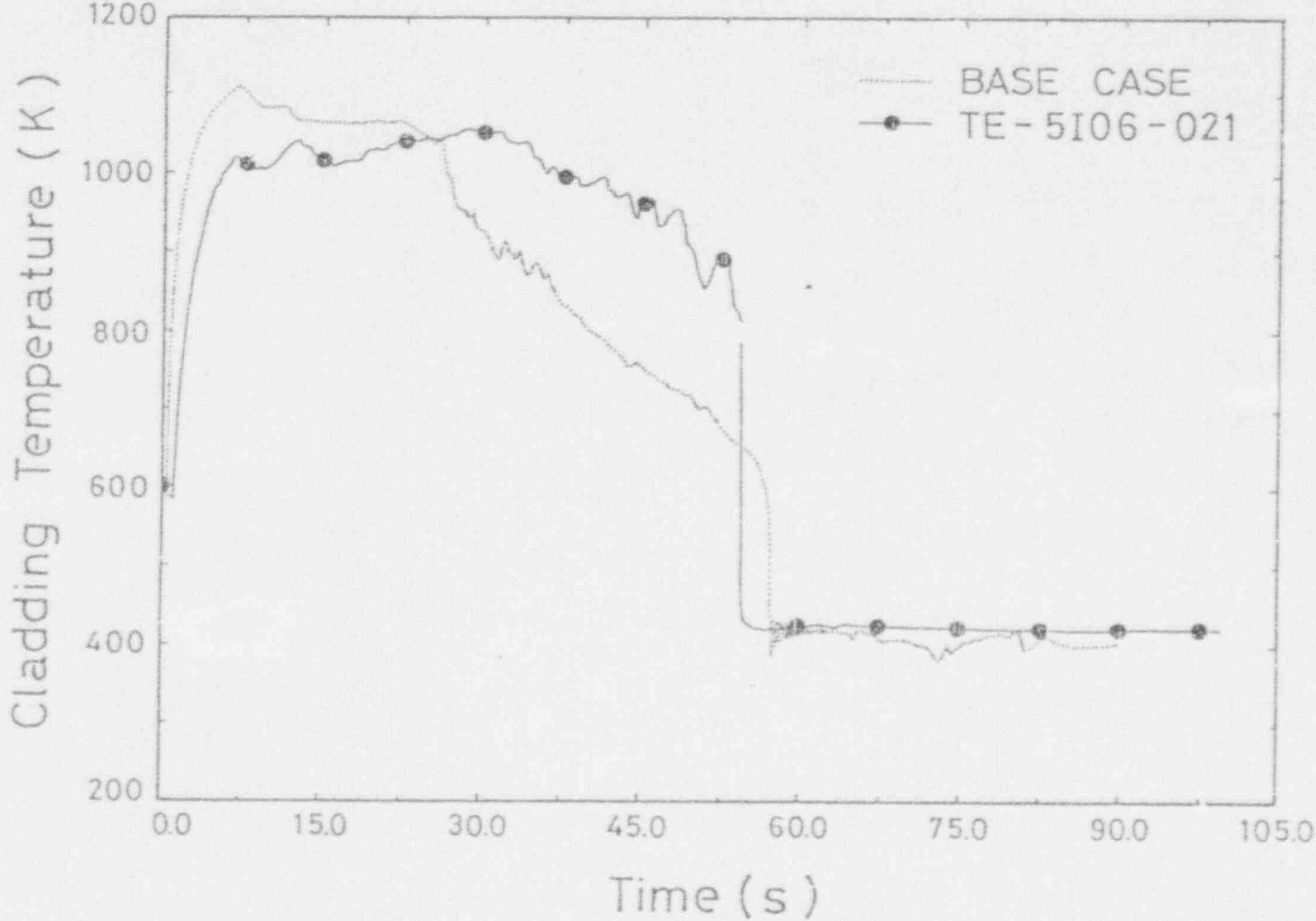


Figure 4.15 Comparison between the Calculated and Measured Cladding Temperatures of Test L2-5

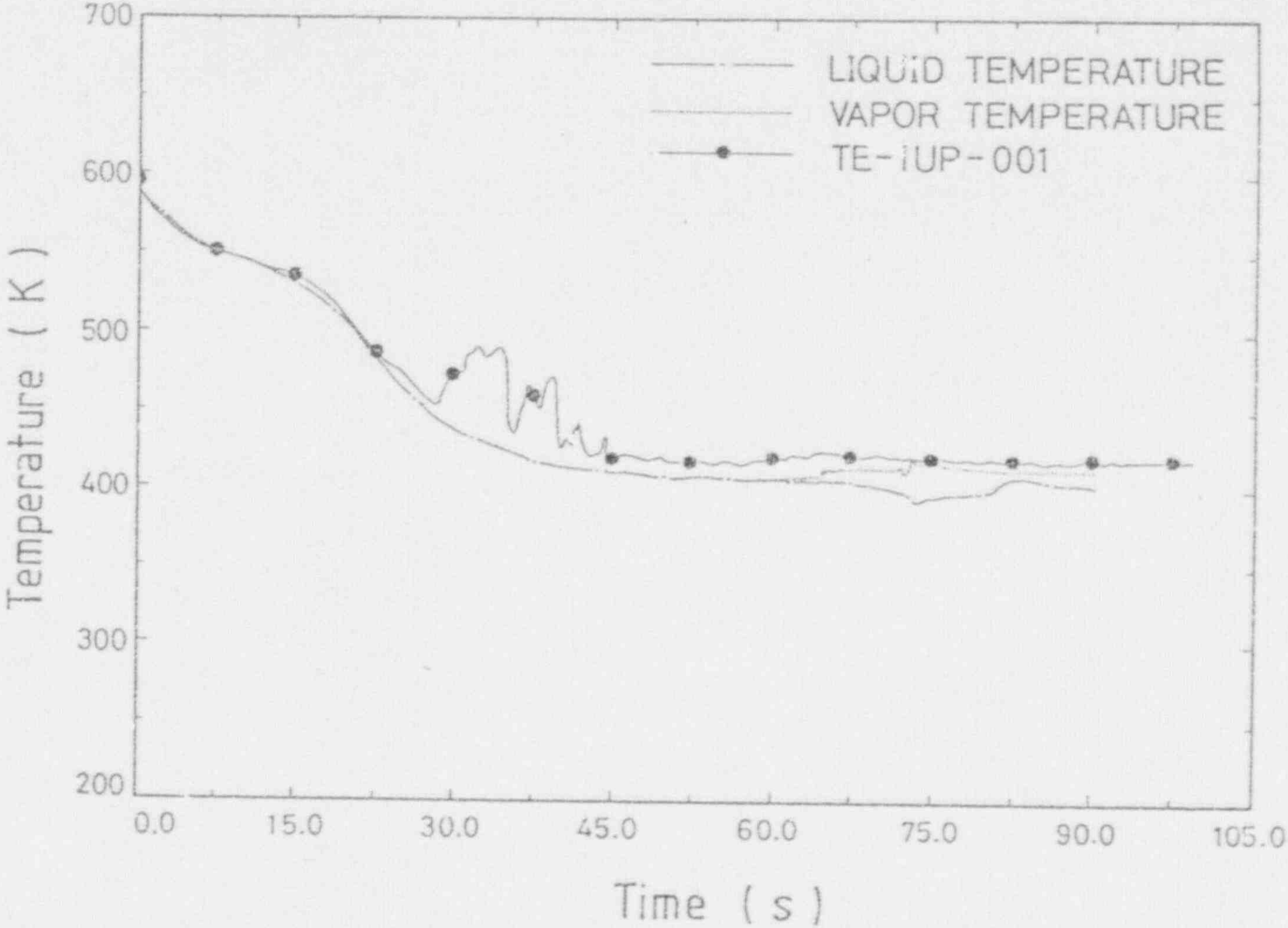


Figure 4.16 Comparison between the Calculated and Measured Upper Plenum Fluid Temperatures of Test L2-5

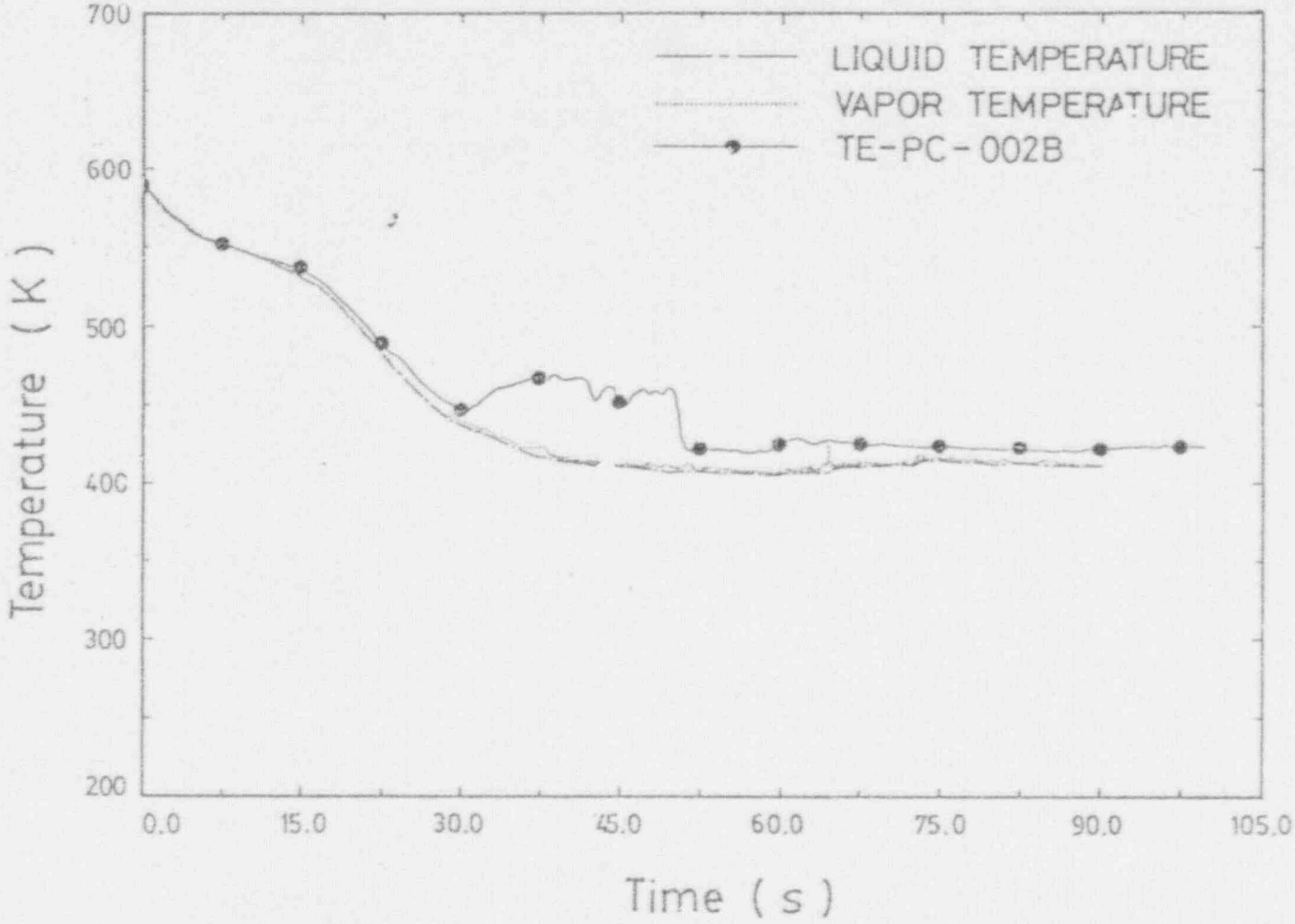


Figure 4.17 Comparison between the Calculated and Measured Intact Loop Hot-Leg Fluid Temperatures of Test L2-5

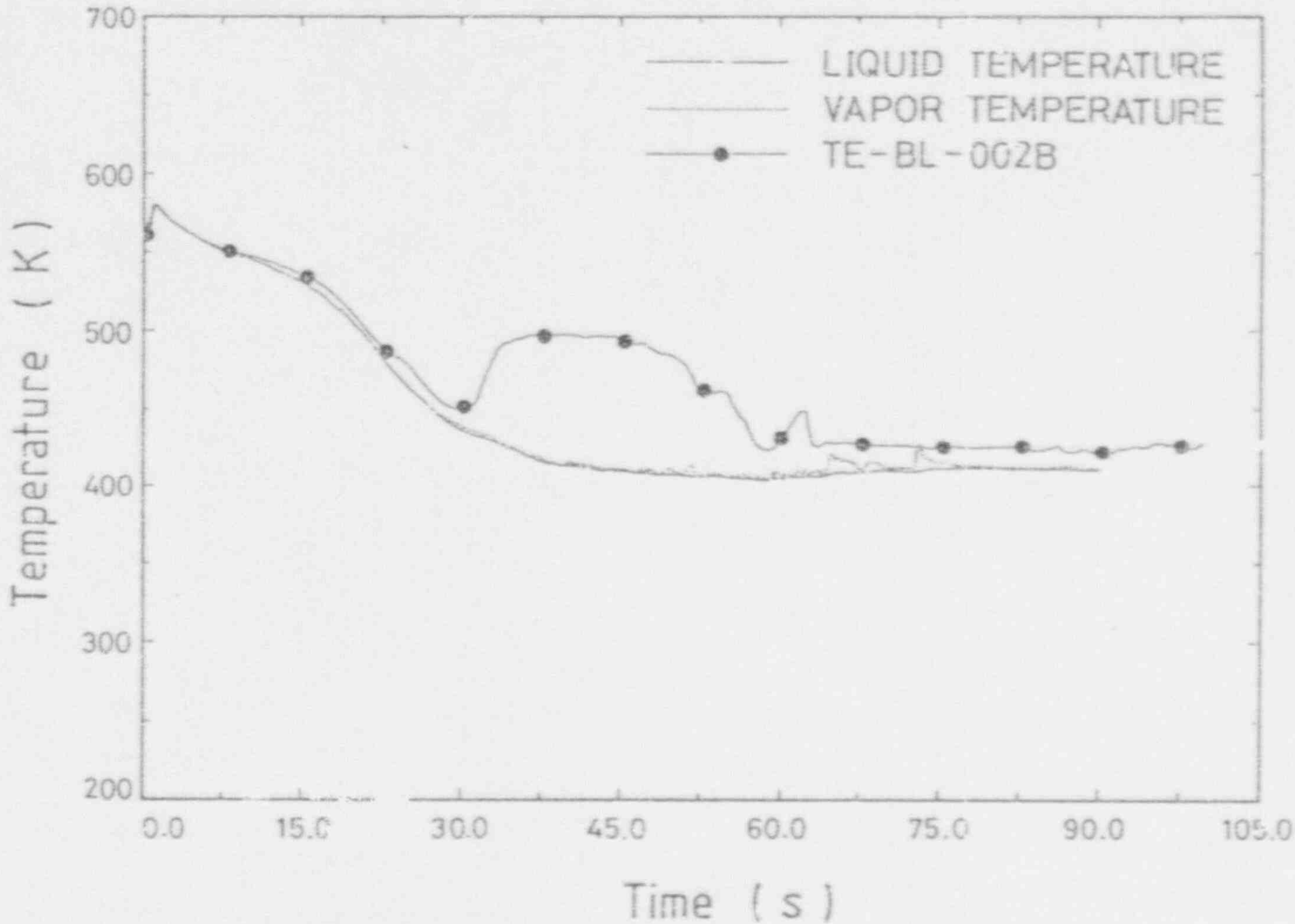


Figure 4.16 Comparison between the Calculated and Measured Broken Loop Hot-Leg Fluid Temperatures of Test L2-5

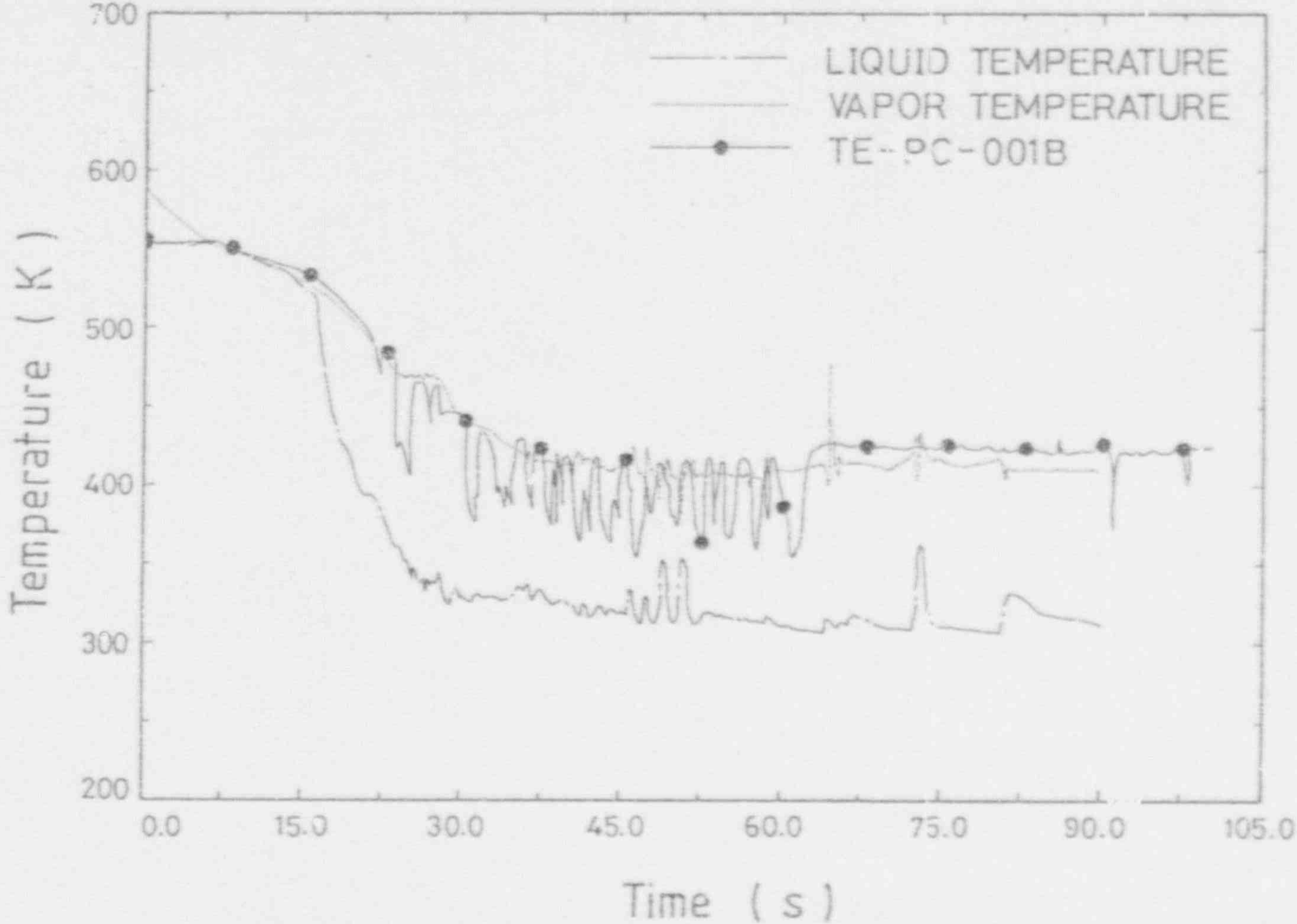


Figure 4.19 Comparison between the Calculated and Measured Intact Loop Cold-Leg Fluid Temperatures of Test L2-5

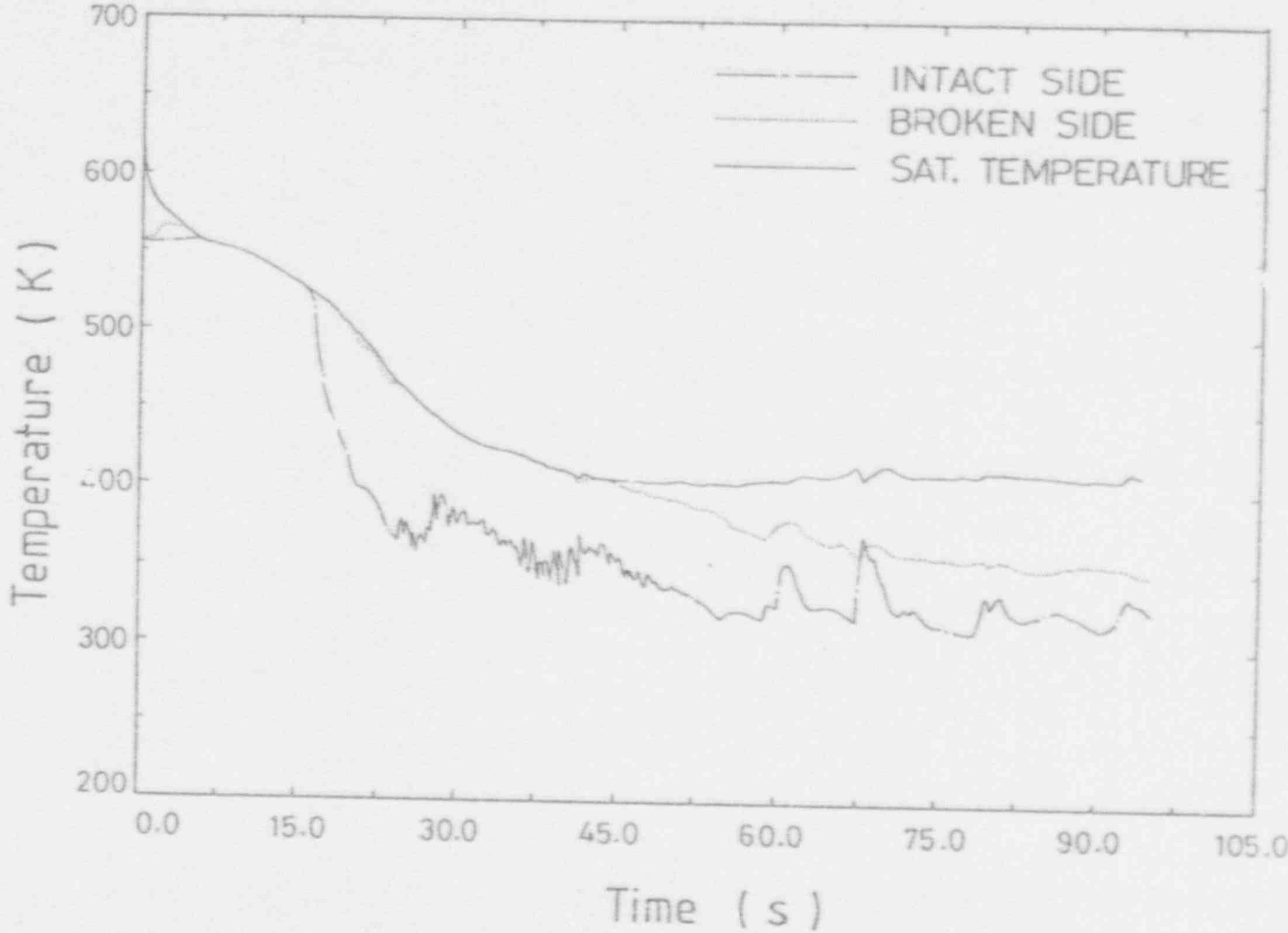


Figure 4.20 Calculated Fluid Temperatures in Upper downcomer of Test L2-5 Simulation

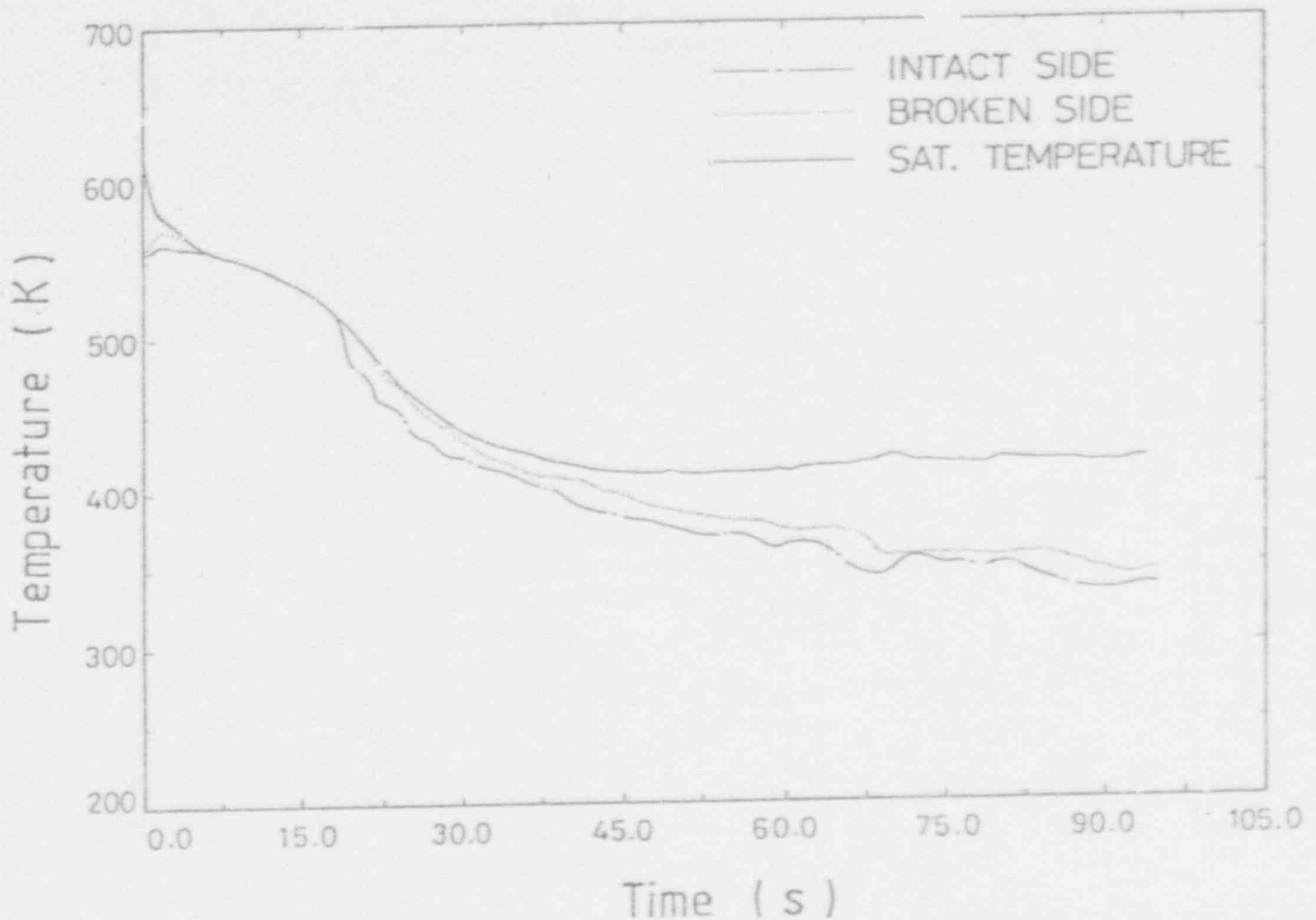


Figure 4.21 Calculated Fluid Temperatures in Lower Downcomer of Test L2-5 Simulation

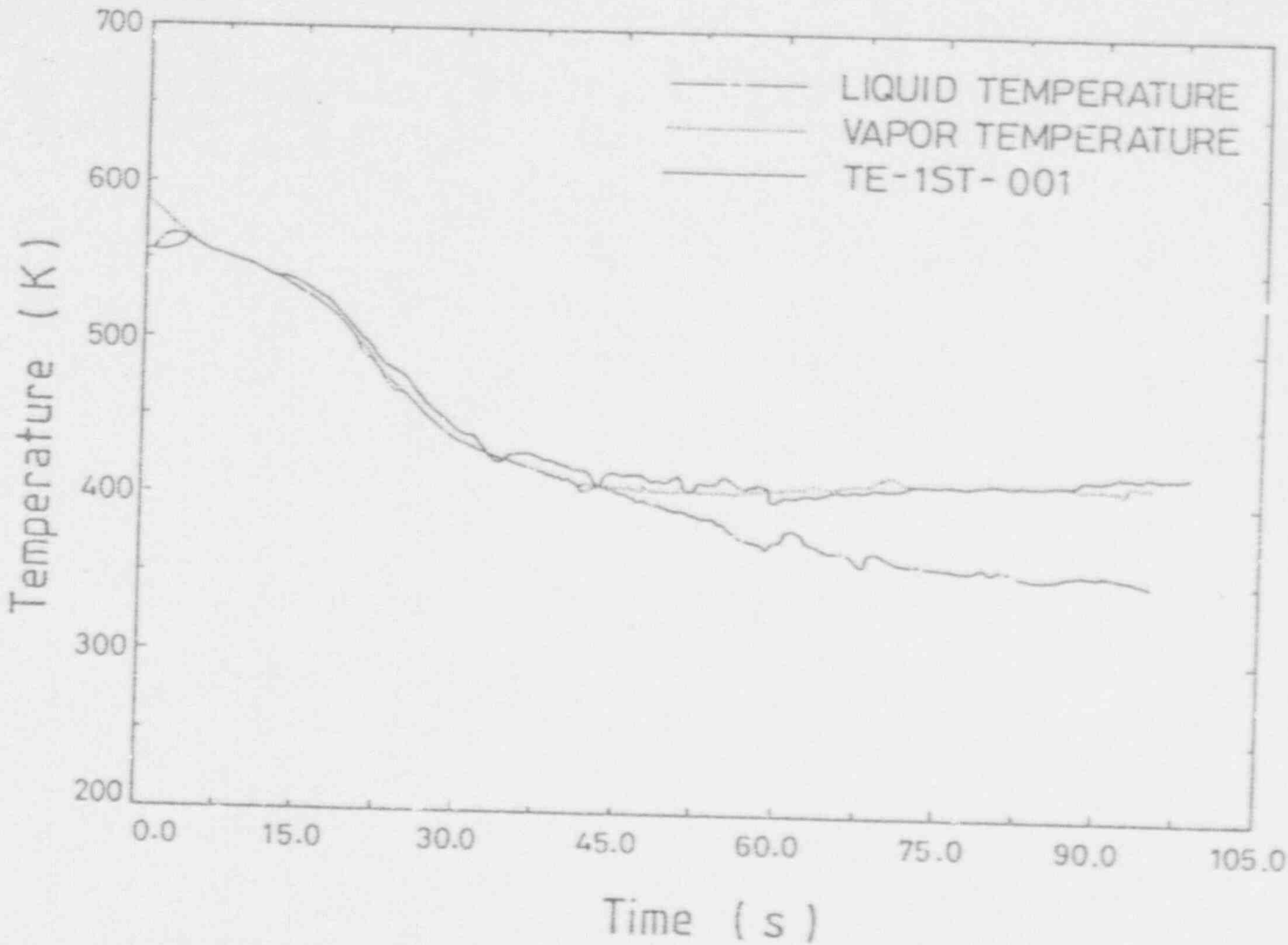


Figure 4.22 Comparison between the Calculated and Measured Downcomer (4.8 m from RV Bottom) Fluid Temperatures of Test L2-5

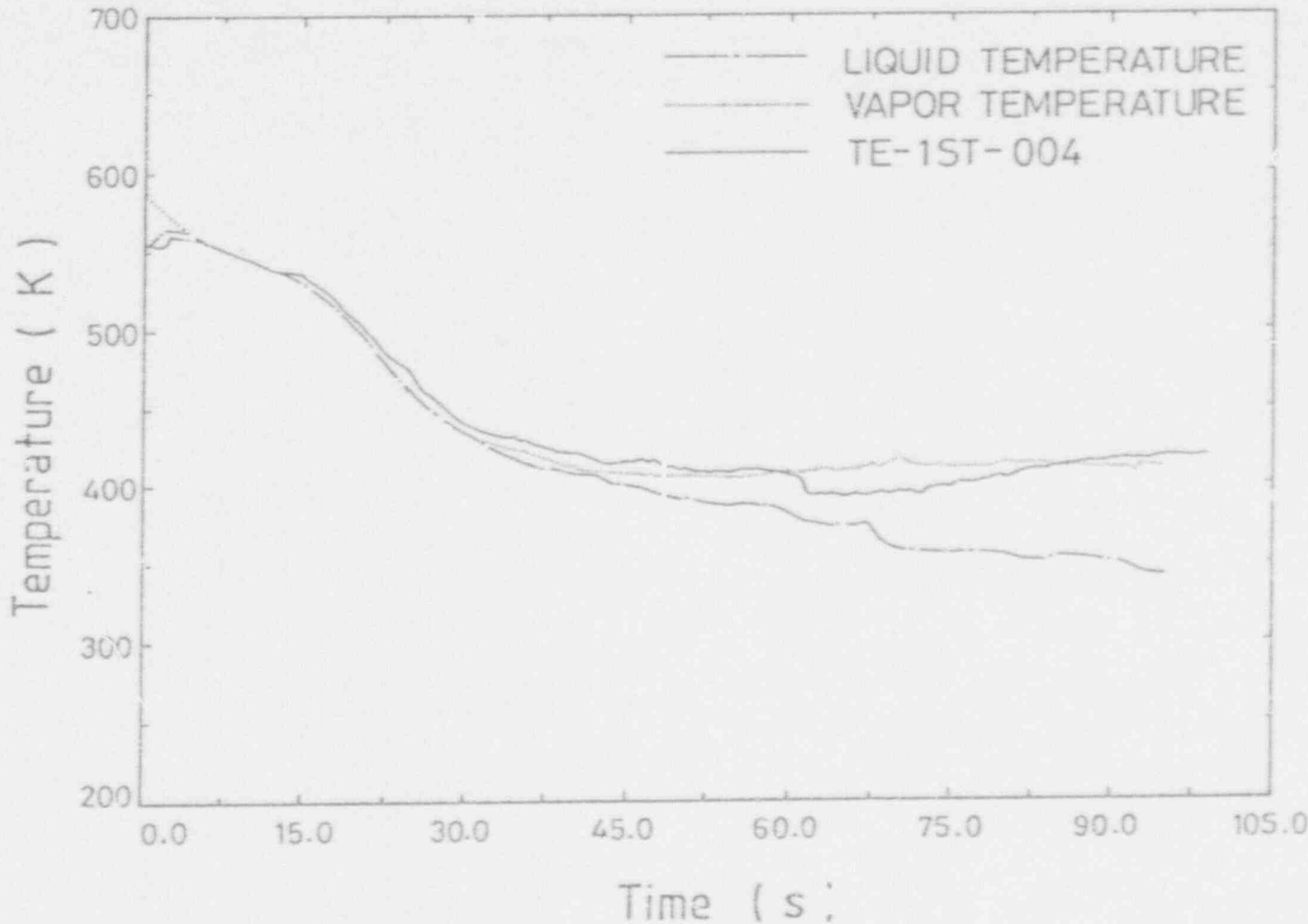


Figure 4.23 Comparison between the Calculated and Measured Downcomer (2.98 m from RV Bottom) Fluid Temperatures of Test L2-5

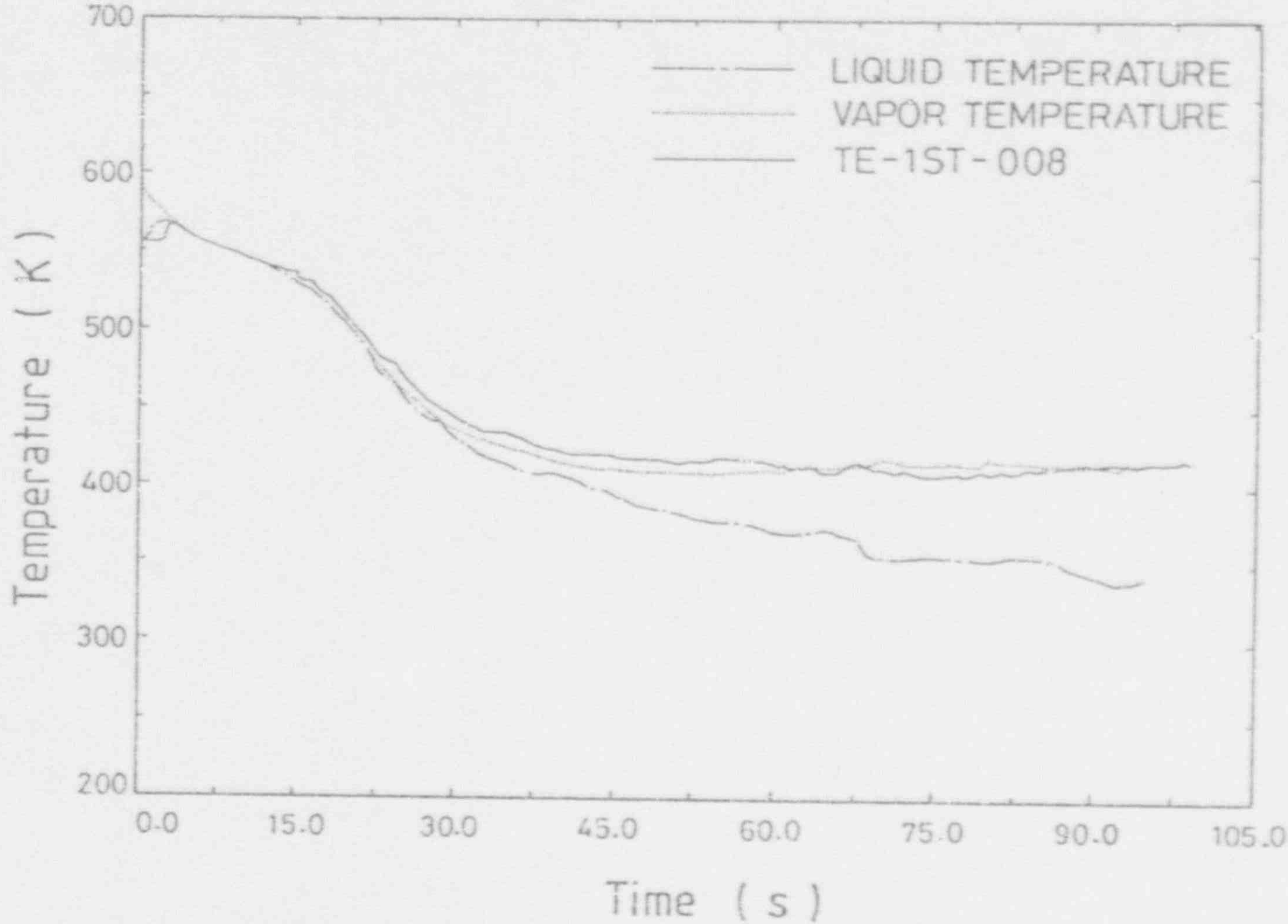


Figure 4.24 Comparison between the Calculated and Measured Downcomer (0.74 m from RV Bottom) Fluid Temperatures of Test L2-5

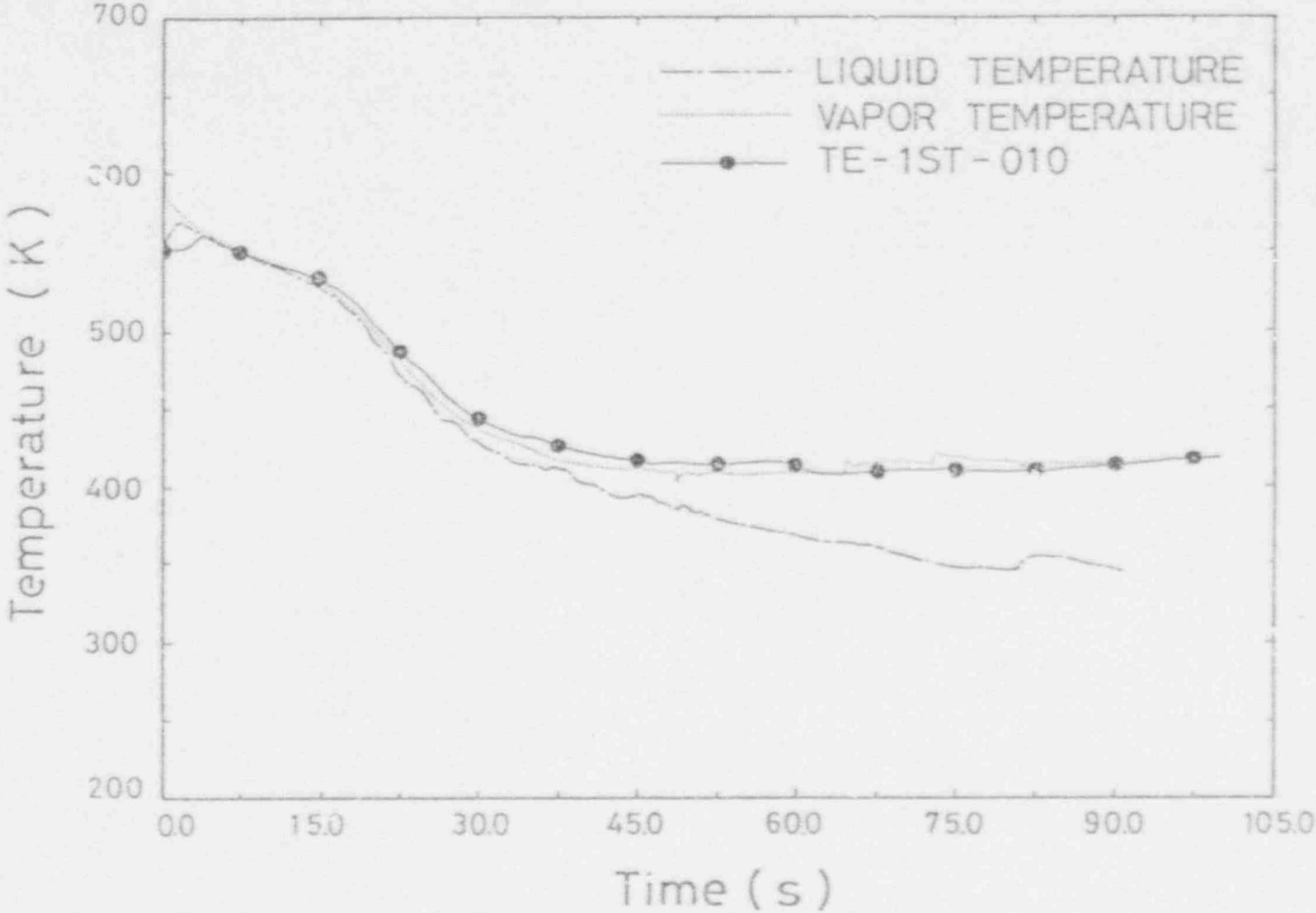


Figure 4.25 Comparison between the Calculated and Measured Downcomer (0.54 m from RV Bottom) Fluid Temperatures of Test L2-5

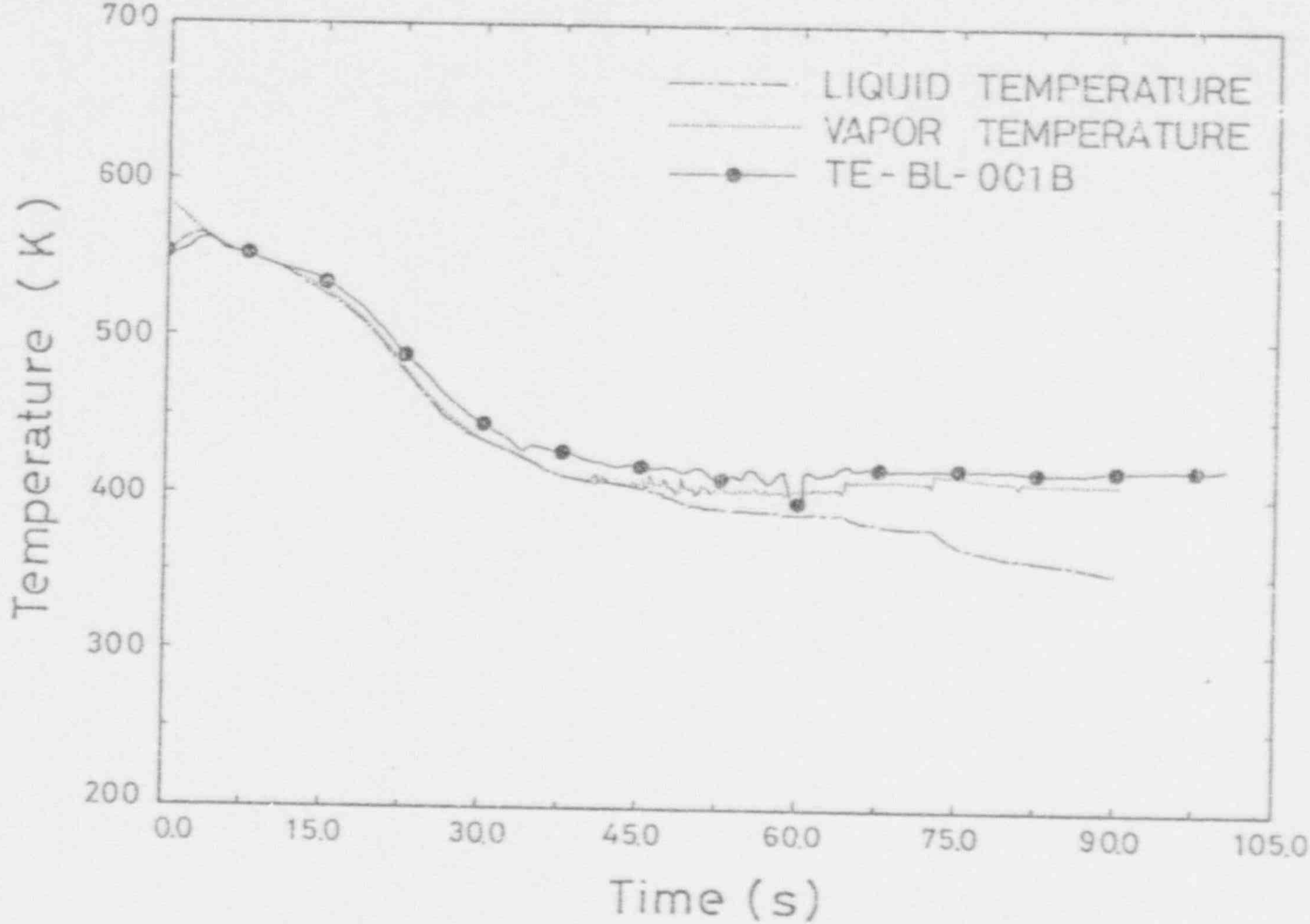


Figure 4.26 Comparison between the Calculated and Measured Broken Loop Cold-Leg Fluid Temperatures of Test L2-5

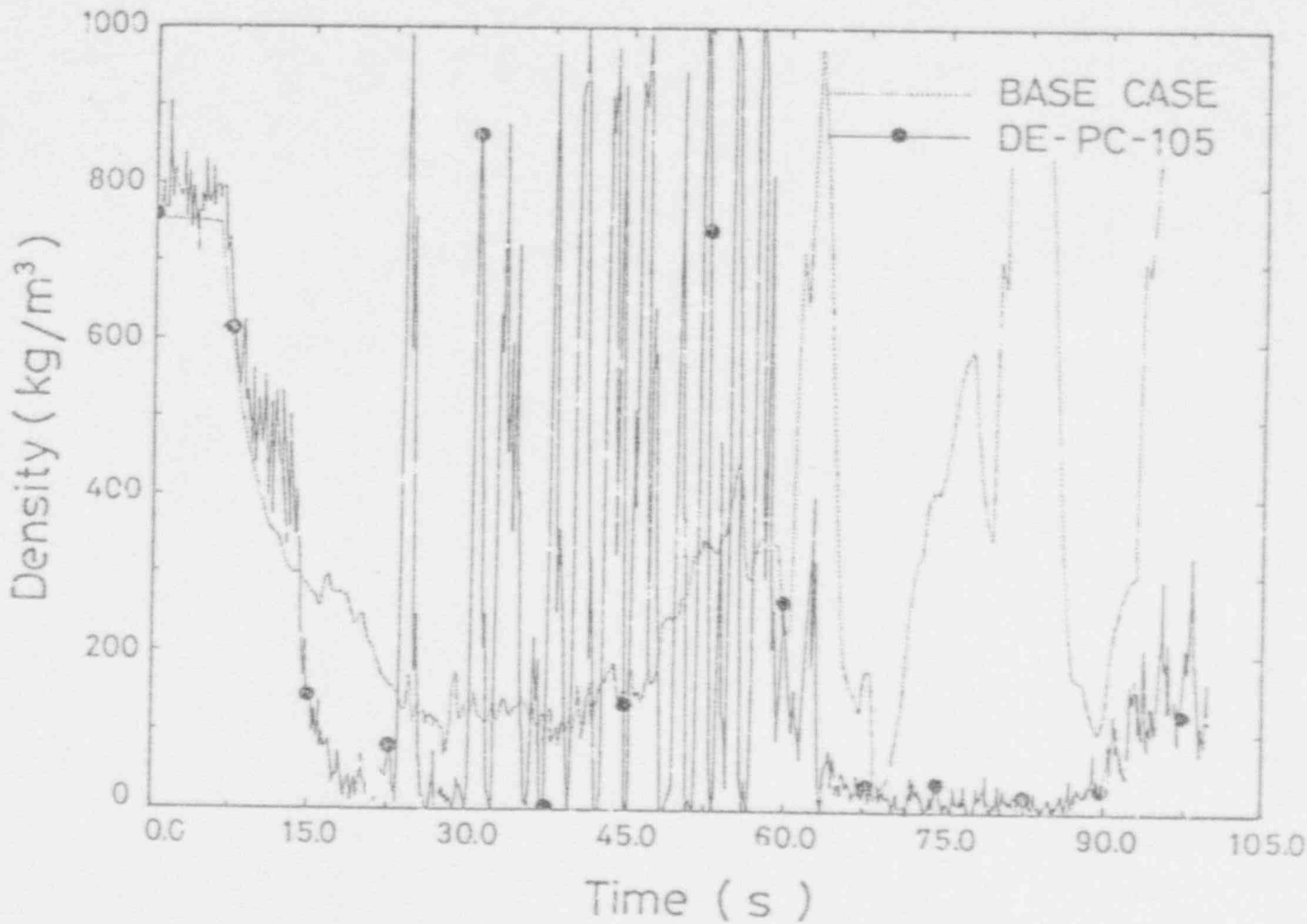


Figure 4.27 Comparison between the Calculated and Measured Intact Loop Cold-Leg Densities of Test L2-5

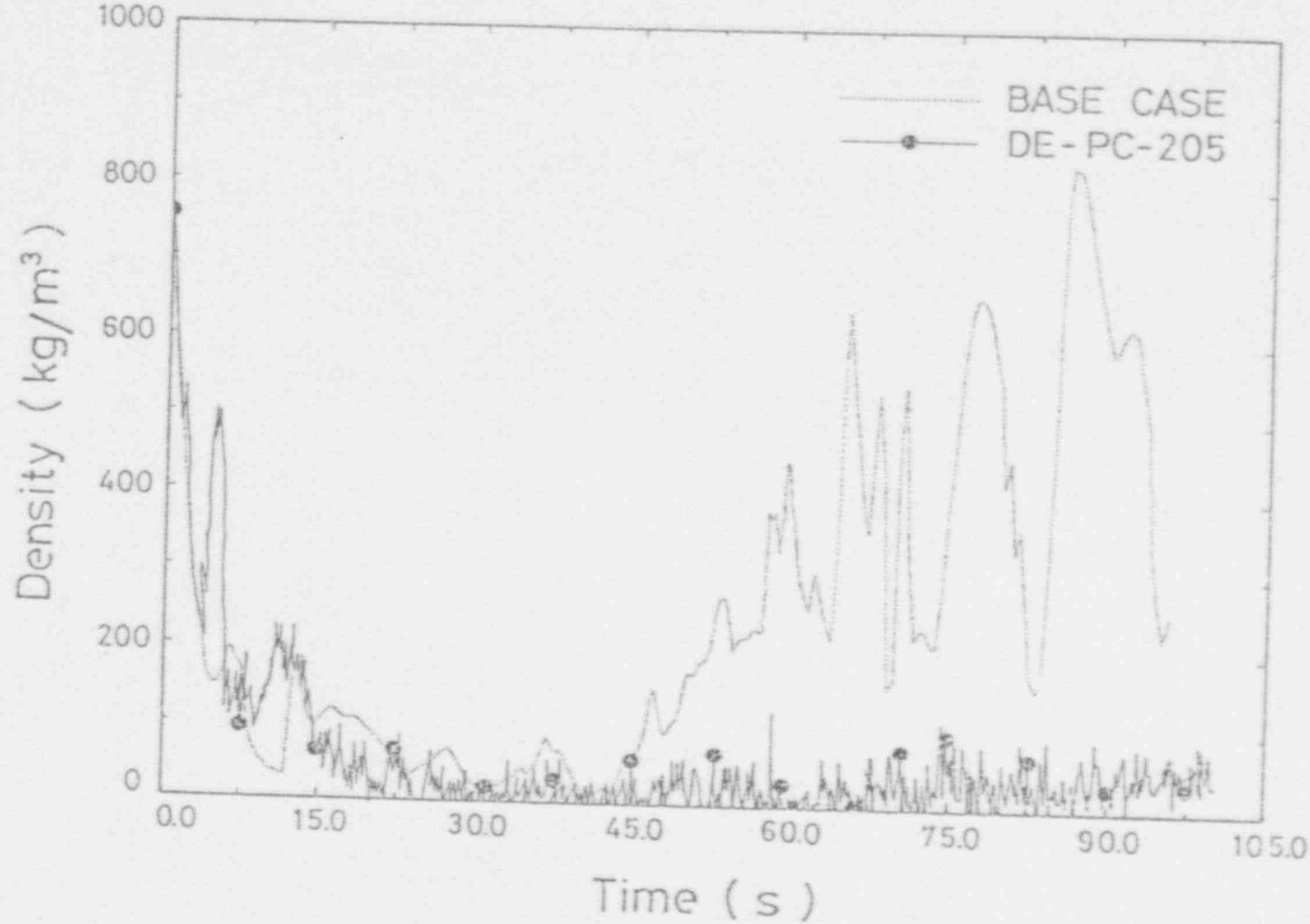


Figure 4.28 Comparison between the Calculated and Measured Intact Loop Hot-Leg Densities of Test L2-5

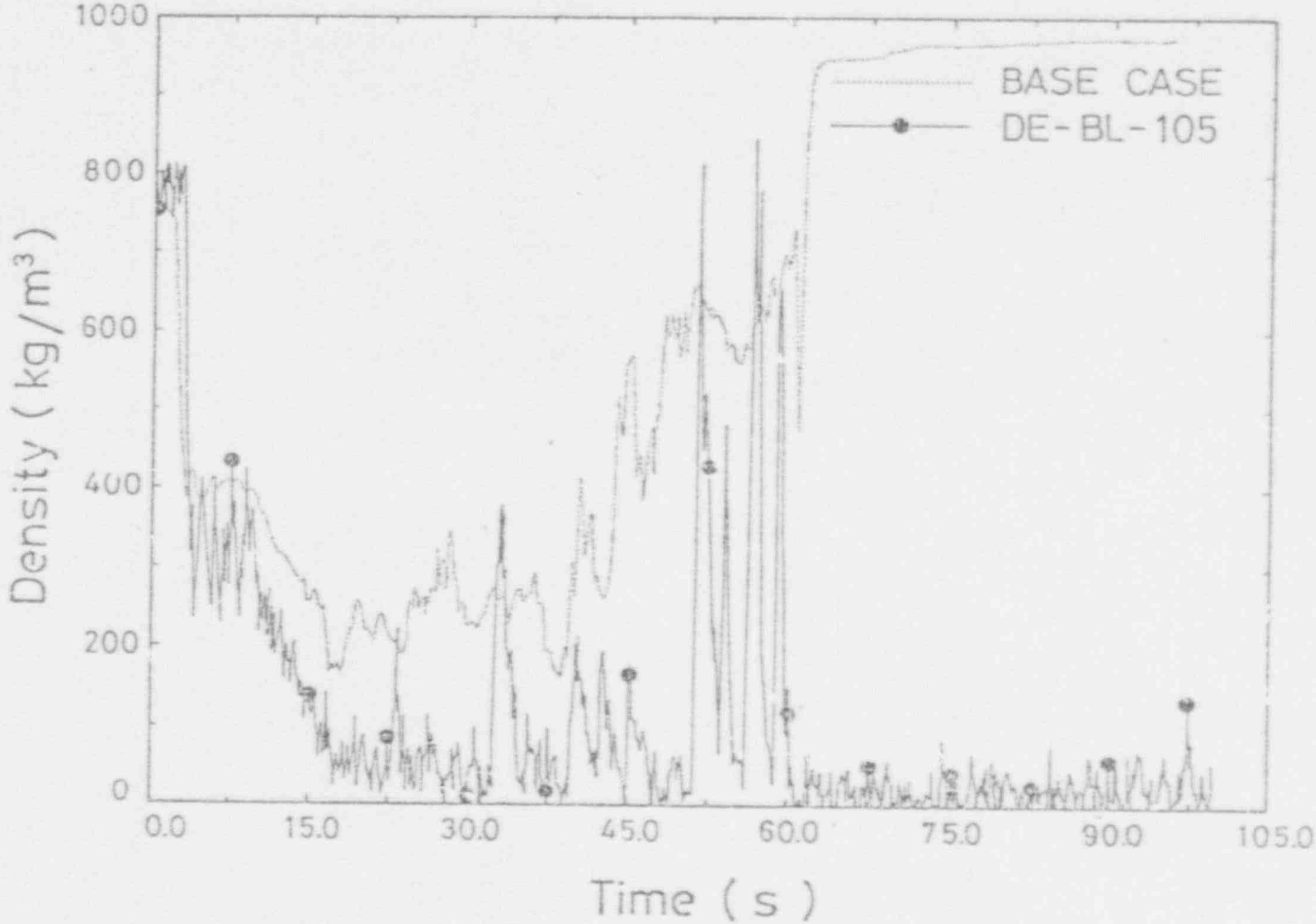


Figure 4.29 Comparison between the Calculated and Measured Broken Loop Cold-Leg Densities of Test L2-5

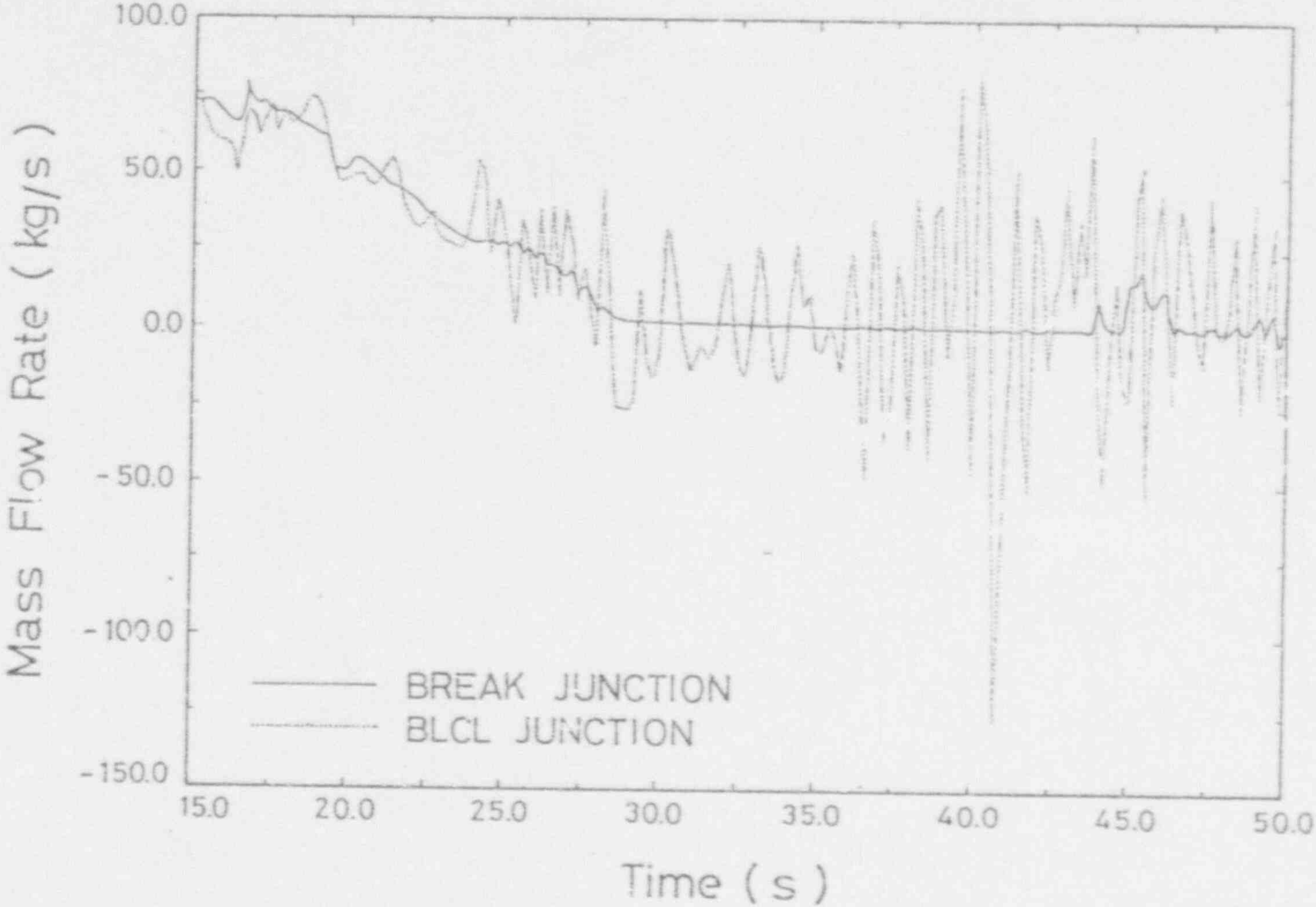


Figure 4.30 Calculated Flow Rates in Broken Loop Cold-Leg of Test L2-5 Simulation

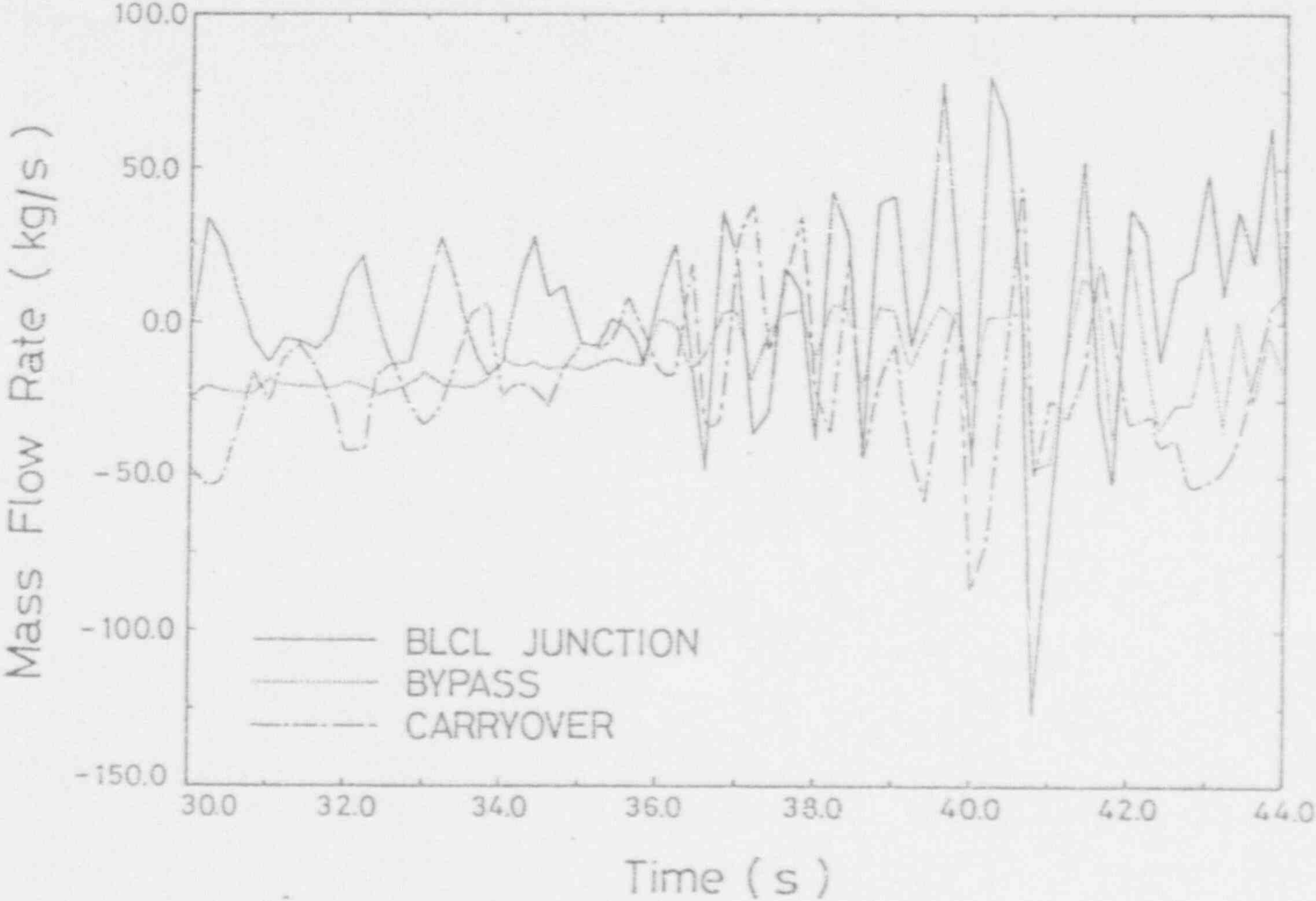
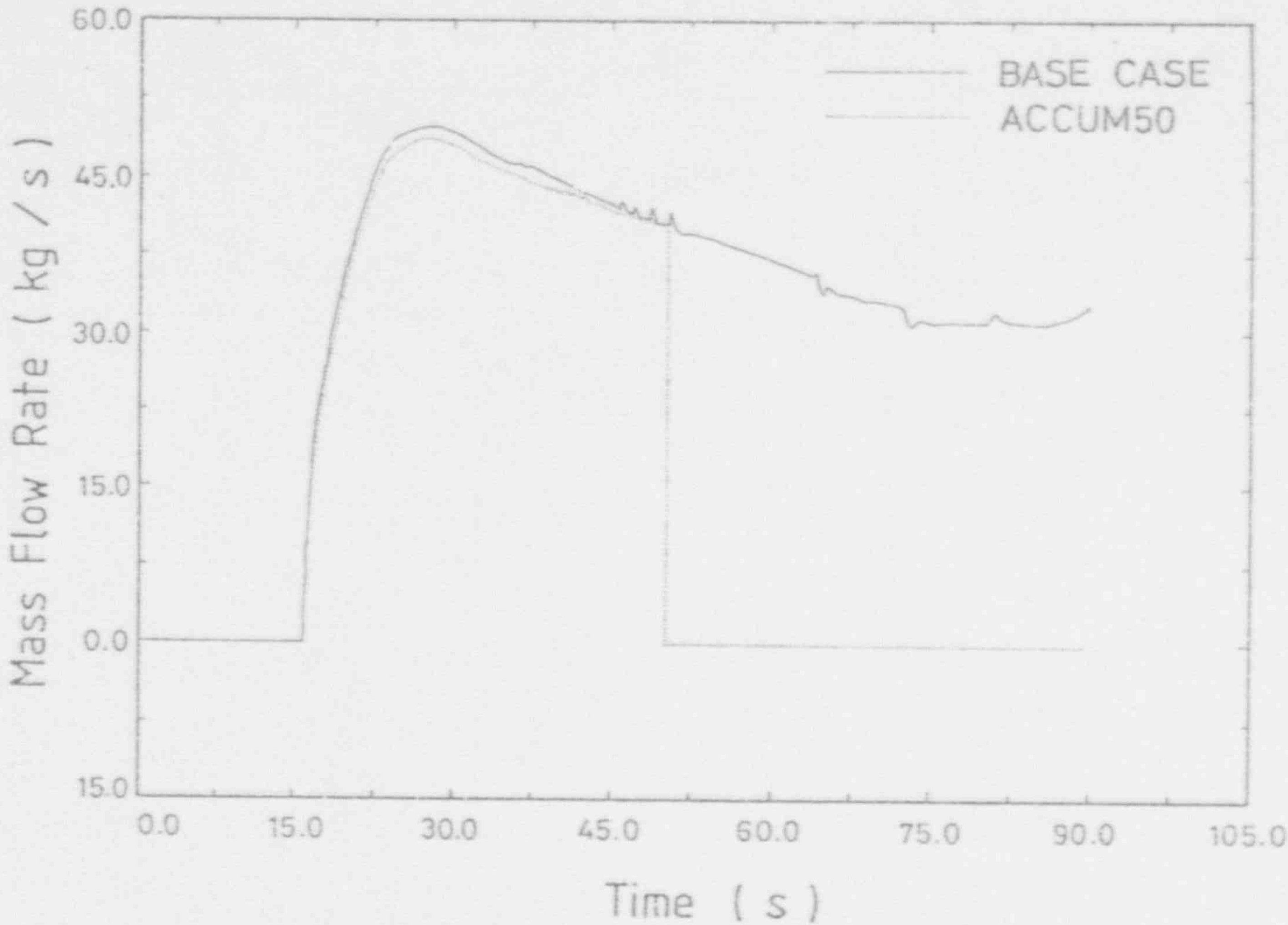


Figure 4.31 Calculated Flow Rates in Reactor Vessel Near Broken Loop Cold-Leg of Test L2-5 Simulation



Figrue 4.37 Comparison between Calculated Accumulator Flow Rates of the BASE and ACCUM50 Cases

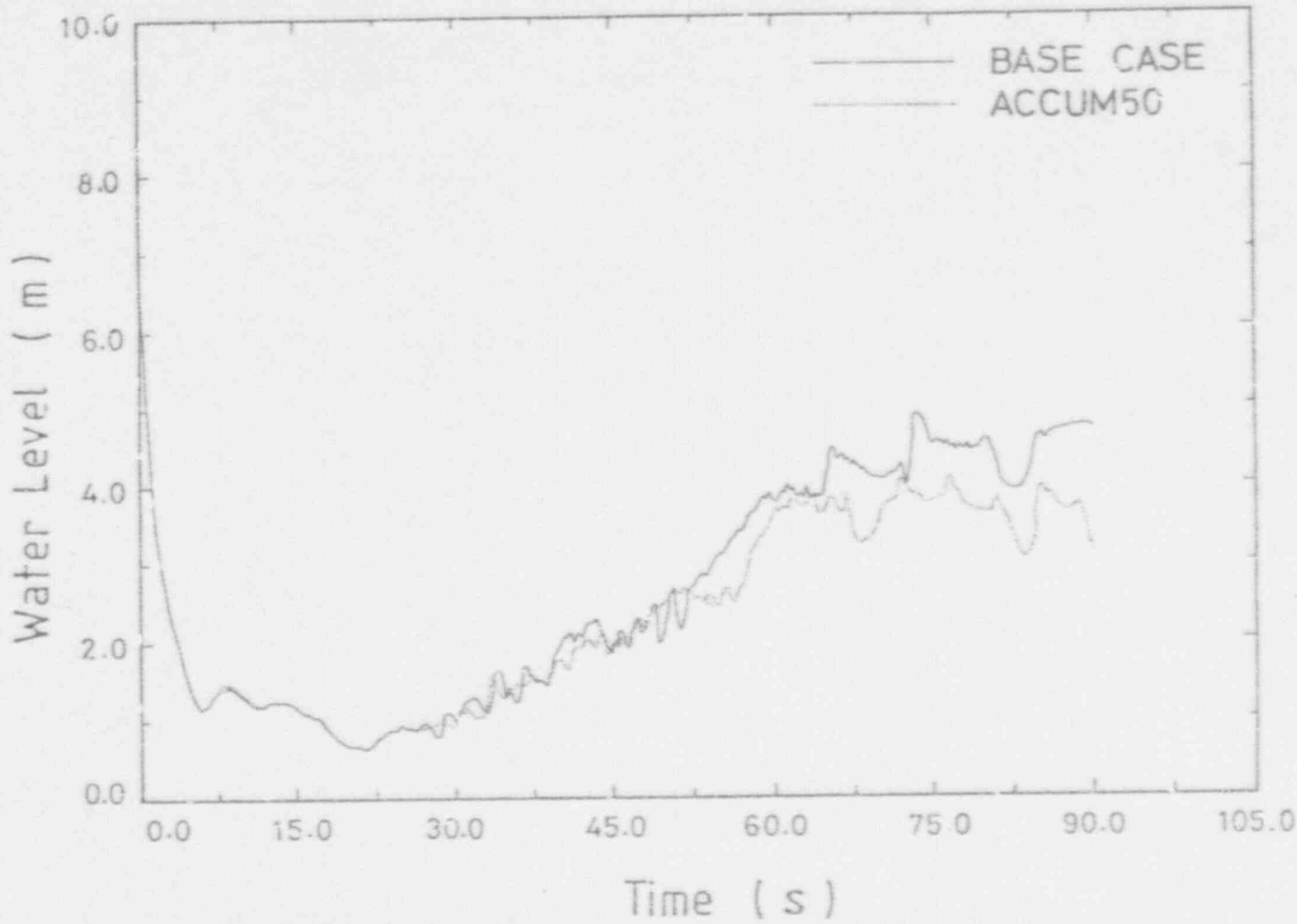


Figure 4.33 Comparison between Calculated Water Levels in Core Region of the BASE and ACCUM50 Cases

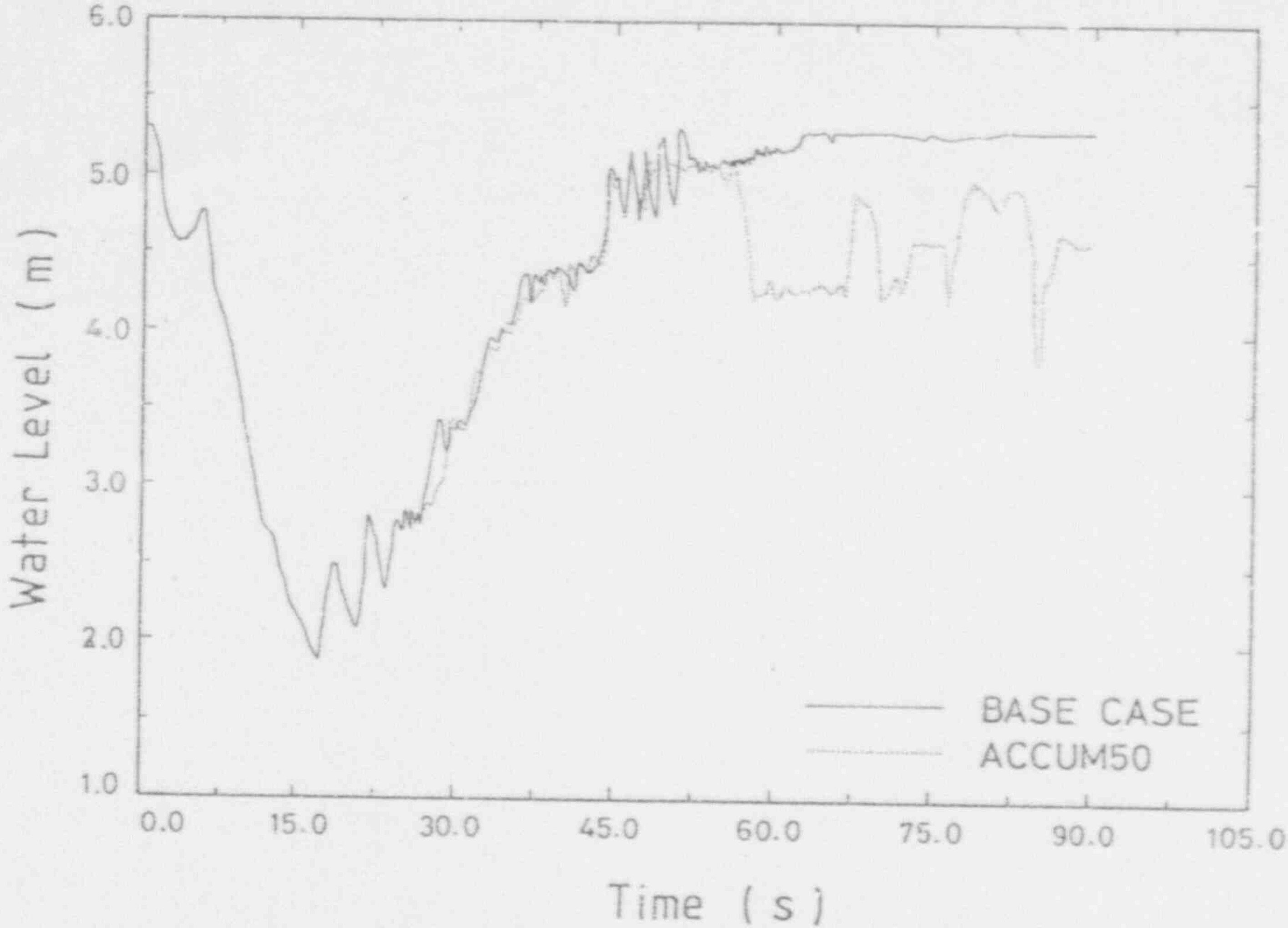


Figure 4.34 Comparison between Calculated Water Levels in Downcomer Near Intact Loop of the BASE and ACCUM50 Cases

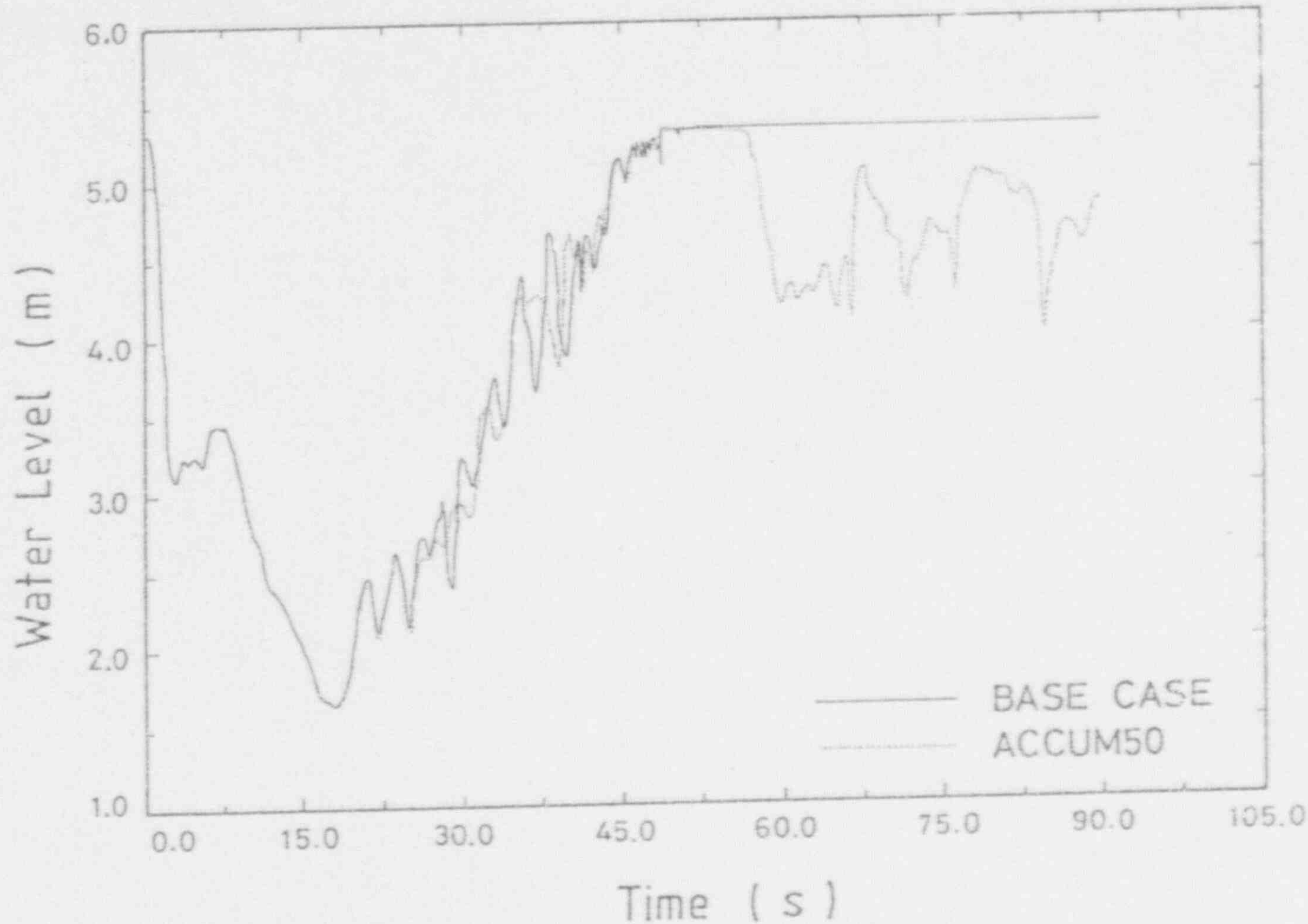


Figure 4.35 Comparison between Calculated Water Levels in Downcomer Near Broken Loop of the BASE and ACCUM50 Cases

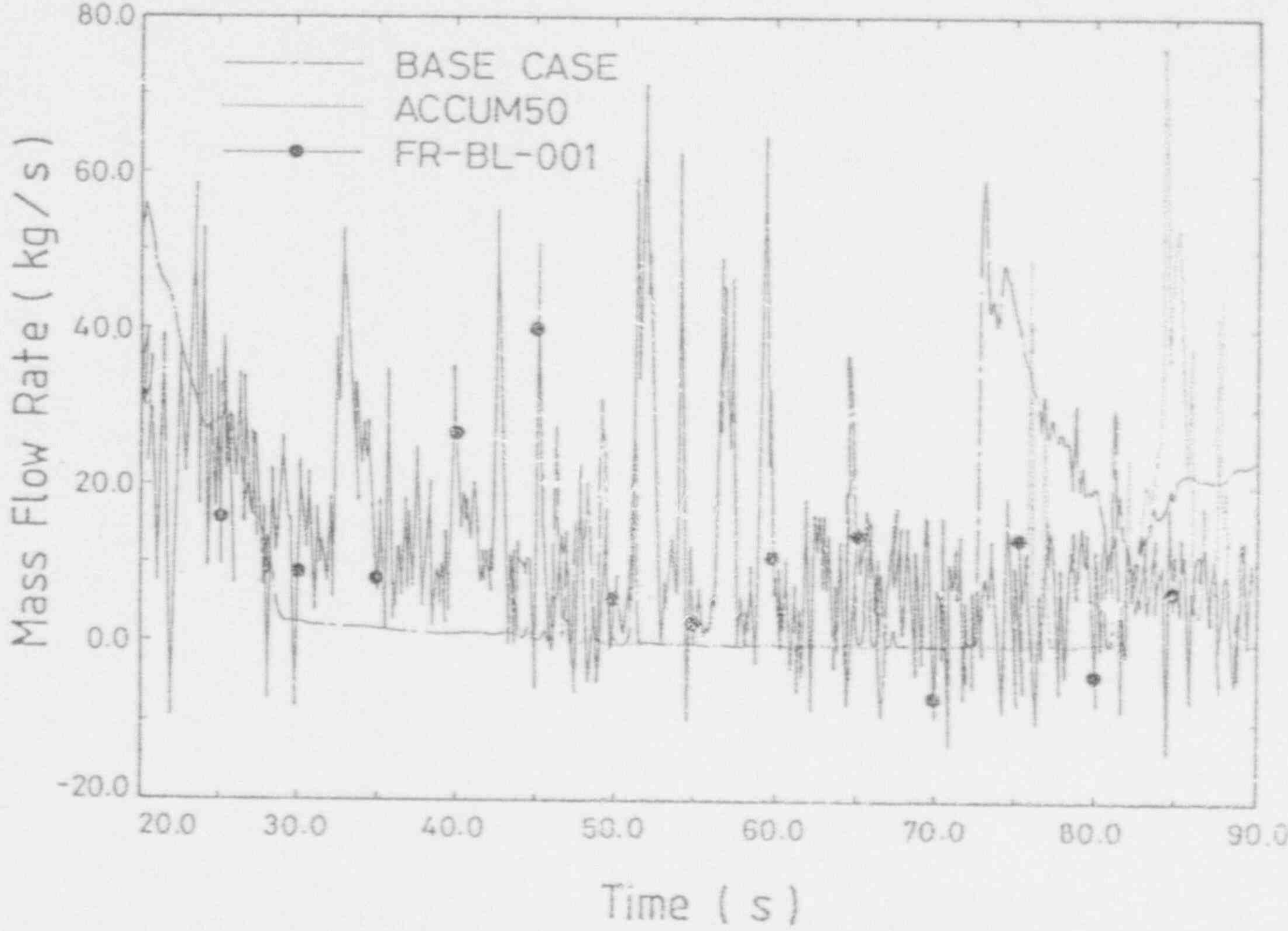


Figure 4.36 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and ACCUM50 Cases

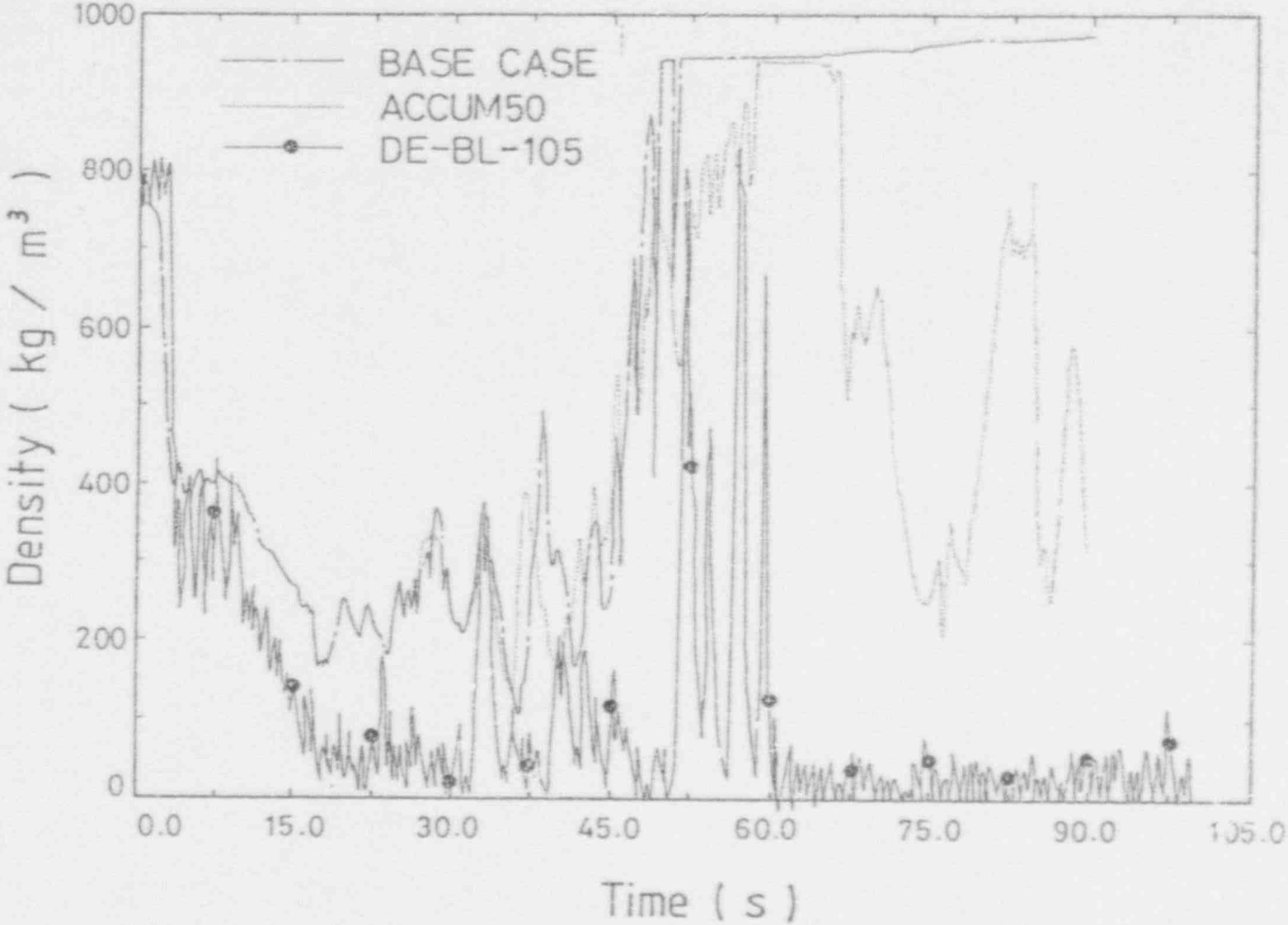


Figure 4.37 Comparison between Calculated Broken Loop Cold-Leg Densities of the BASE and ACCUM50 Cases

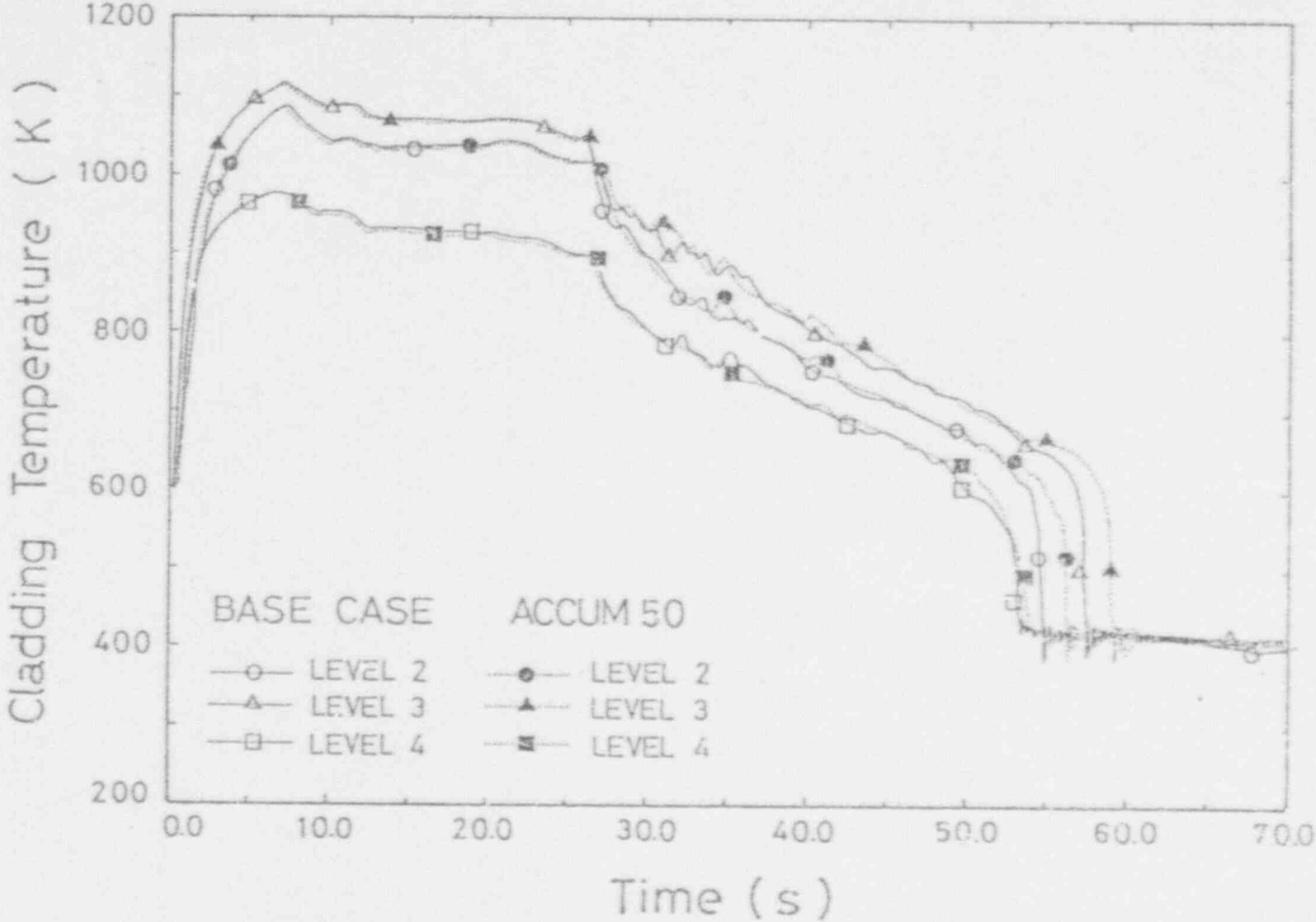


Figure 4.38 Comparison between Calculated Cladding Temperatures at Various Axial Locations of the BASE and ACCUM50 Cases

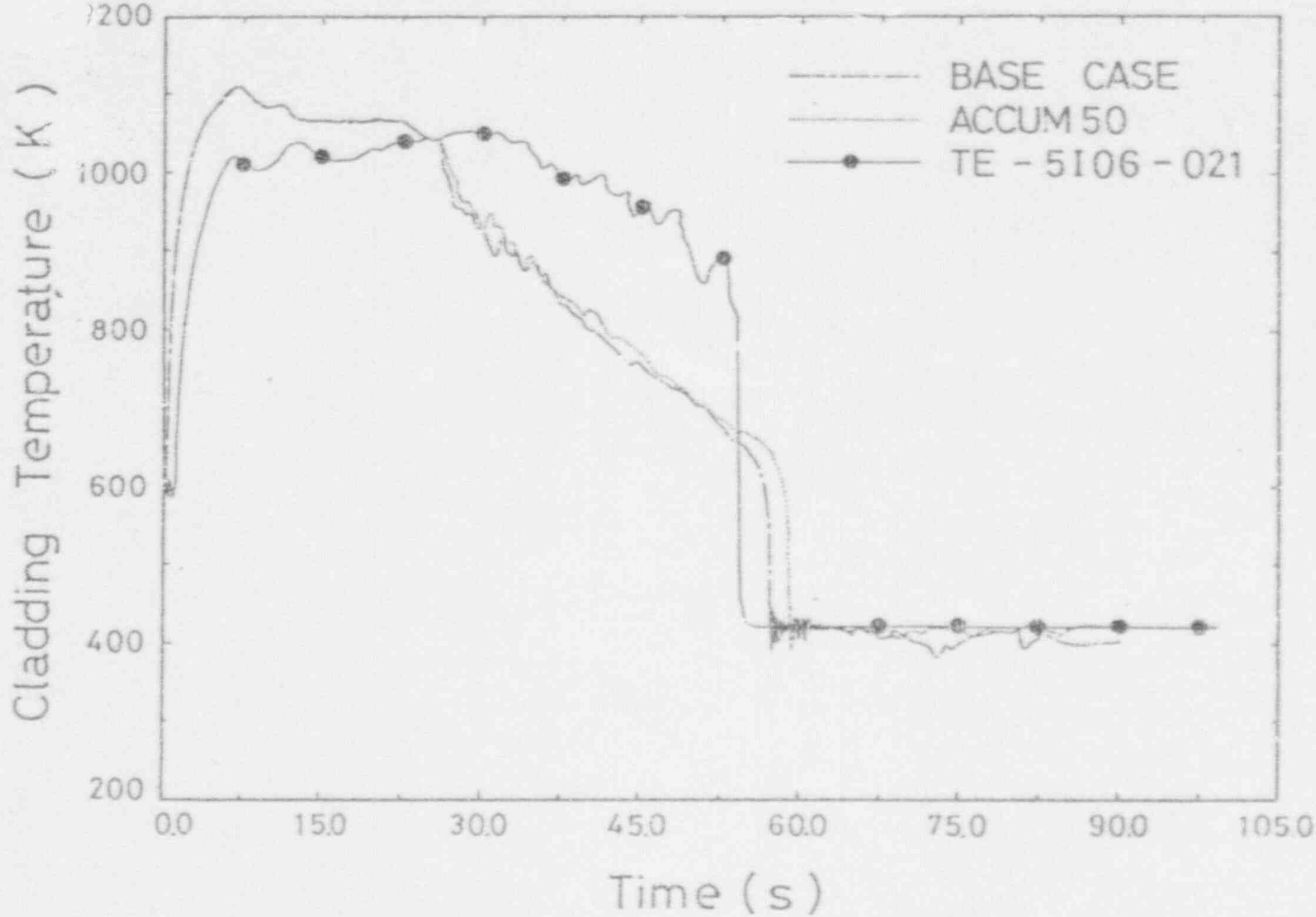


Figure 4.39 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and ACCUM50 Cases

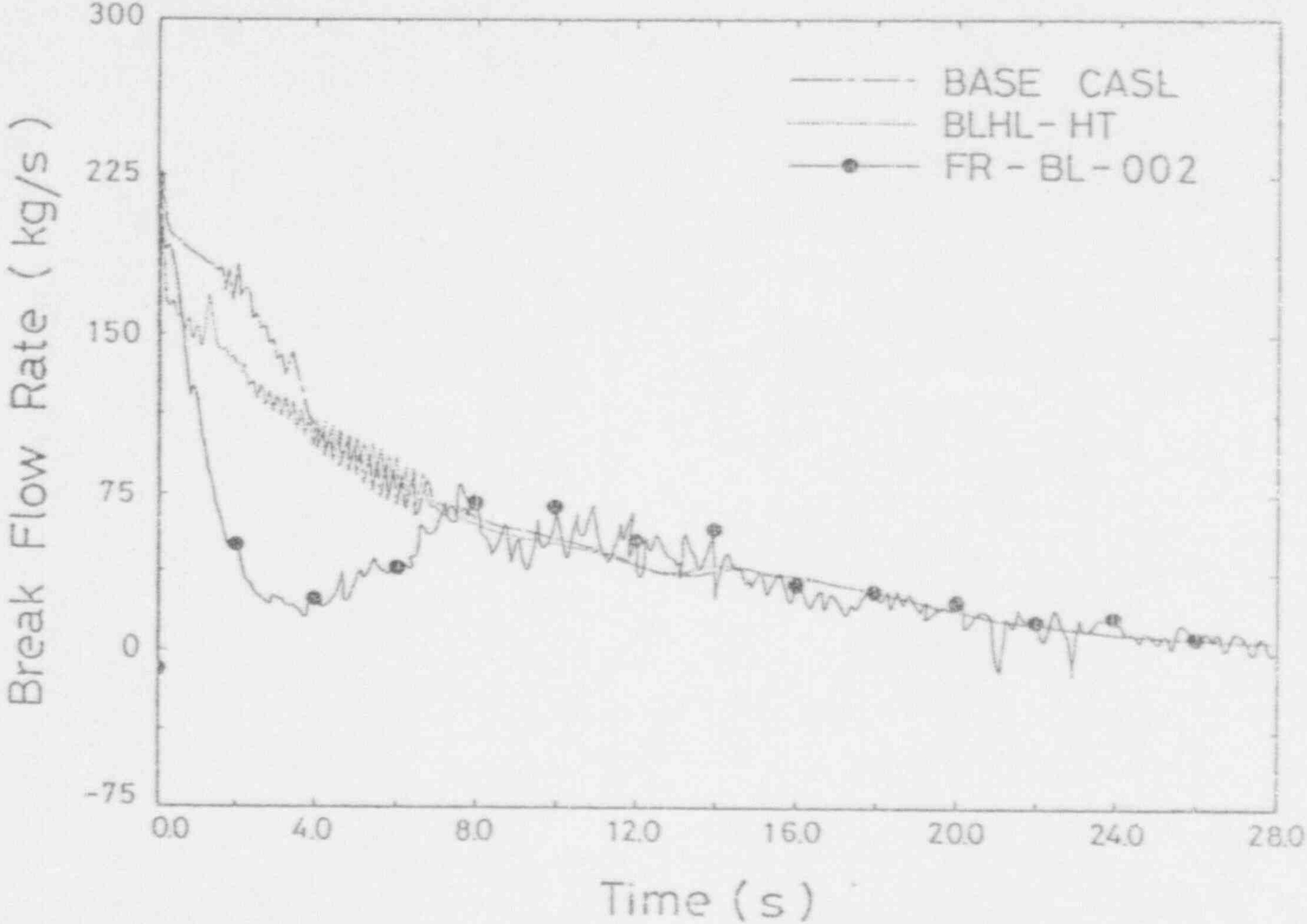


Figure 4.40 Comparison between Calculated Hot-Leg Break Flow Rates of the BASE and BLHL-HT Cases

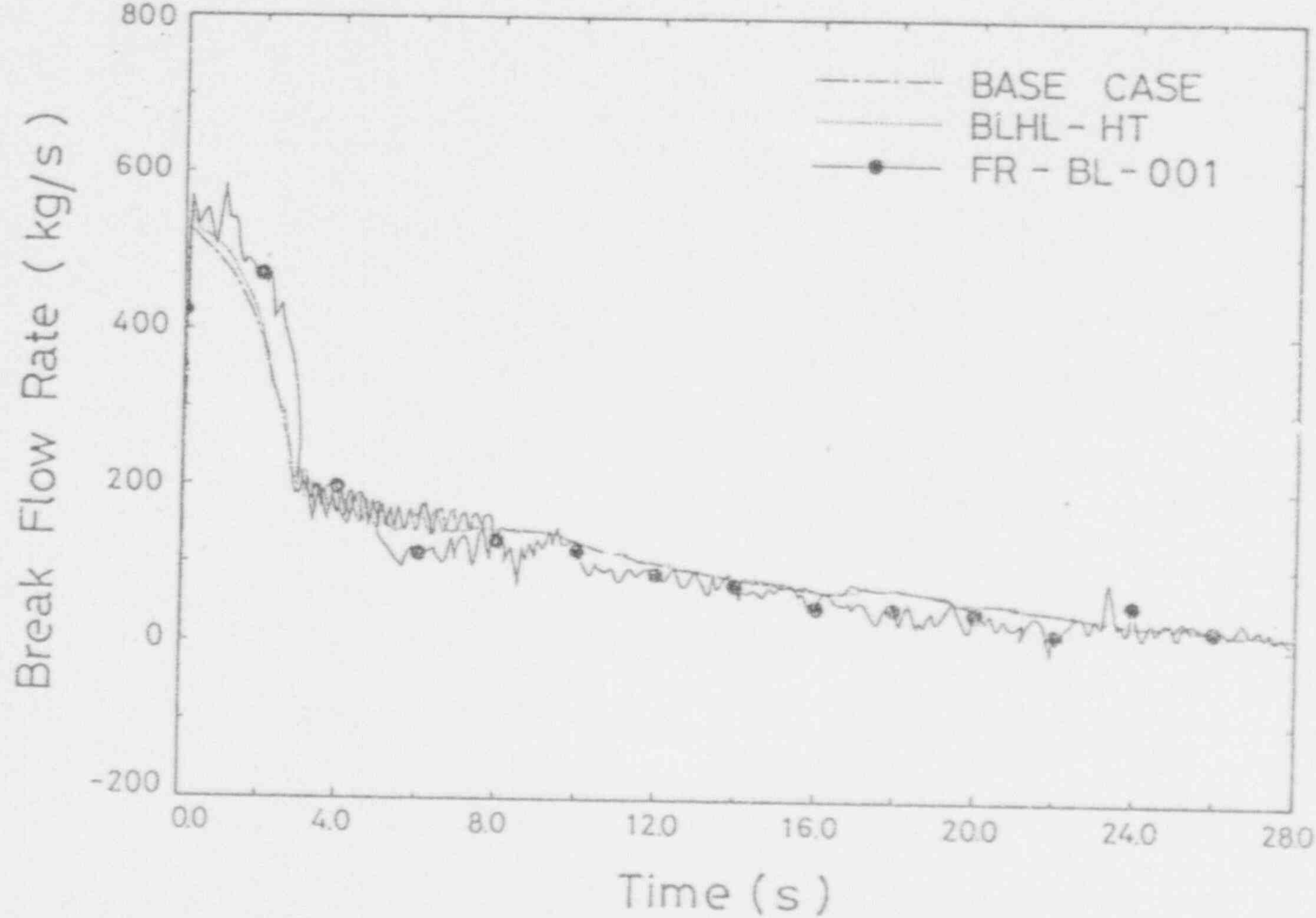


Figure 4.41 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and BLHL-HT Cases

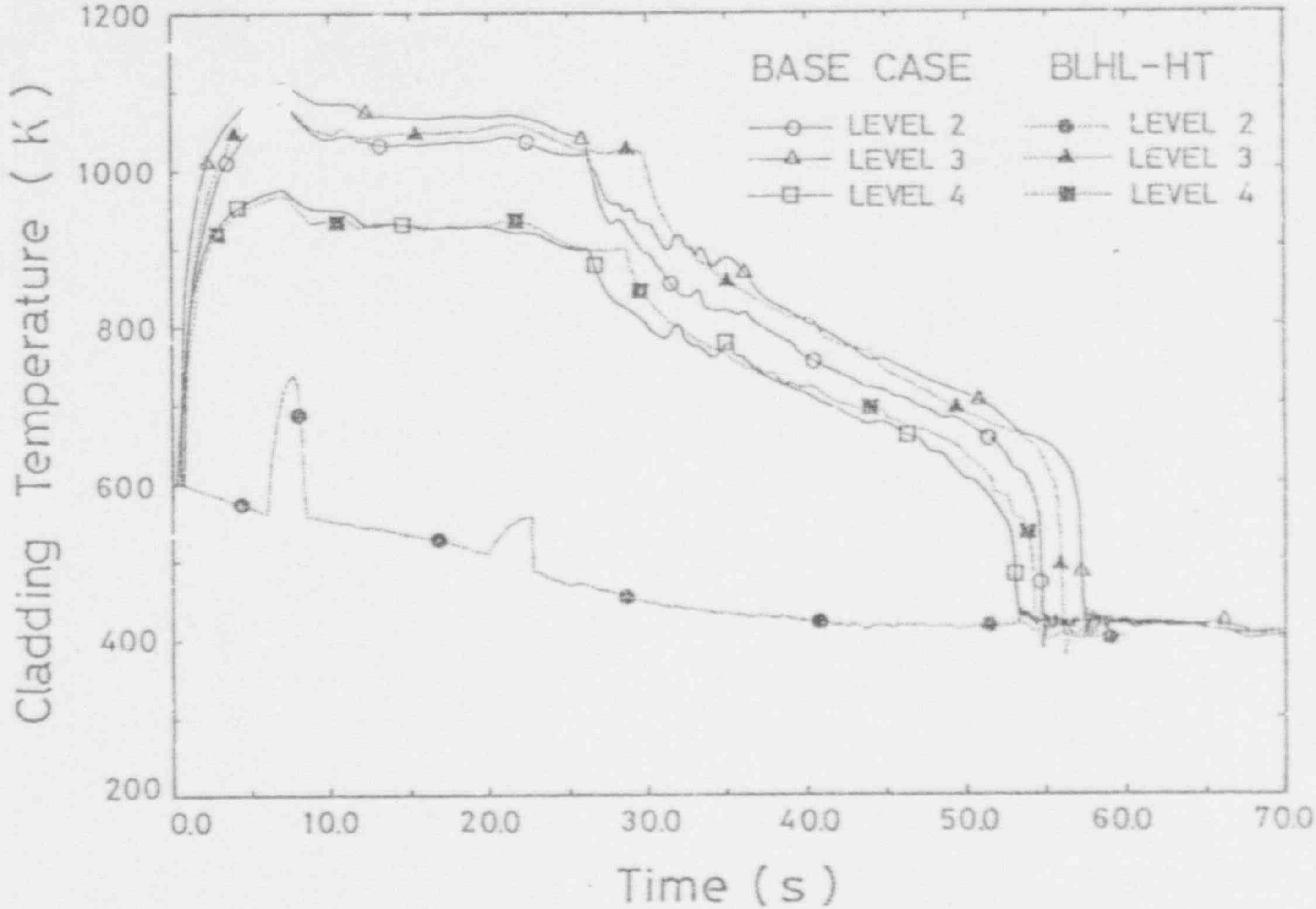


Figure 4.42 Comparison between Calculated Cladding Temperatures at Various Axial Locations of the BASE and BLHL-HT Cases

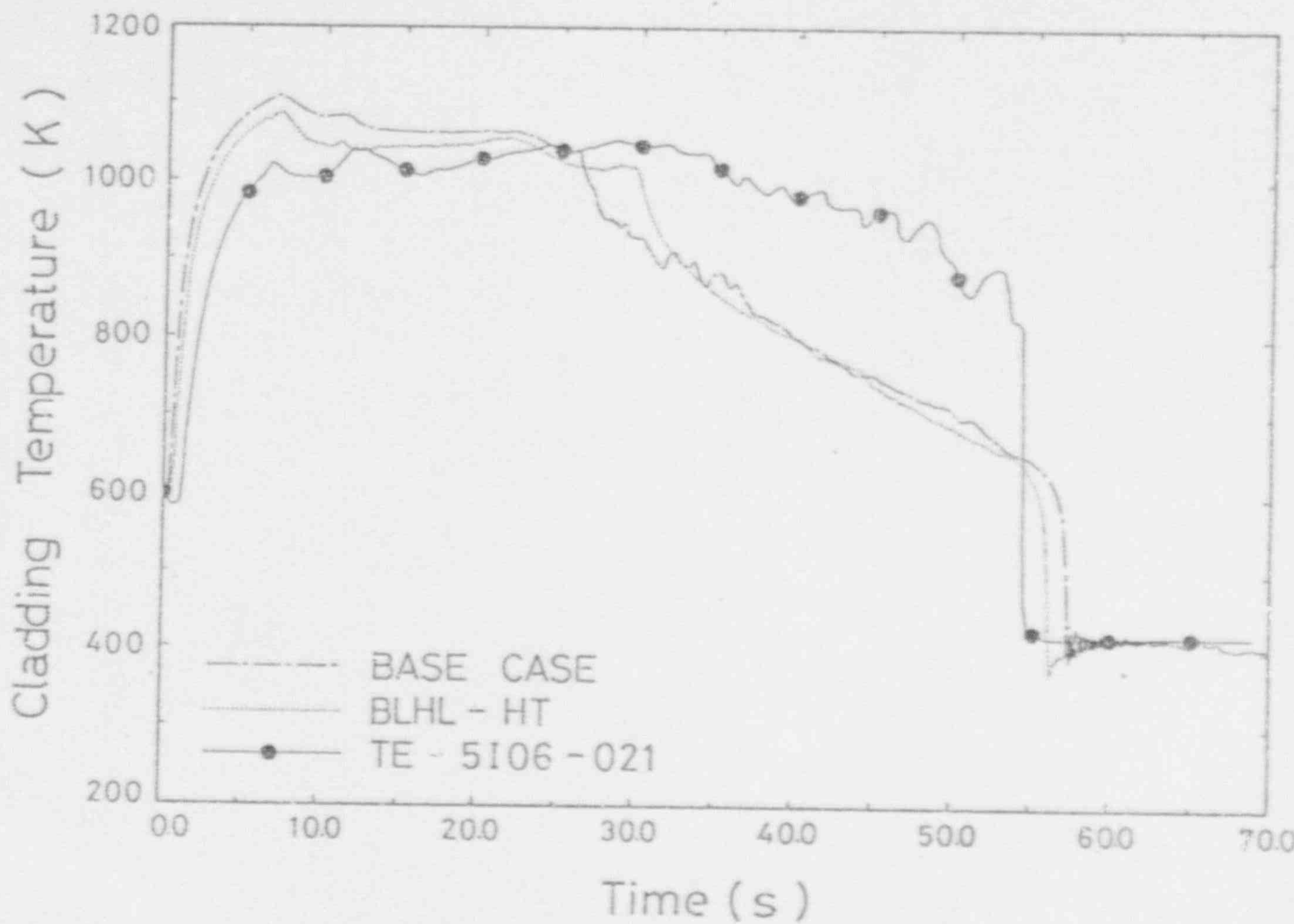


Figure 4.43 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and BLHL-HT Cases

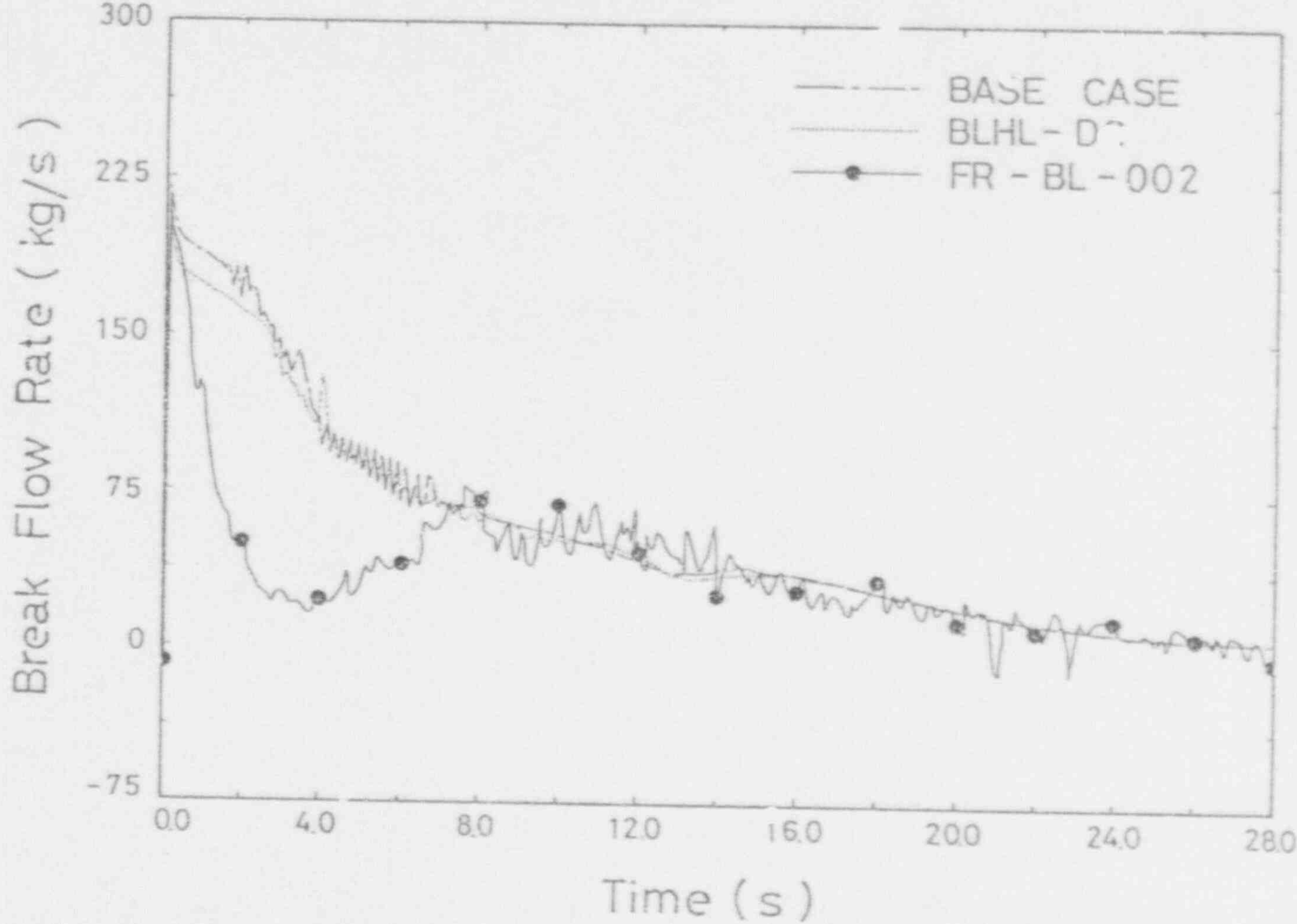


Figure 4.44 Comparison between Calculated Hot-Leg Break Flow Rates of the BASE and BLHL-DC Cases

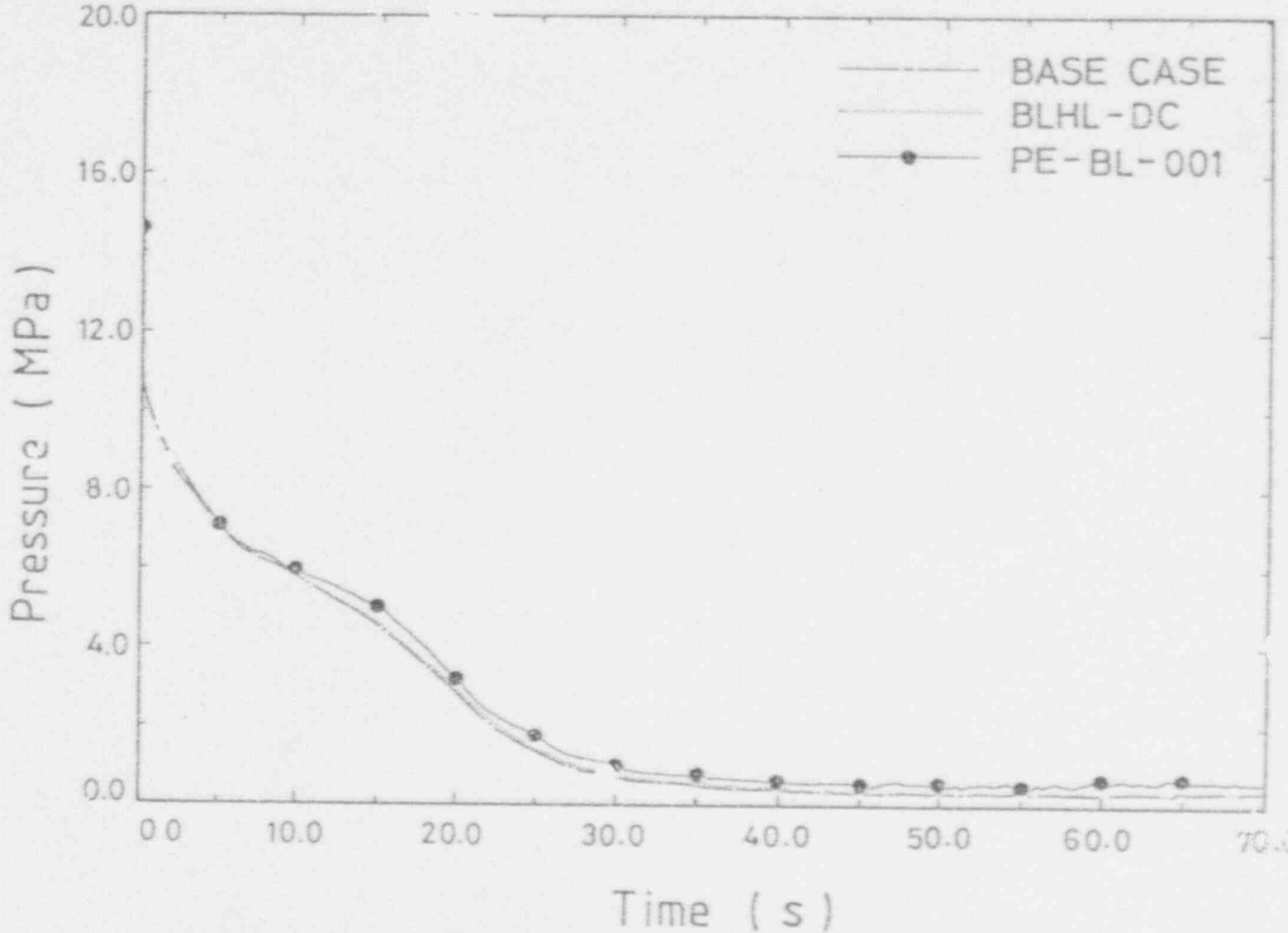


Figure 4.45 Comparison between Calculated Broken Loop Cold-Leg Pressures of the BASE and BLHL-DC Cases

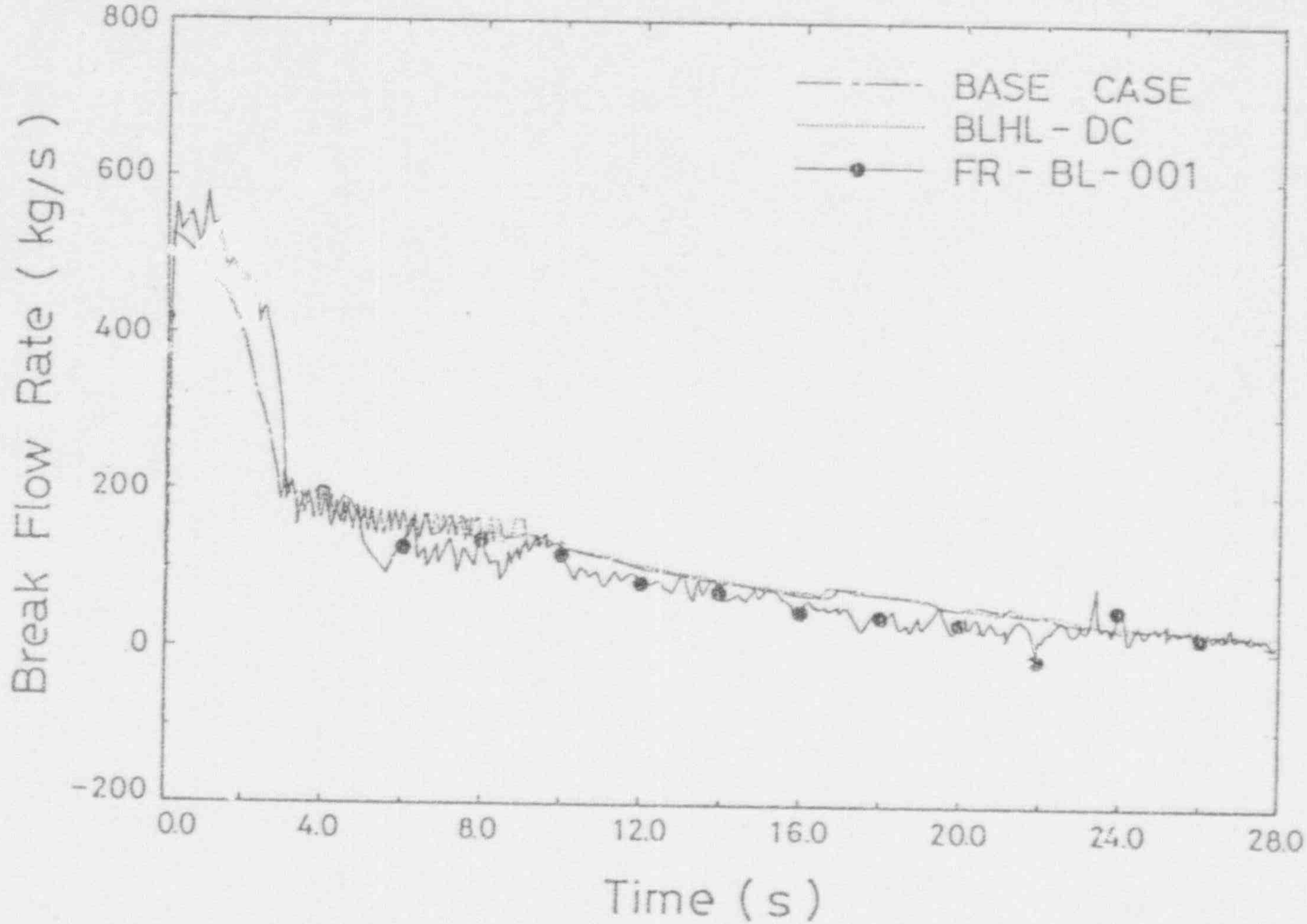


Figure 4.46 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and BLHL-DC Cases

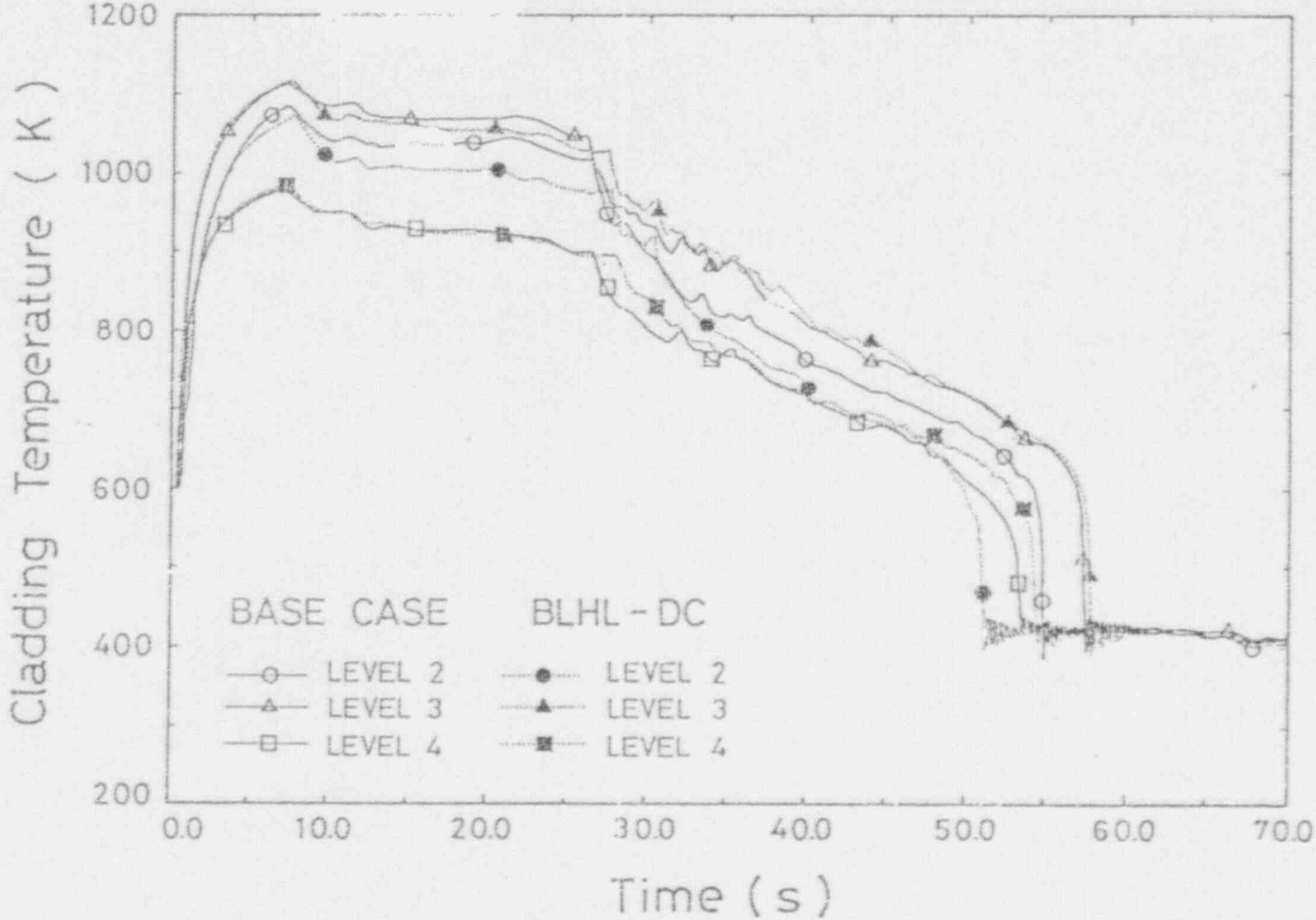


Figure 4.47 Comparison between Calculated Cladding Temperatures at Various Axial Locations of the BASE and BLHL-DC Cases

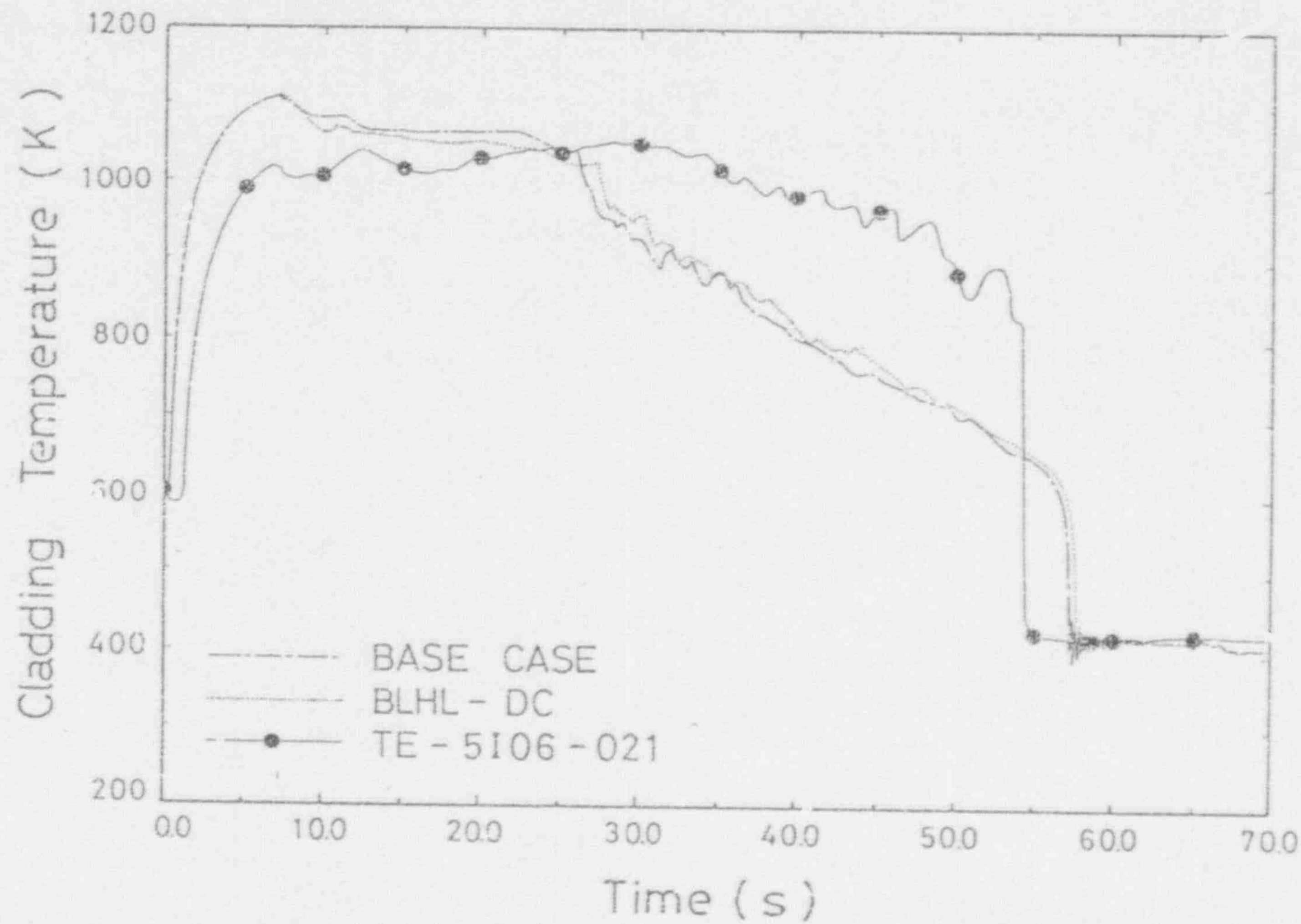


Figure 4.48 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and BLHL-DC Cases

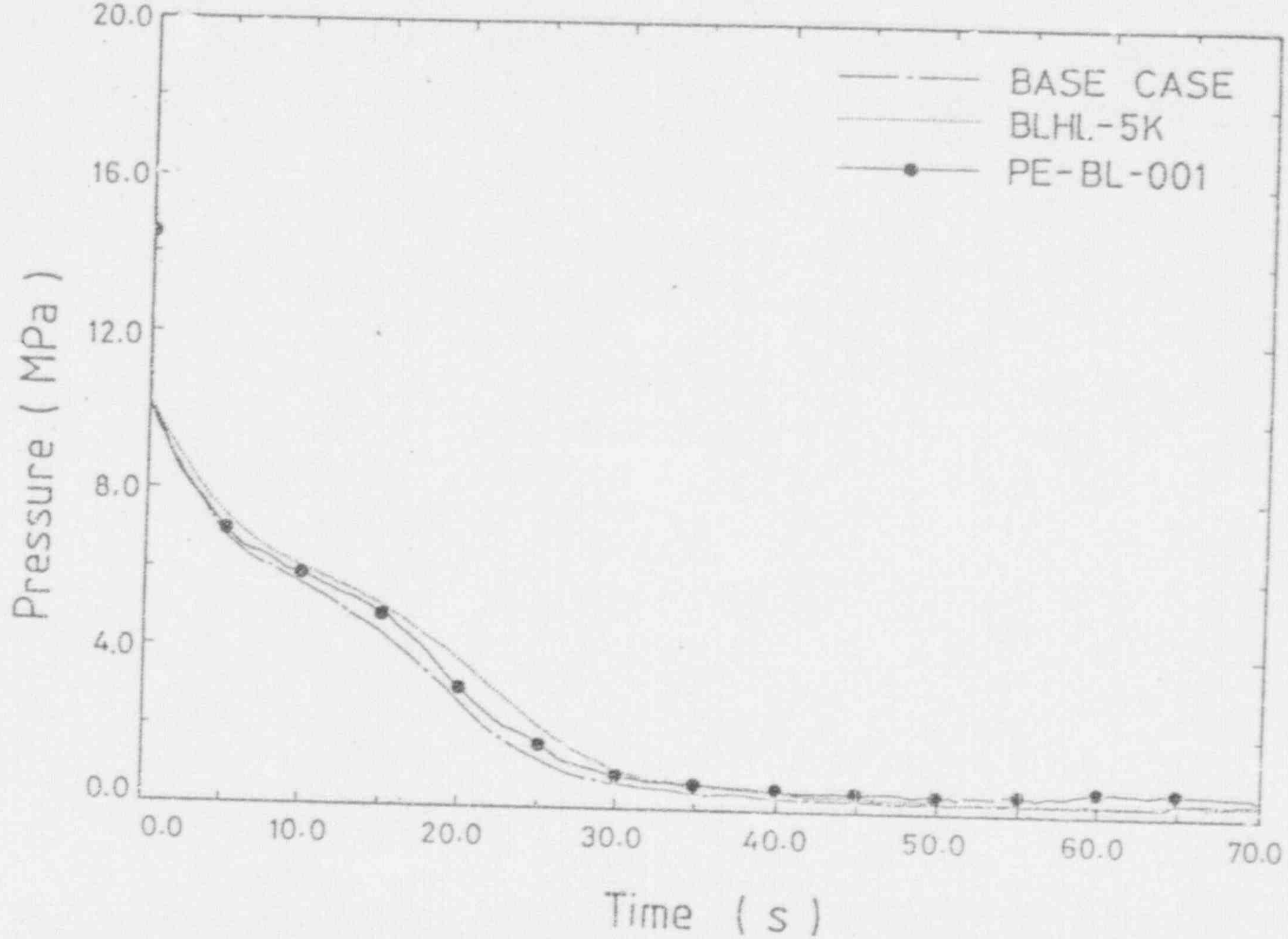


Figure 4.49 Comparison between Calculated Broken Loop Cold-Leg Pressures of the BASE and BLHL-5K Cases

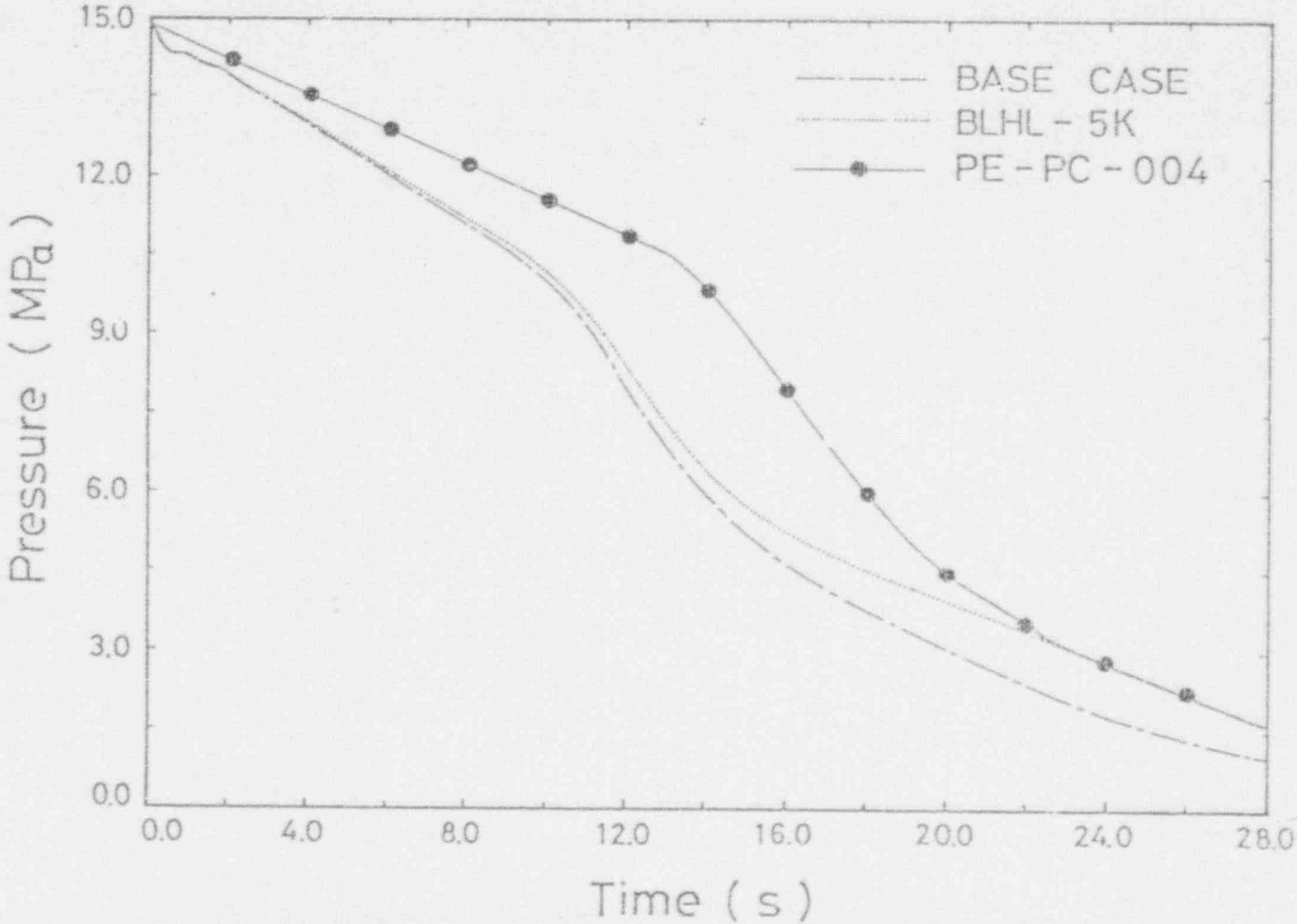


Figure 4.50 Comparison between Calculated Pressurizer Pressures of the BASE and BLHL-5K Cases

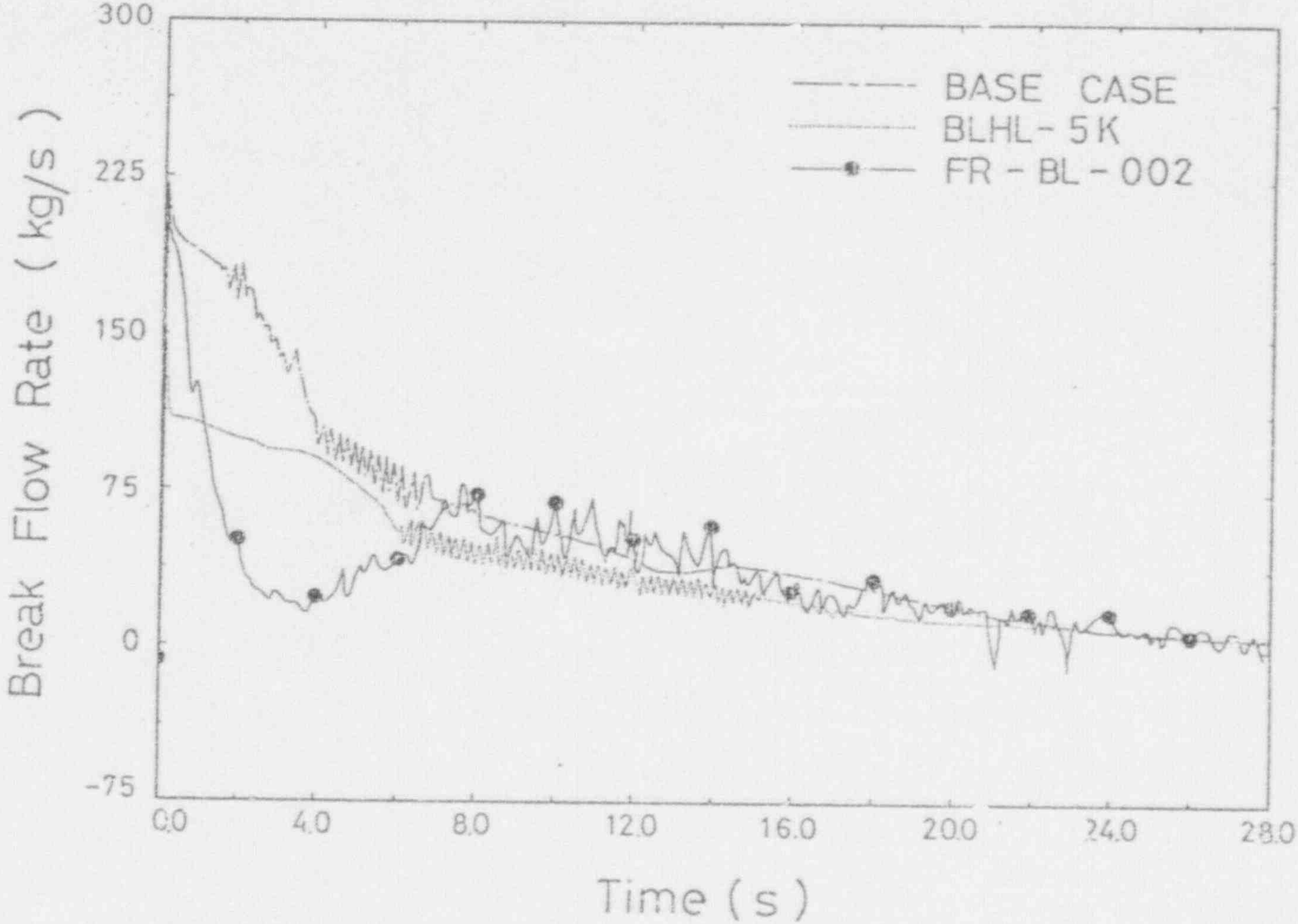


Figure 4.51 Comparison between Calculated Hot-Leg Break Flow Rates of the BASE and BLHL-5K Cases

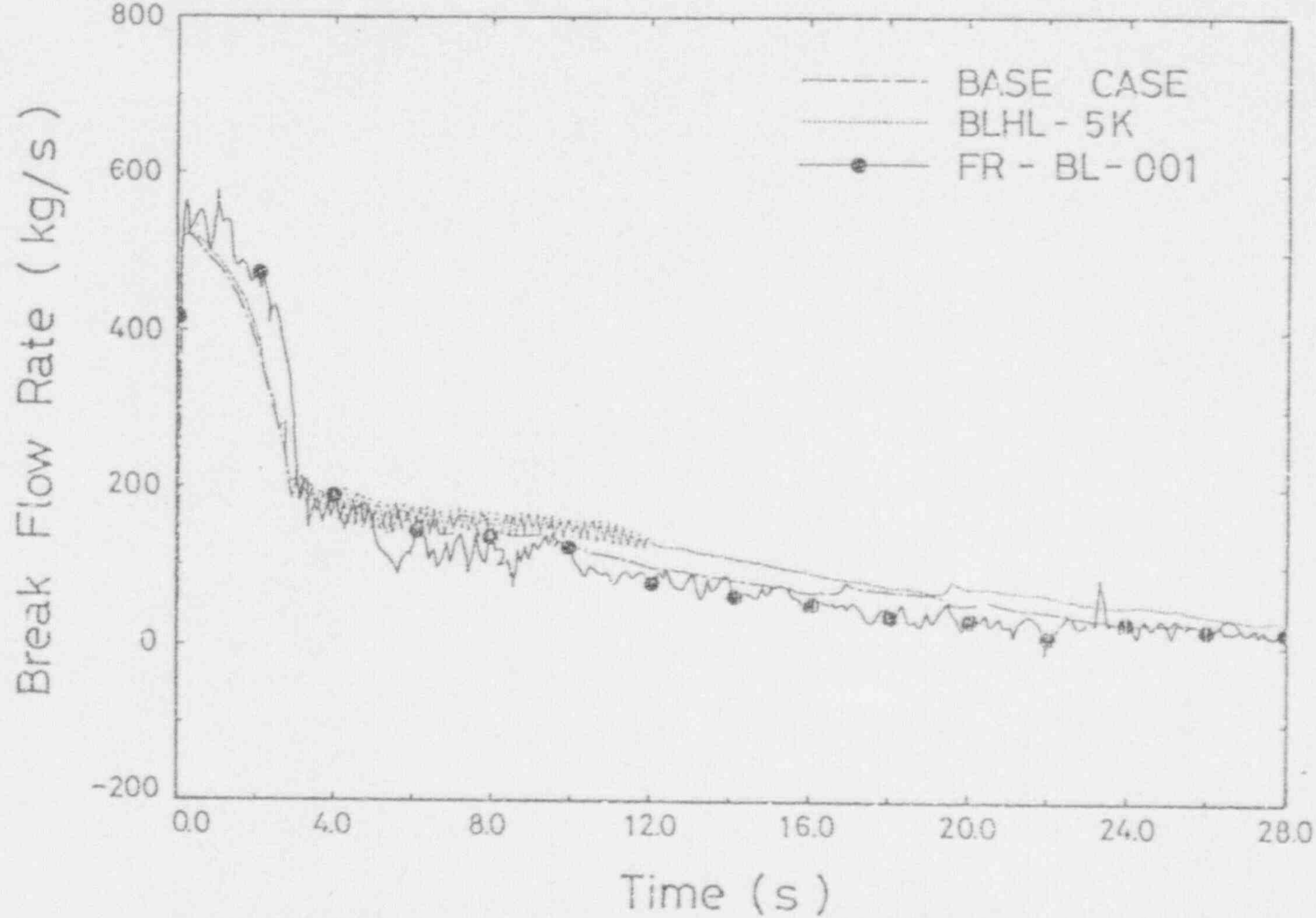


Figure 4.52 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and BLHL-5K Cases

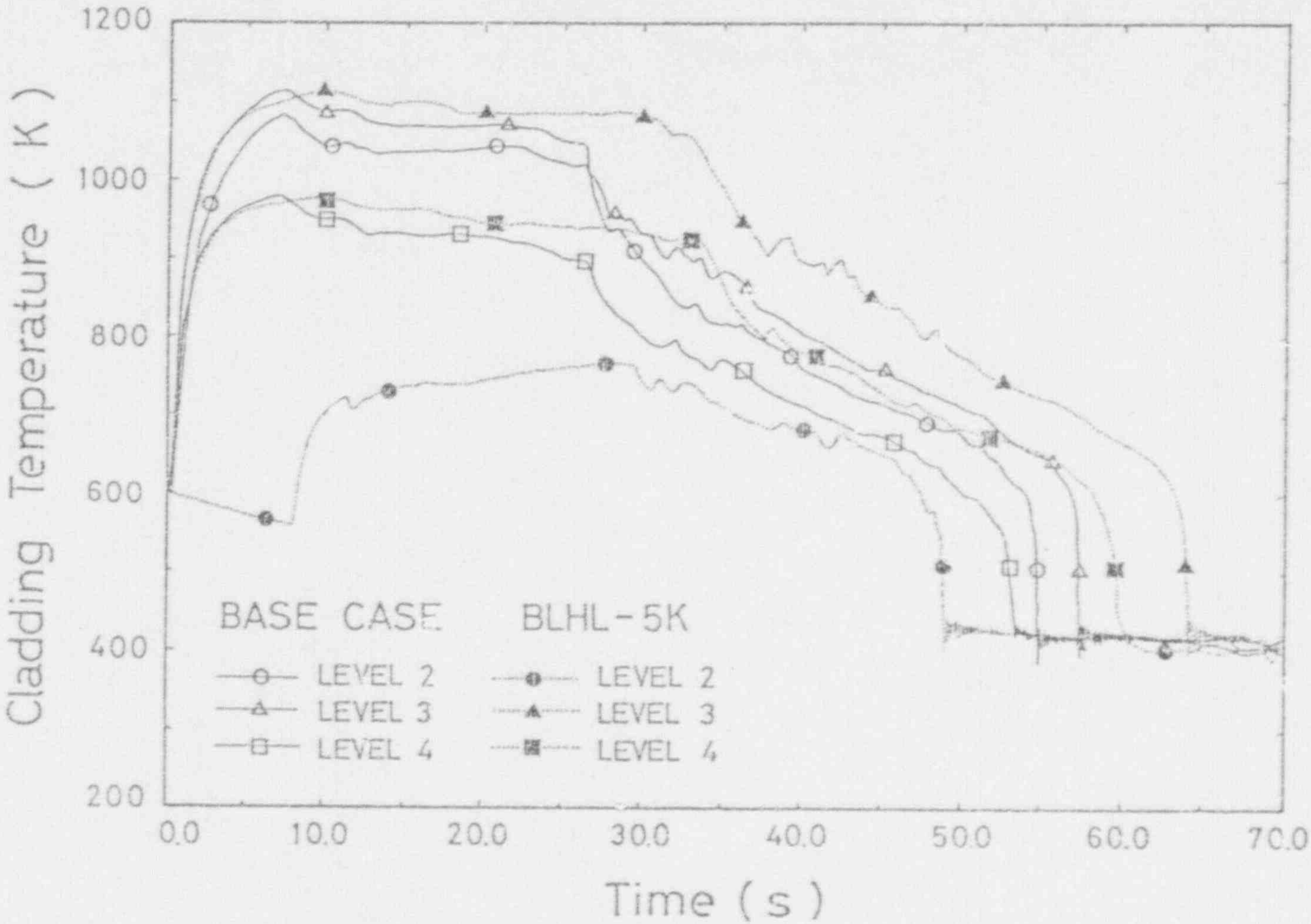


Figure 4.53 Comparison between Calculated Cladding Temperatures at Various Axial Locations of the BASE and BLHL-5K Cases

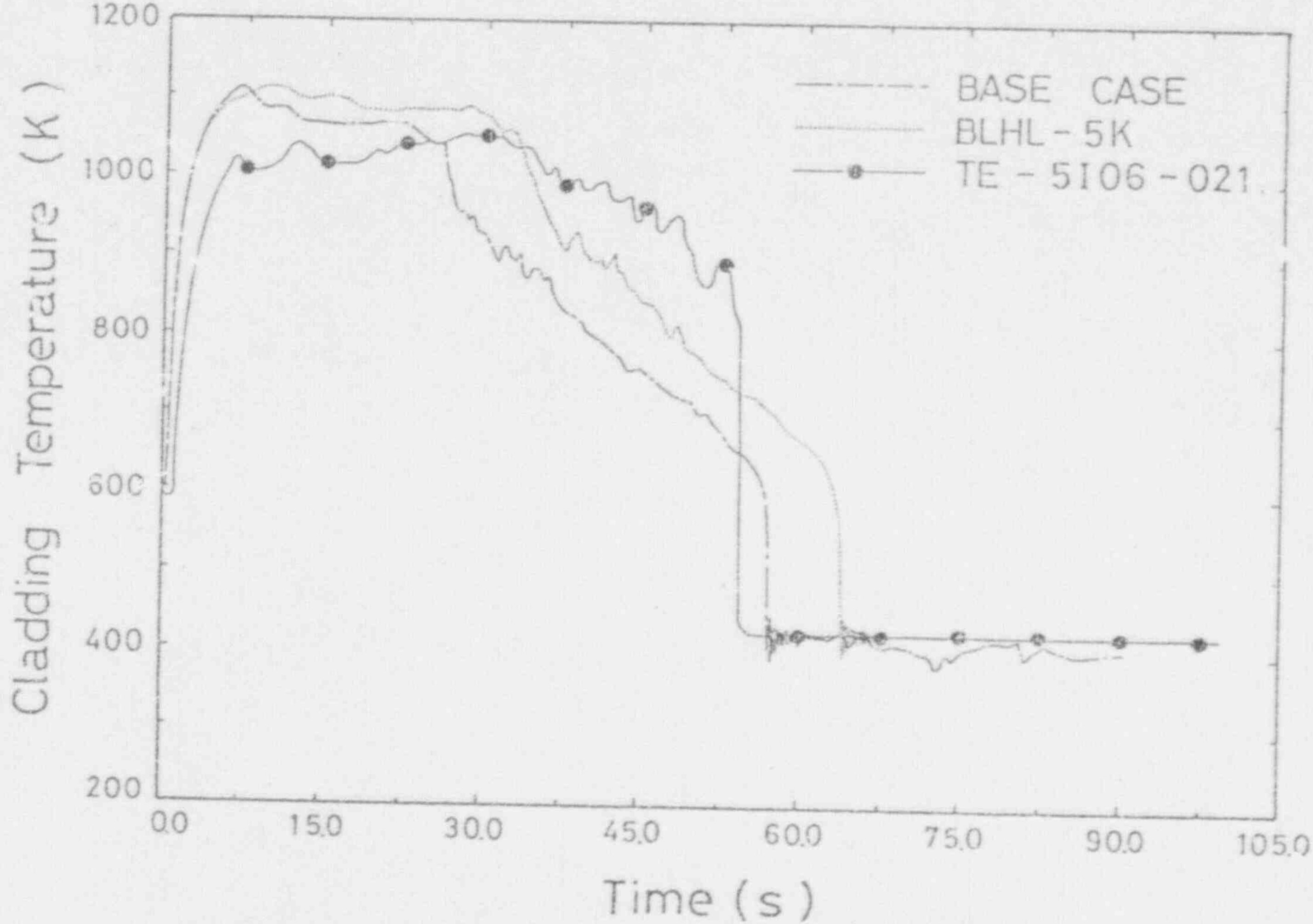


Figure 4.54 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and BLHL-5K Cases

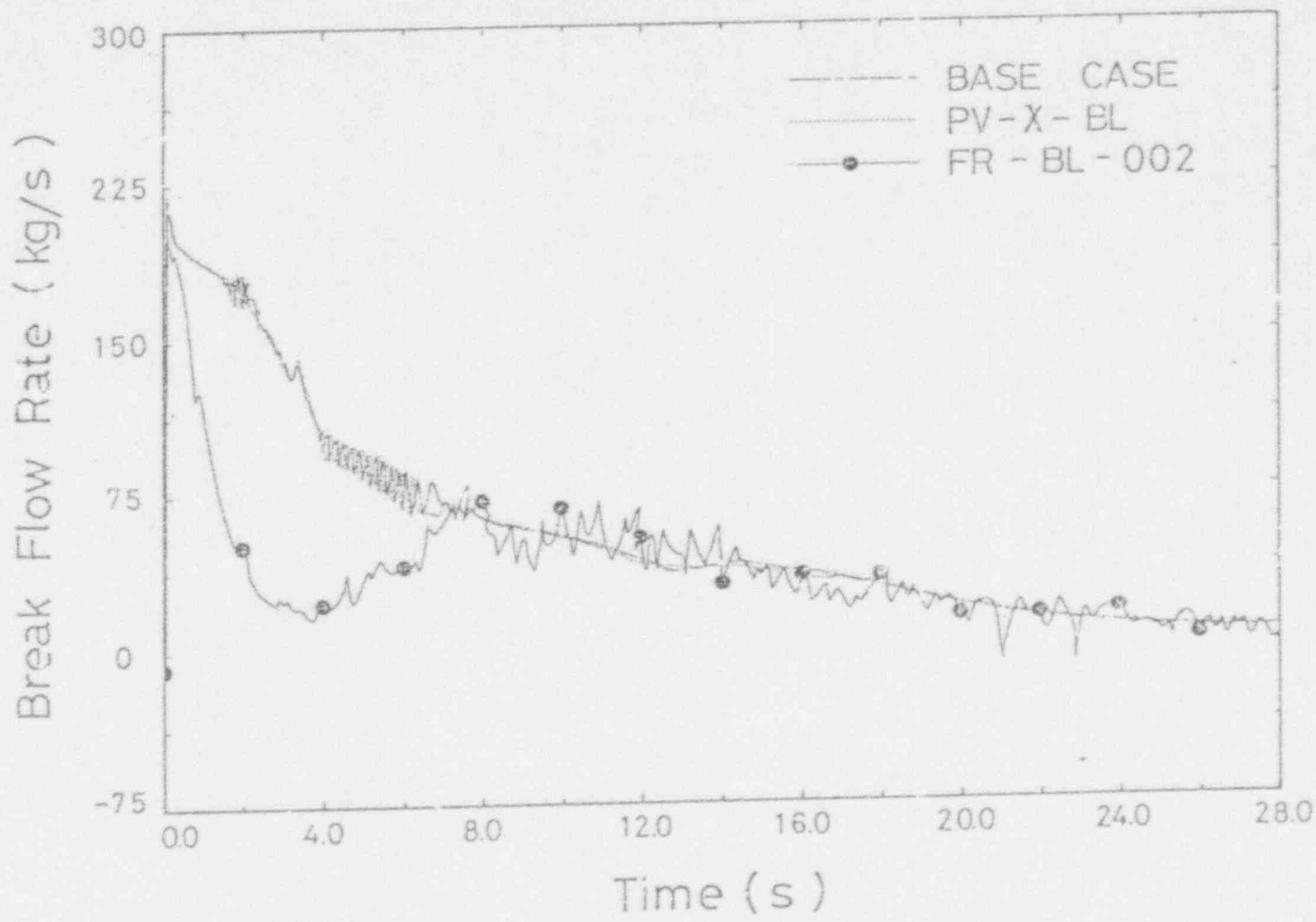


Figure 4.55 Comparison between Calculated Hot-Leg Break Flow Rates of the BASE and PV-X-BL Cases

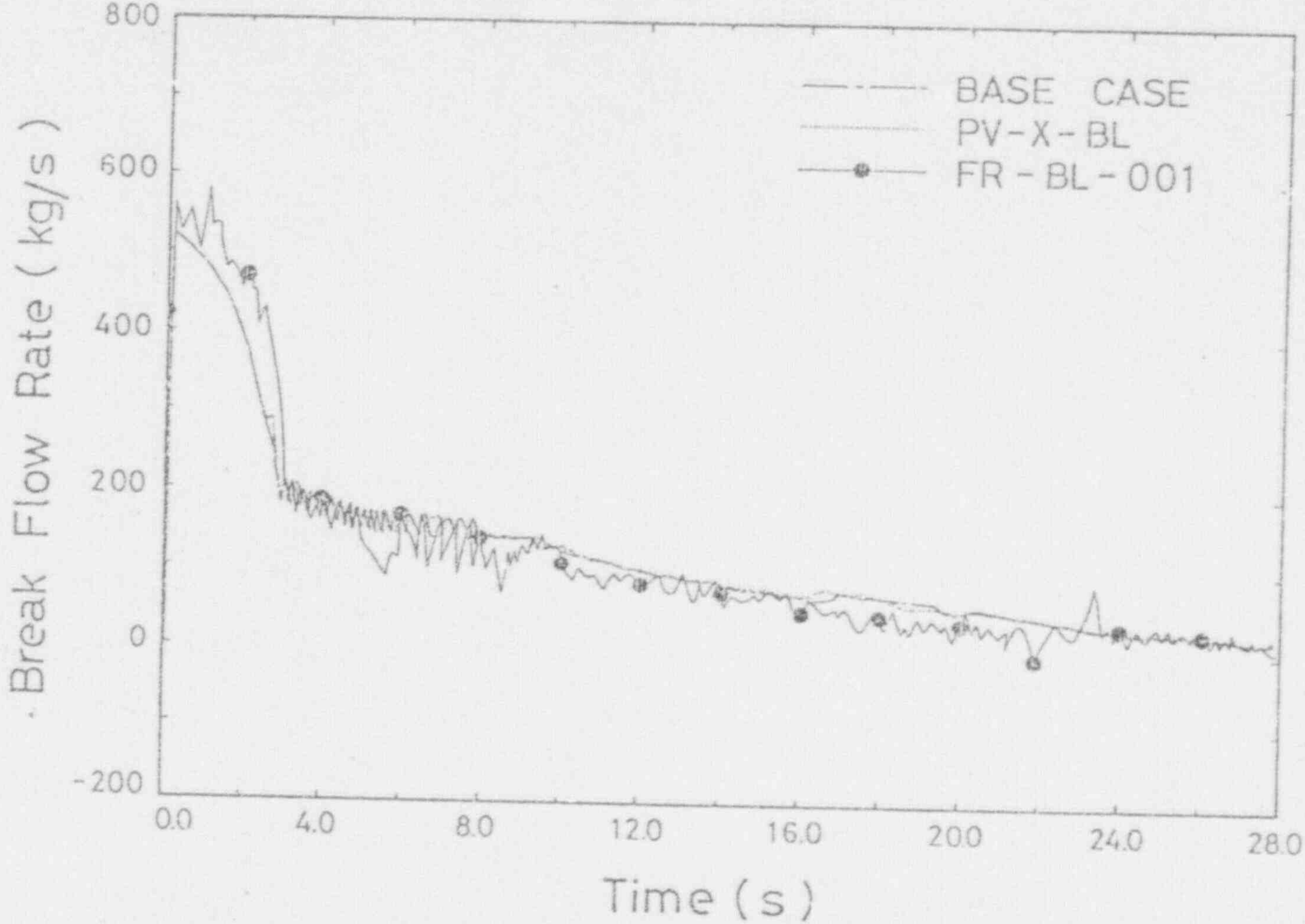


Figure 4.56 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and PV-X-BL Cases

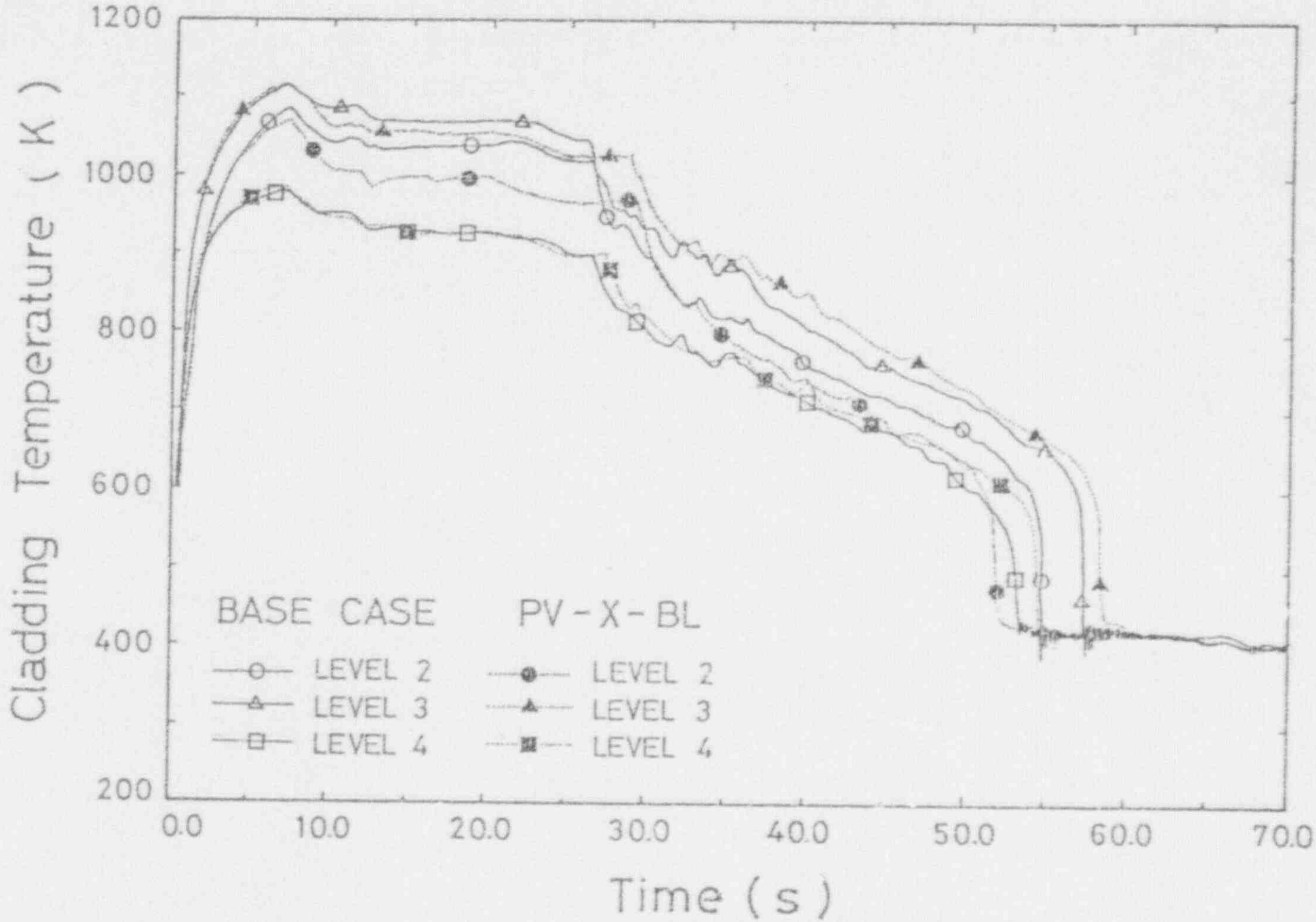


Figure 4.57 Comparison between Cladding Temperatures at Various Axial Locations of the BASE and PV-X-BL Cases

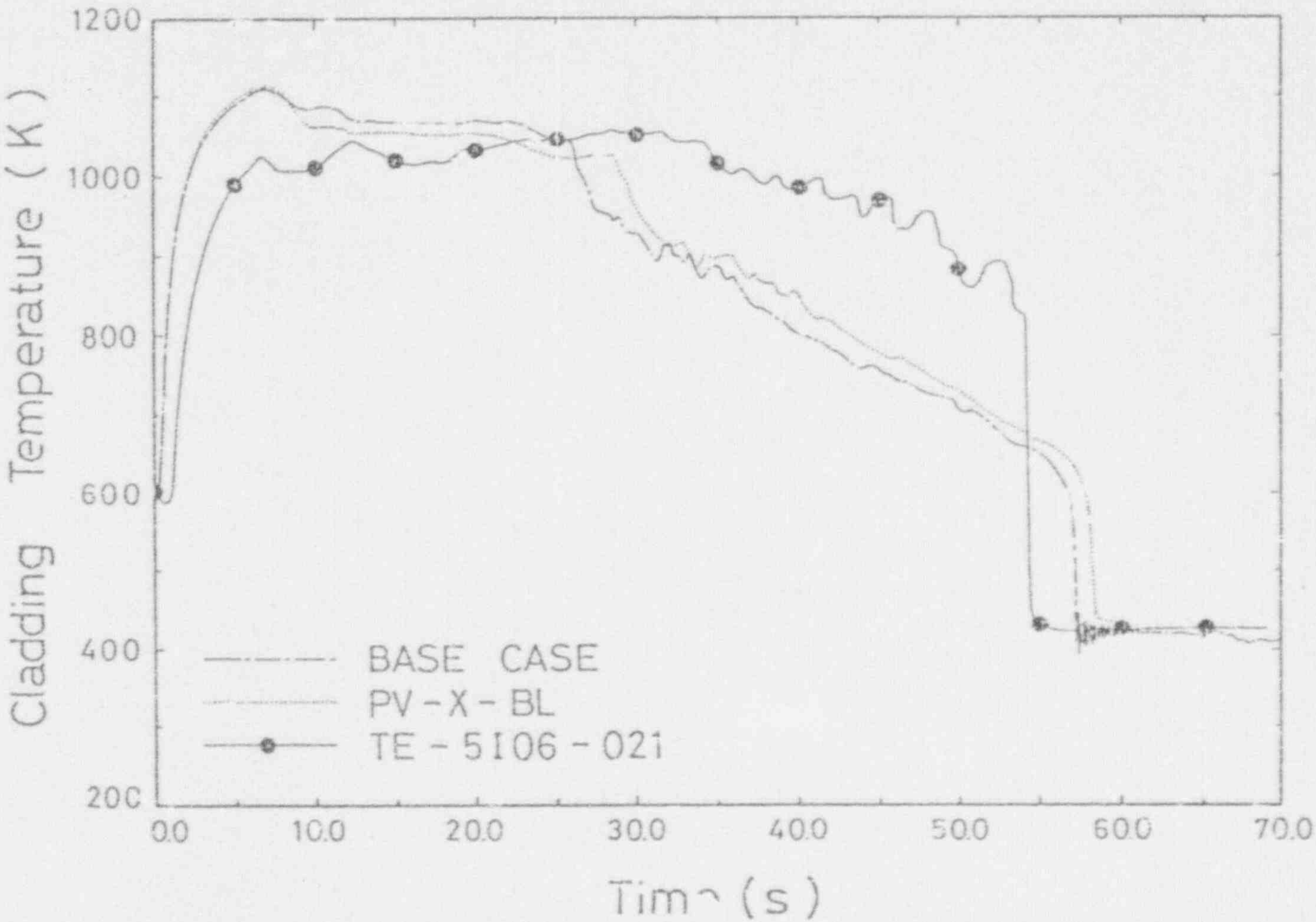


Figure 4.58 Comparison between Cladding Temperatures at Hottest Location of the BASE and PV-X-BL Cases

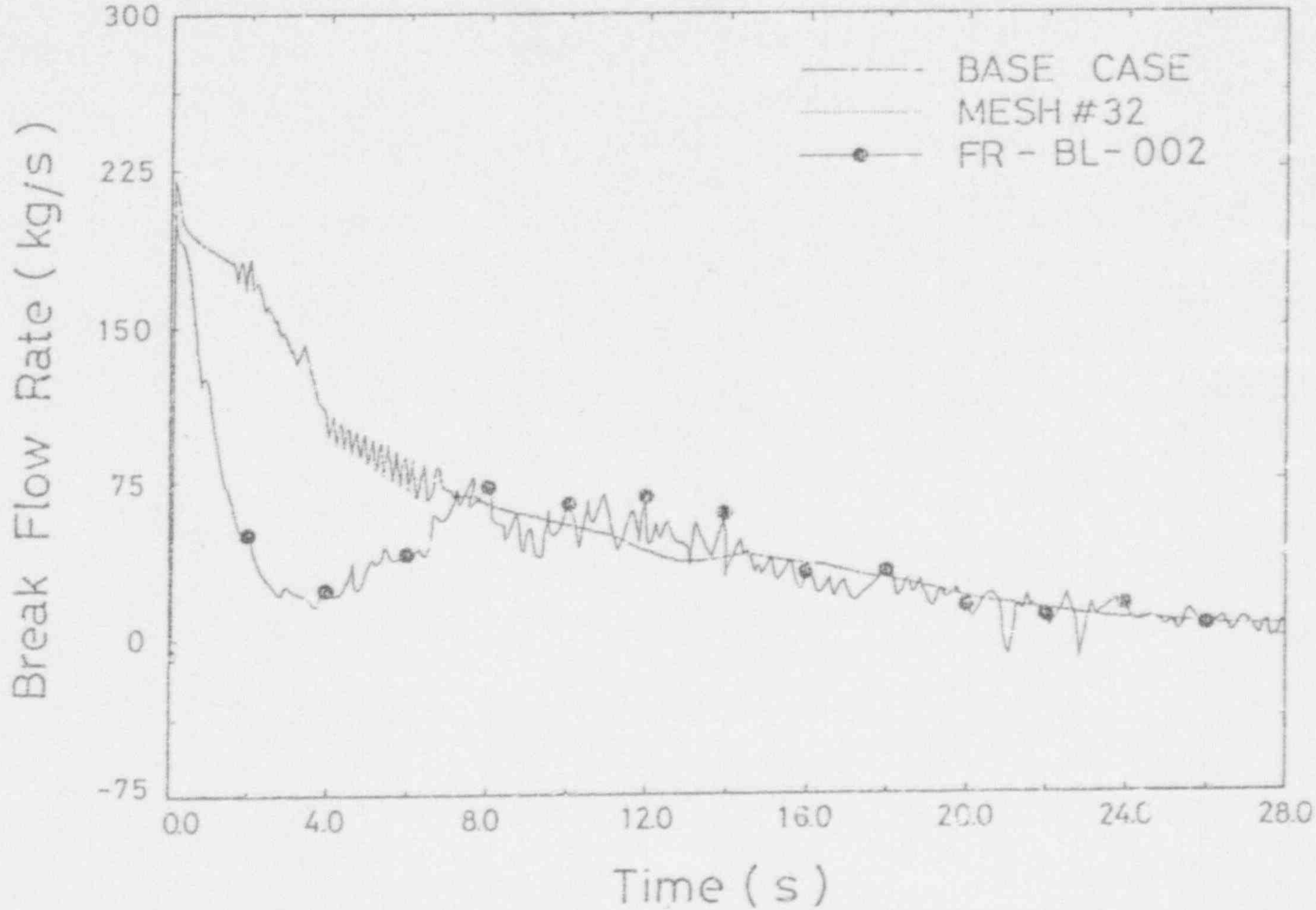


Figure 4.59 Comparison between Calculated Hot-Leg Break Flow of the BASE and MESH#32 Cases

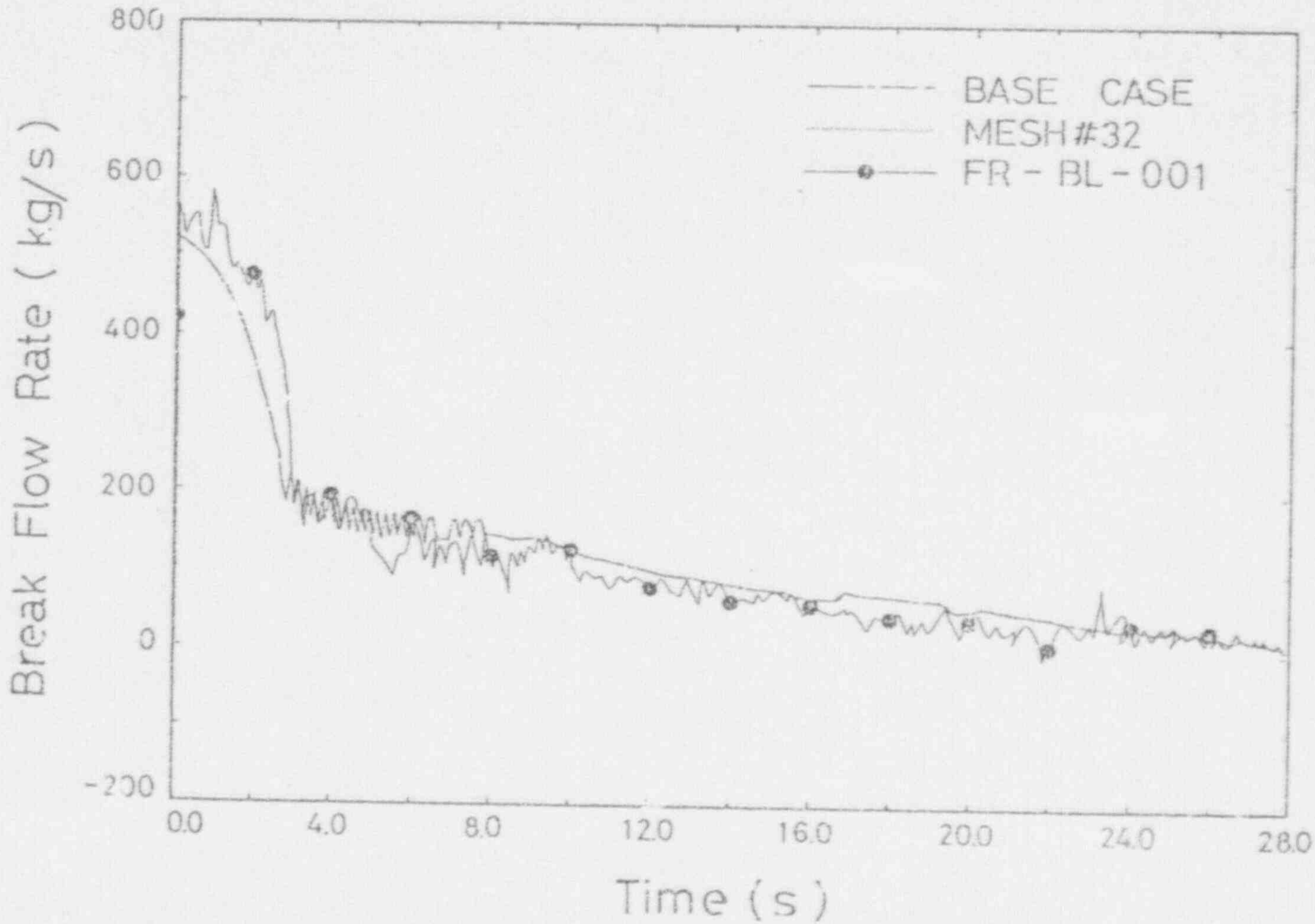


Figure 4.60 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and MESH#32 Cases

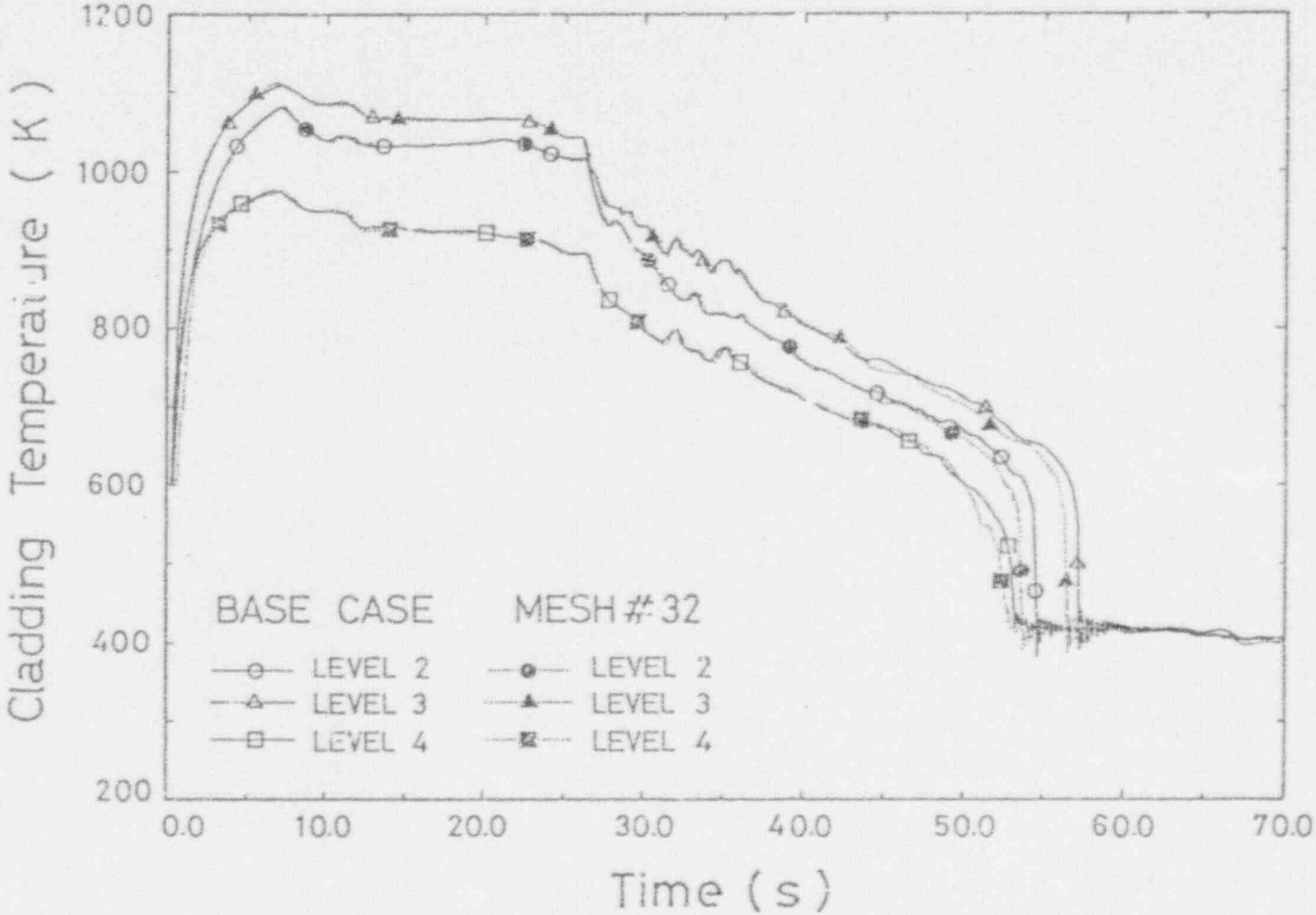


Figure 4.61 Comparison between Calculated Cladding Temperatures at Various Axial Locations of the BASE and MESH#32 Cases

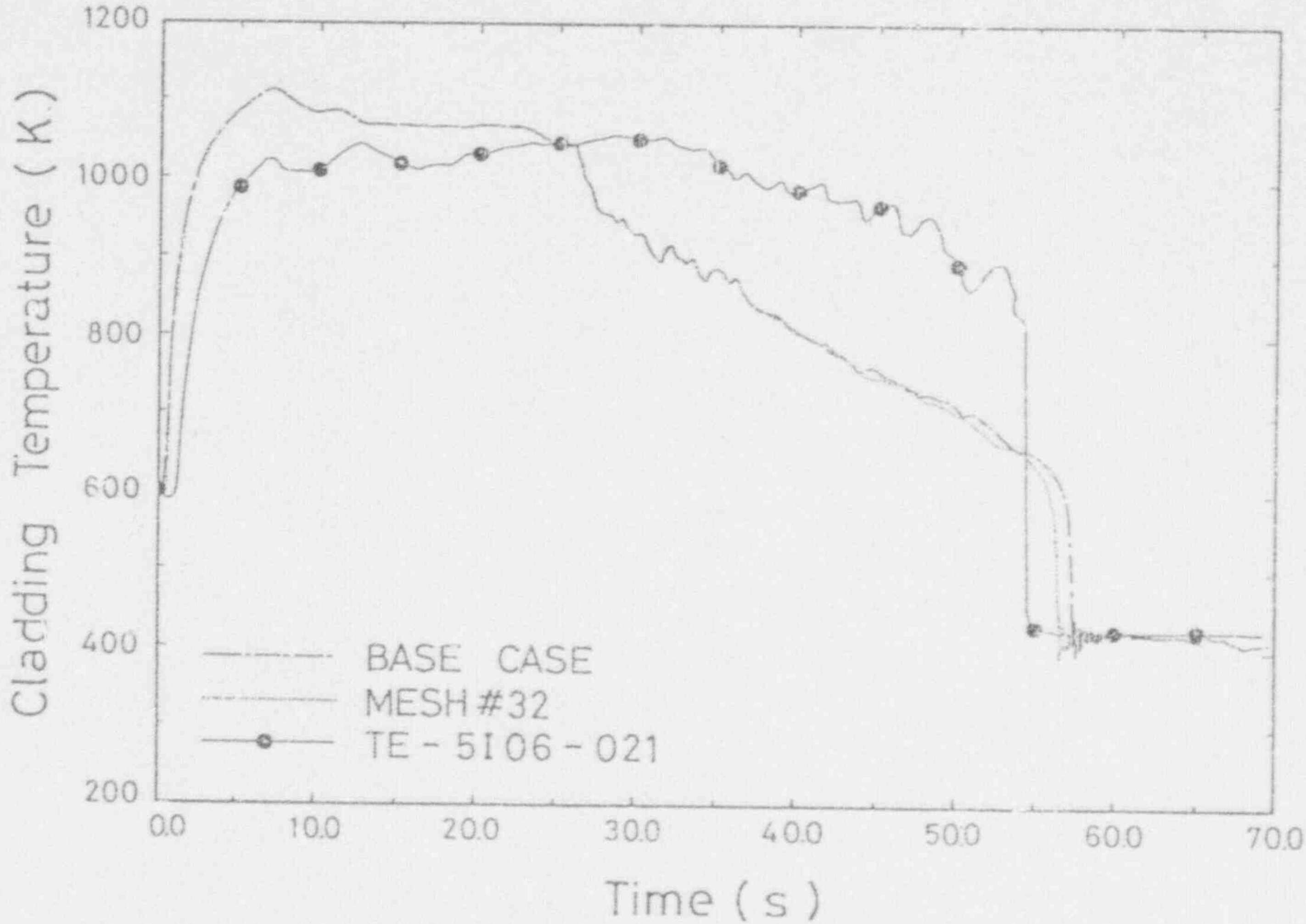


Figure 4.62 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and MESH#32 Cases

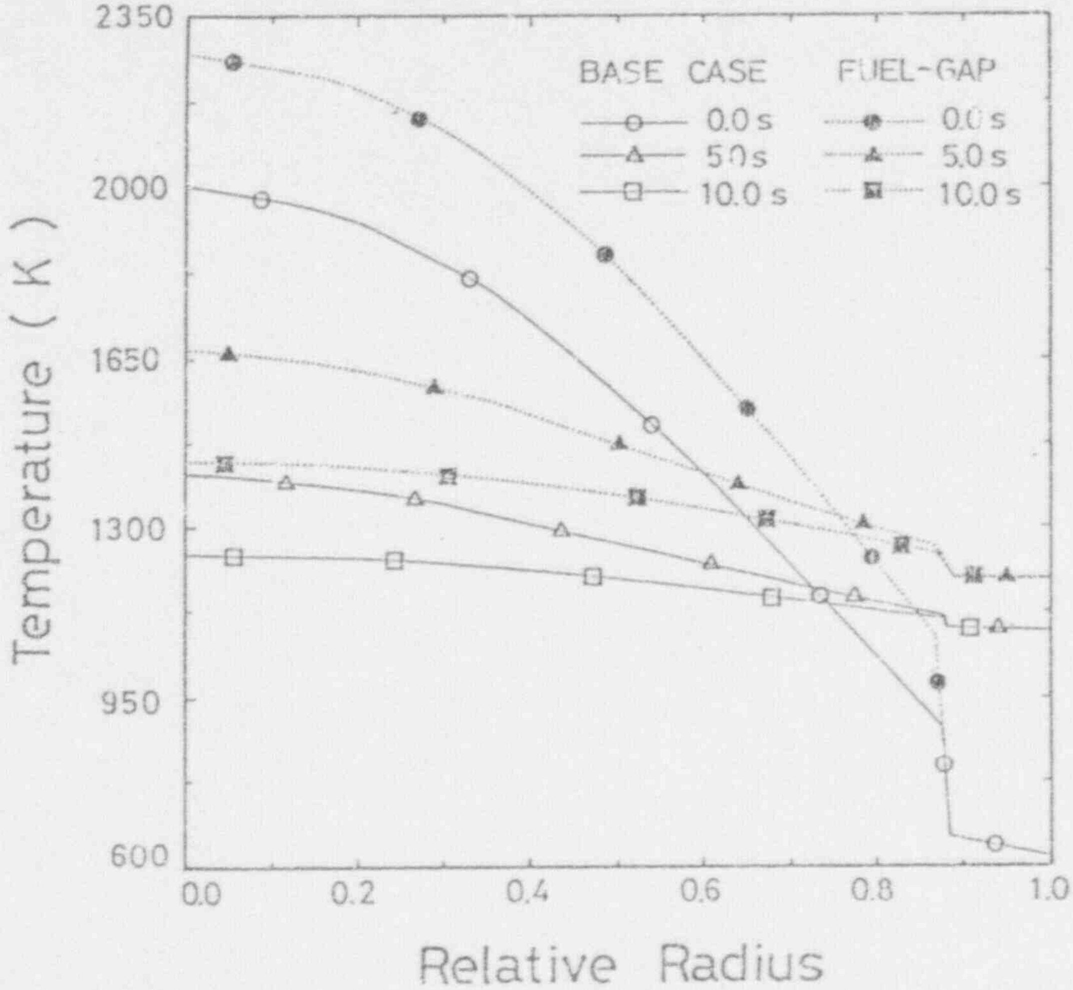


Figure 4.63 Comparison between Calculated Radial Temperature Distributions in Fuel Rod of the BASE and FUEL-GAP Cases

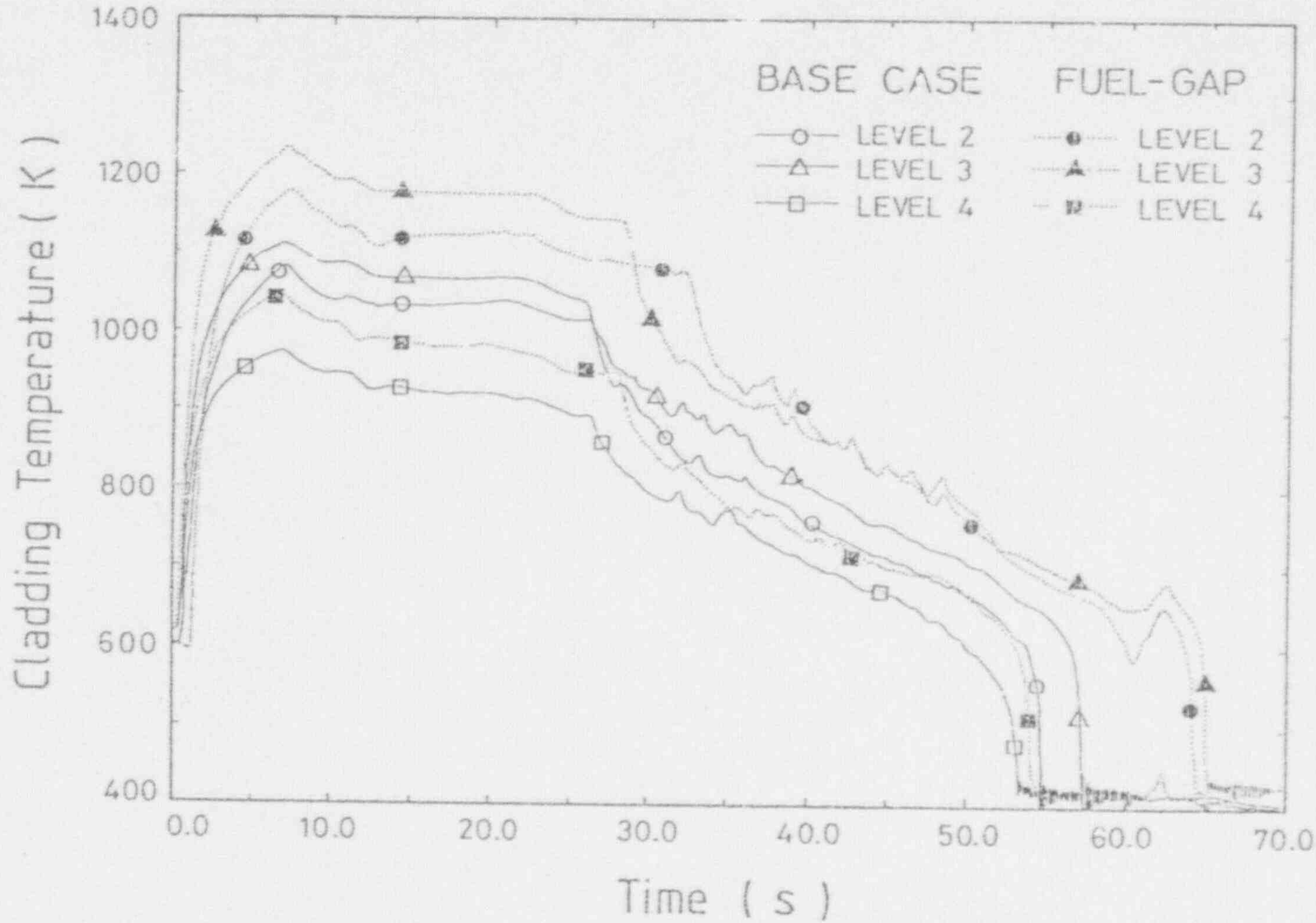


Figure 4.64 Comparison between Calculated Cladding Temperatures at Various Axial Locations of the BASE and FUEL-GAP Cases

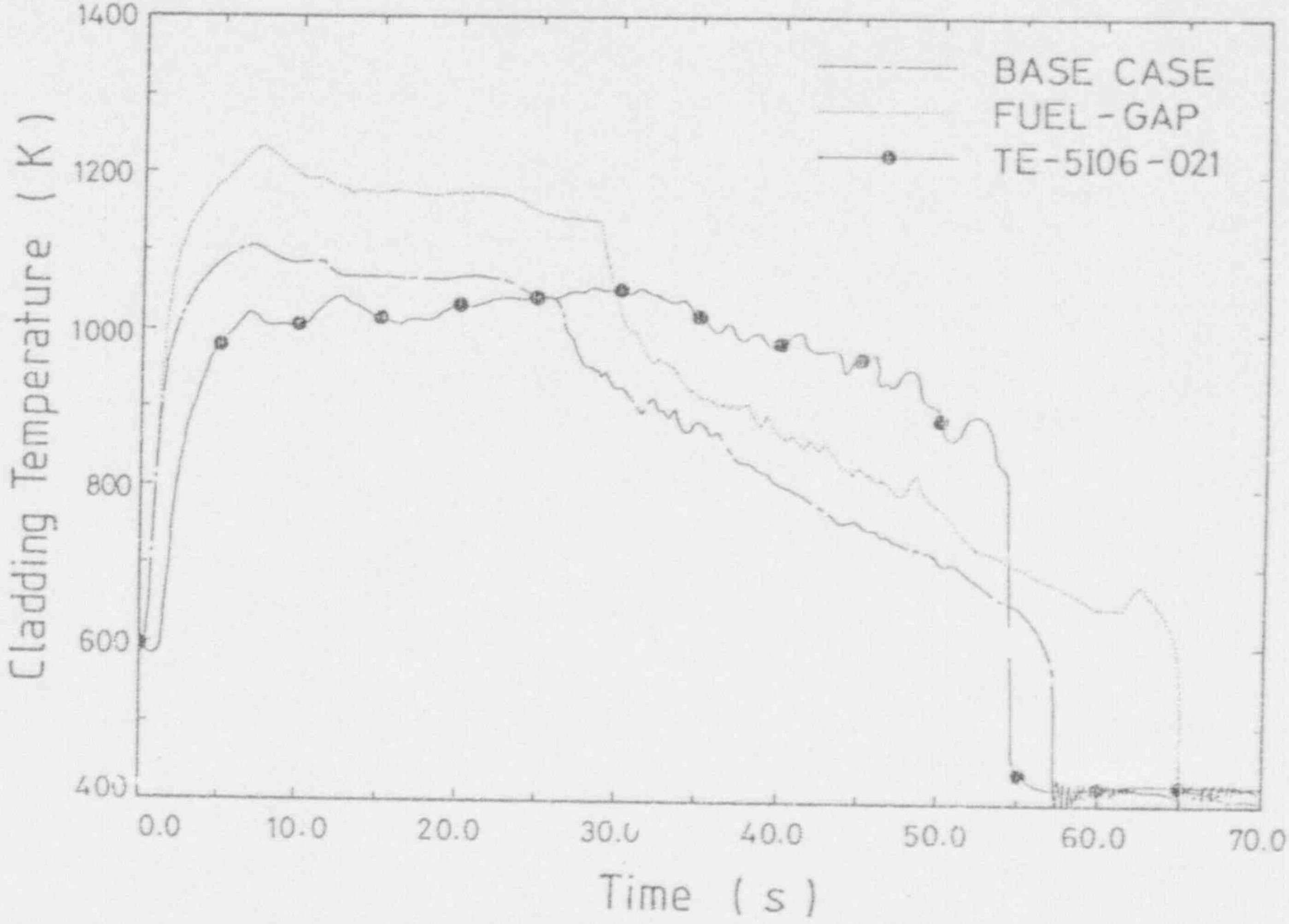


Figure 4.65 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and FUEL-GAP Cases

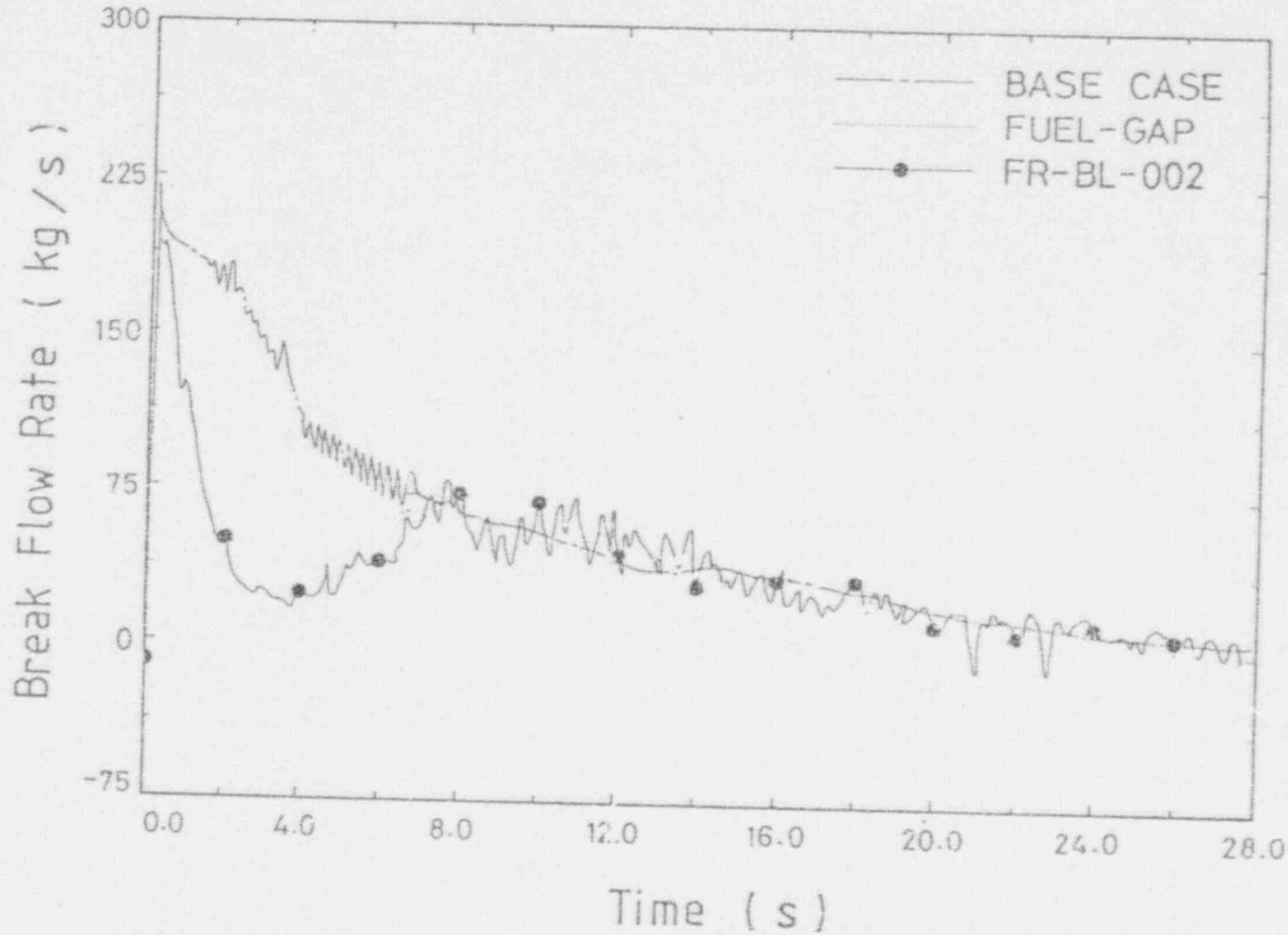


Figure 4.66 Comparison between Ca.cualted Hot-Leg Break Flow Rates of the BASE and FUEL-GAP Cases

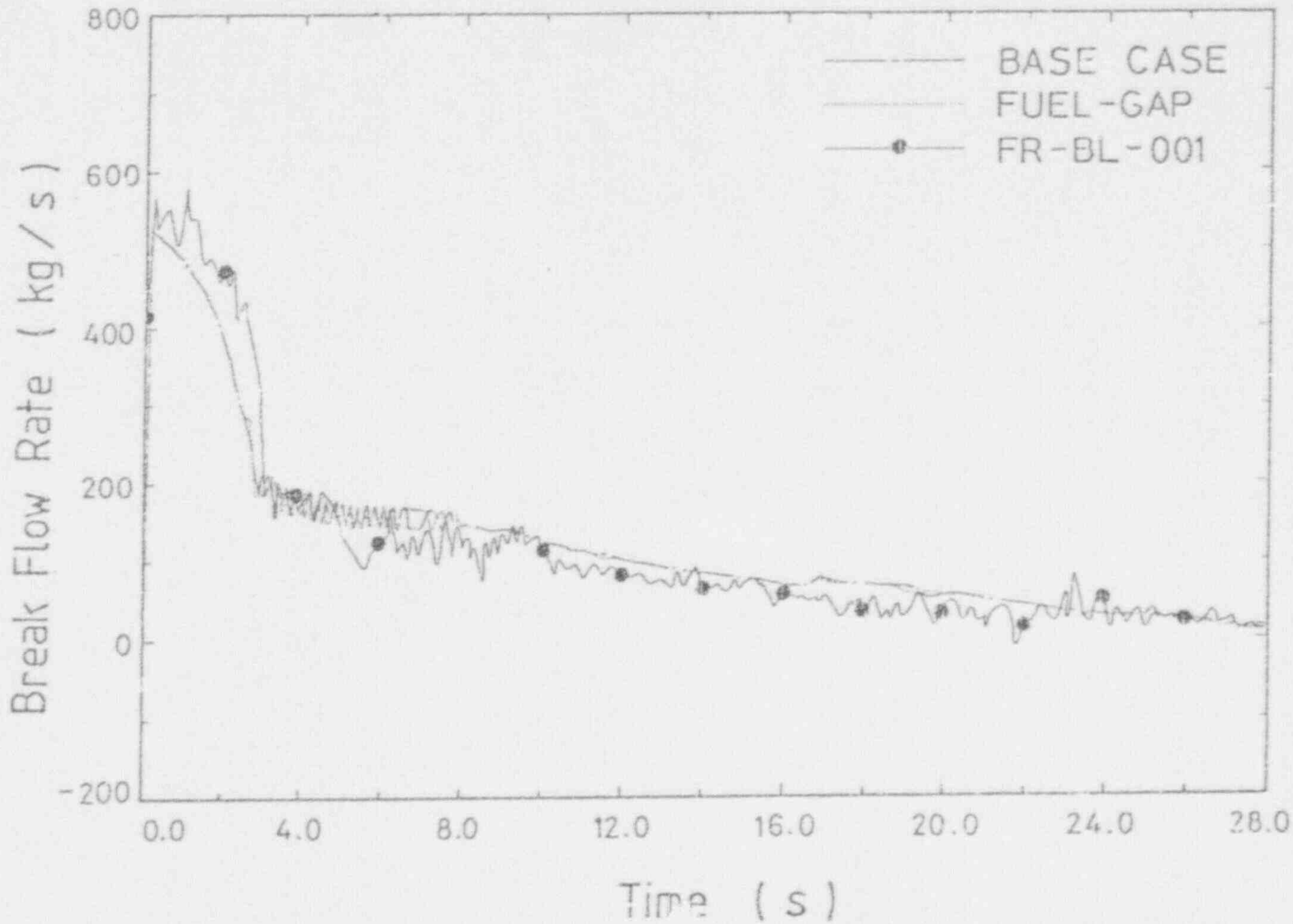


Figure 4.67 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and FUEL-Gap Cases

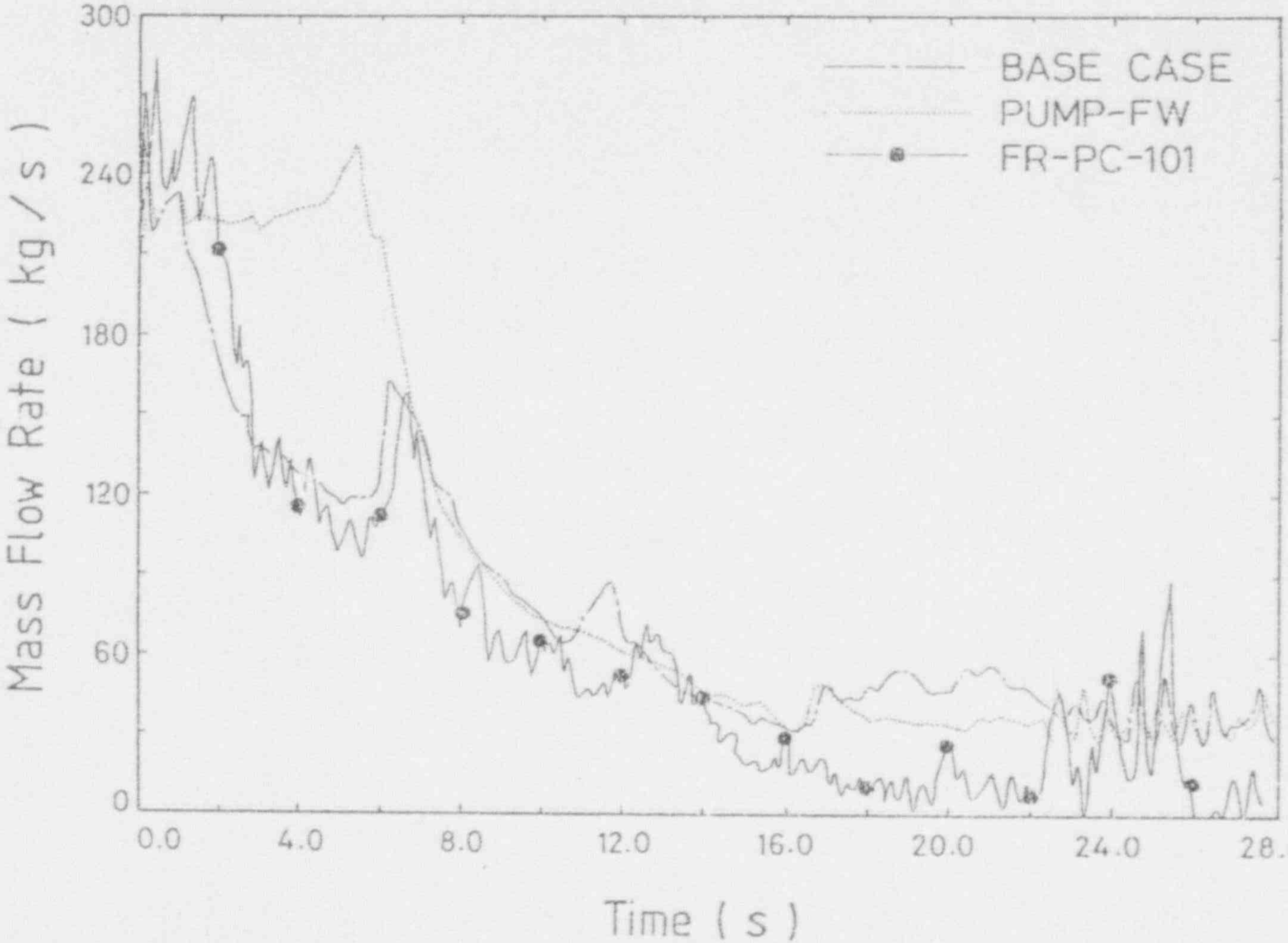


Figure 4.68 Comparison between Calculated Intact Loop Cold-Leg Flow Rates of the BASE and PUMP-FW Cases

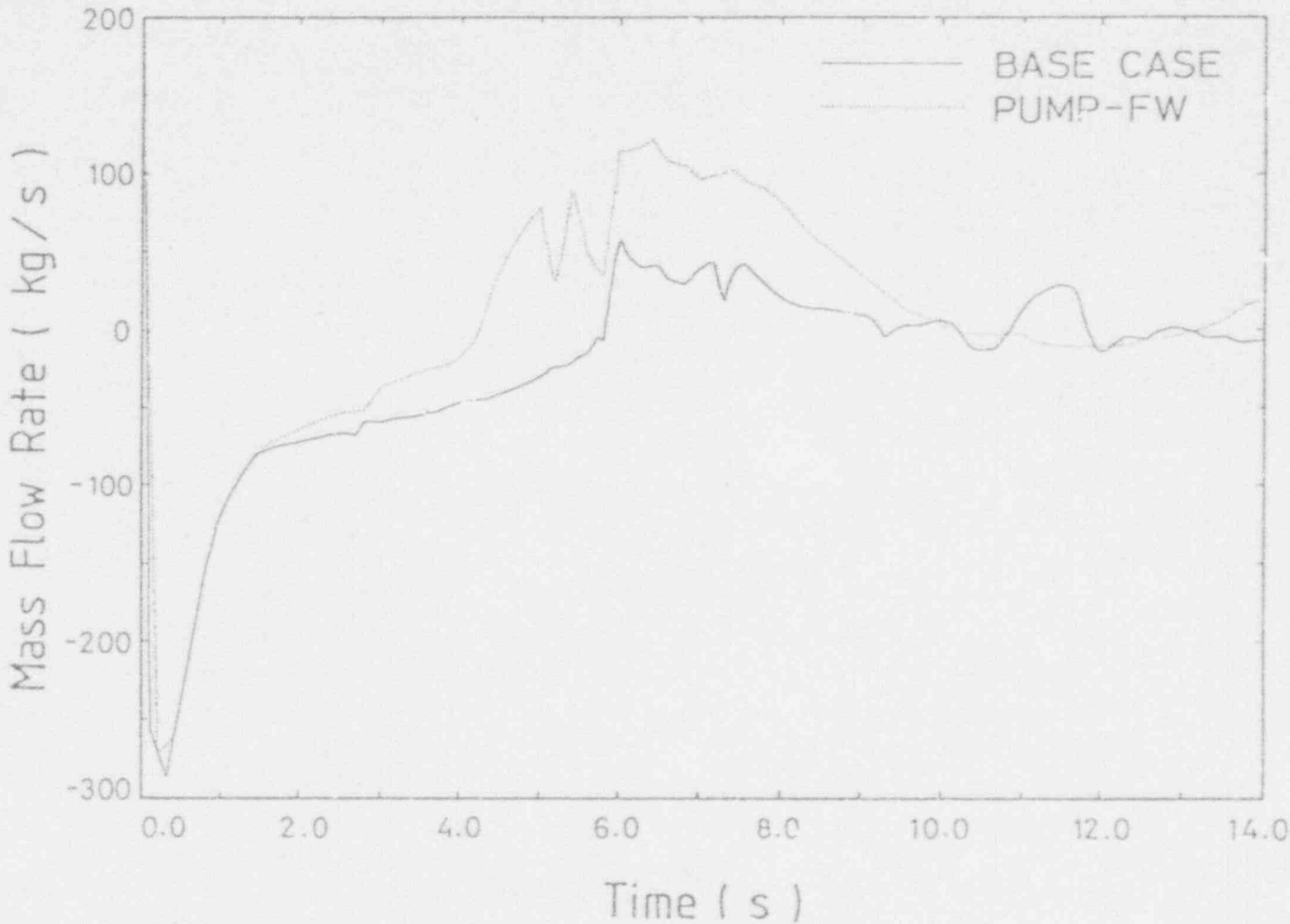


Figure 4.69 Comparison between Calculated Core Inlet Flow Rates of the BASE and PUMP-FW Cases

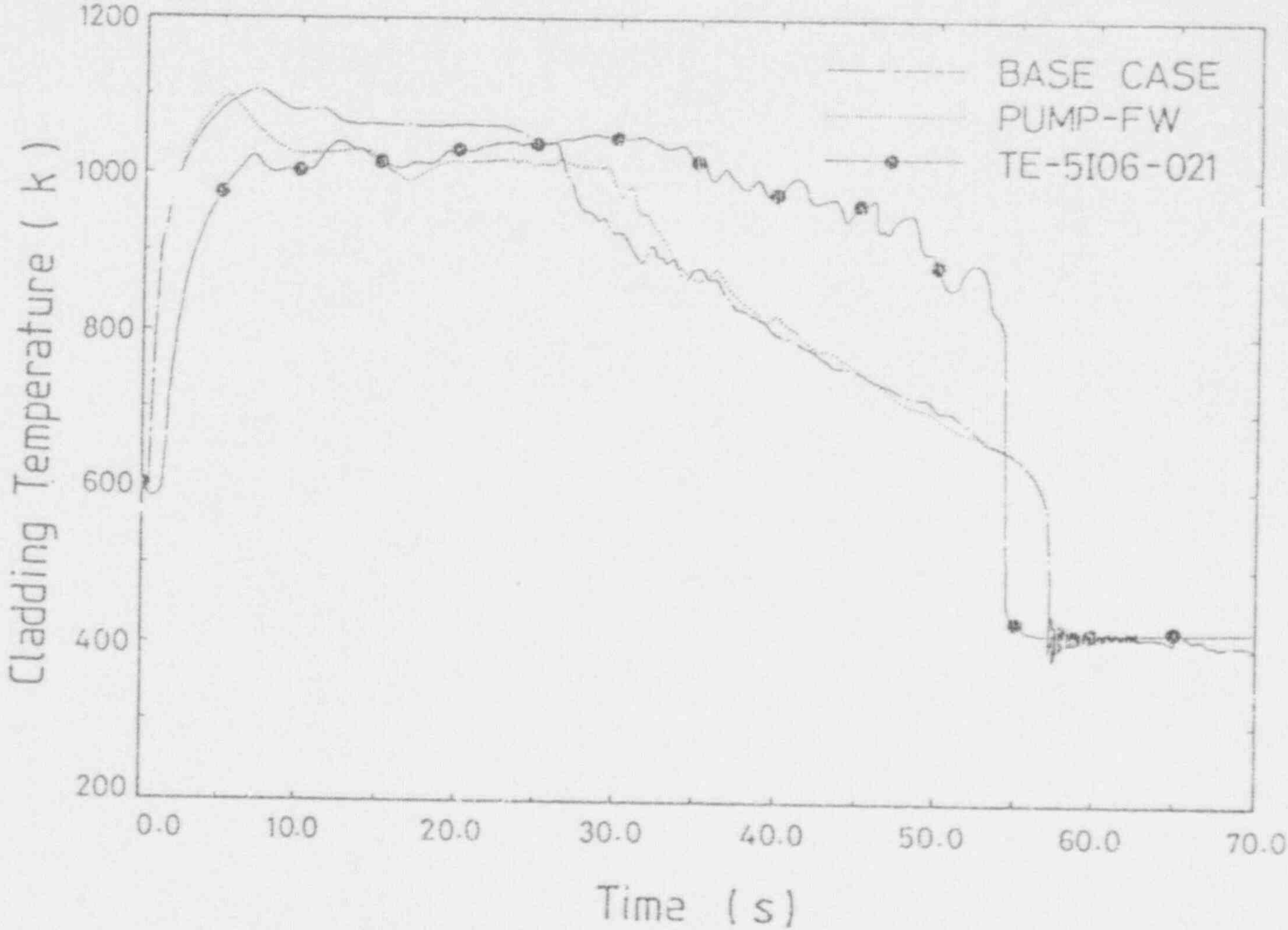


Figure 4.70 Comparison between Calculated Cladding Temperatures at Hottest Location of the BASE and PUMP-FW Cases

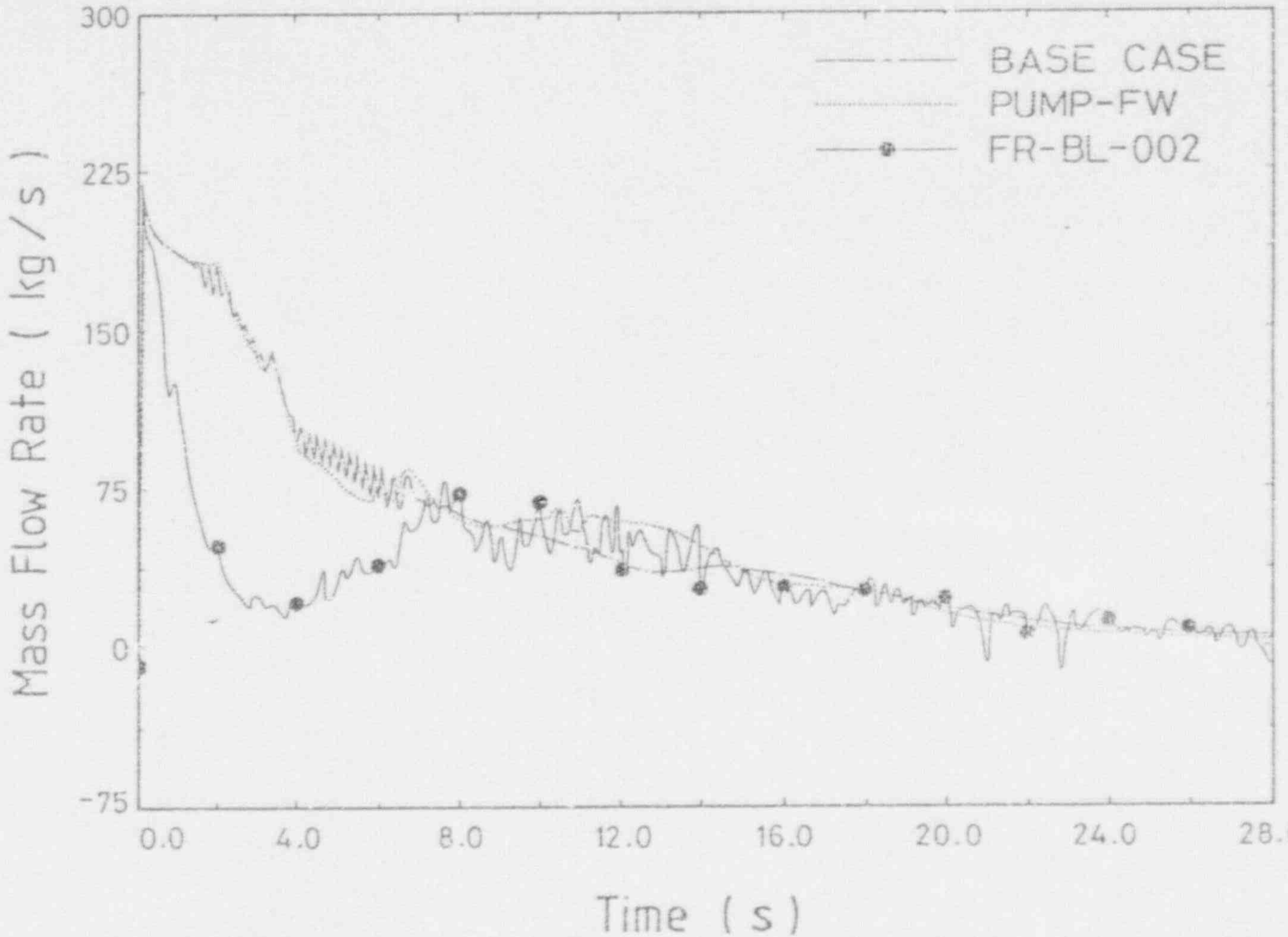


Figure 4.71 Comparison between Calculated Hot-L ᵣ Brak Flow Rates of the BASE and PUMP-FW Cases

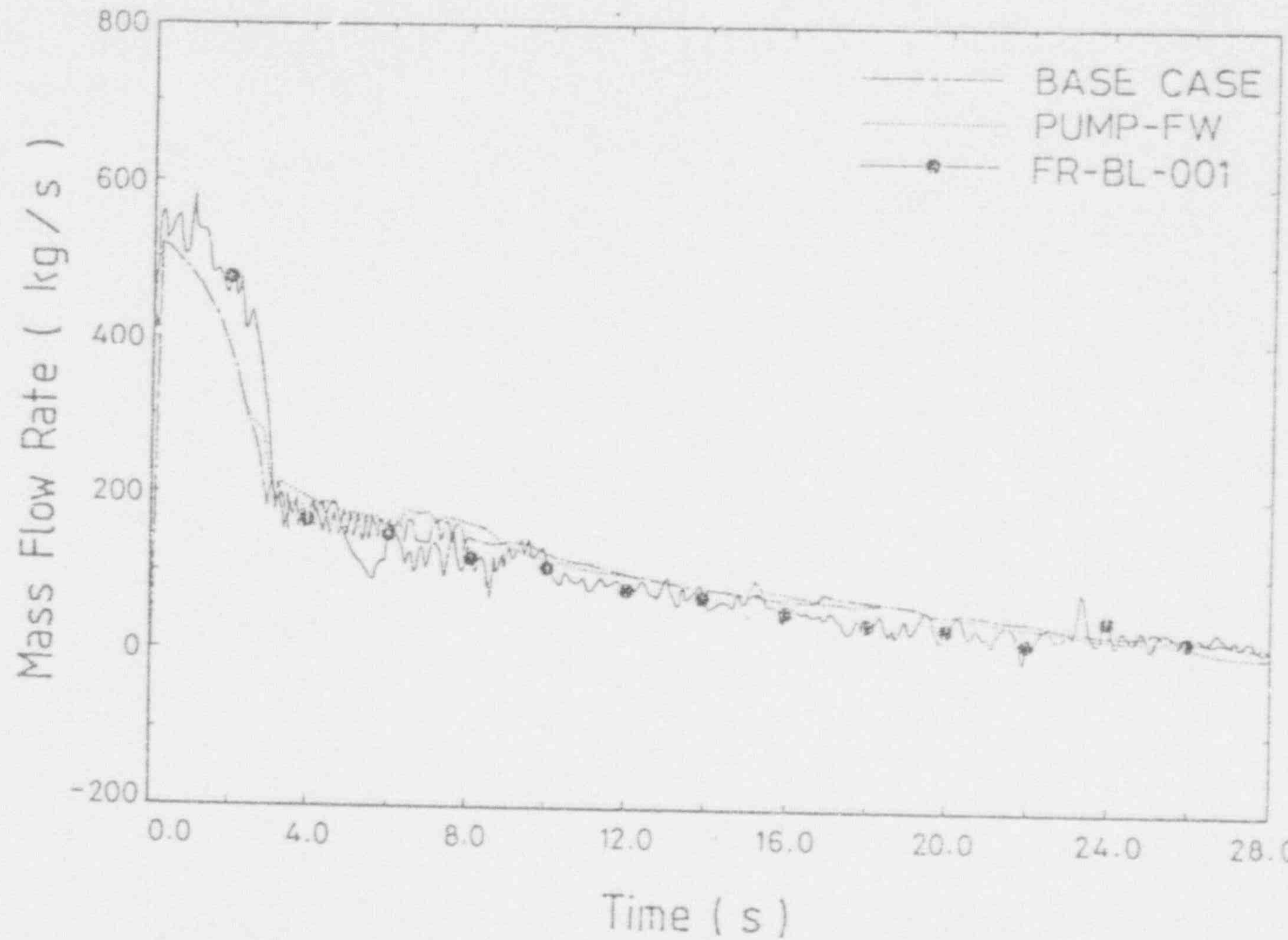


Figure 4.72 Comparison between Calculated Cold-Leg Break Flow Rates of the BASE and PUMP-FW Cases

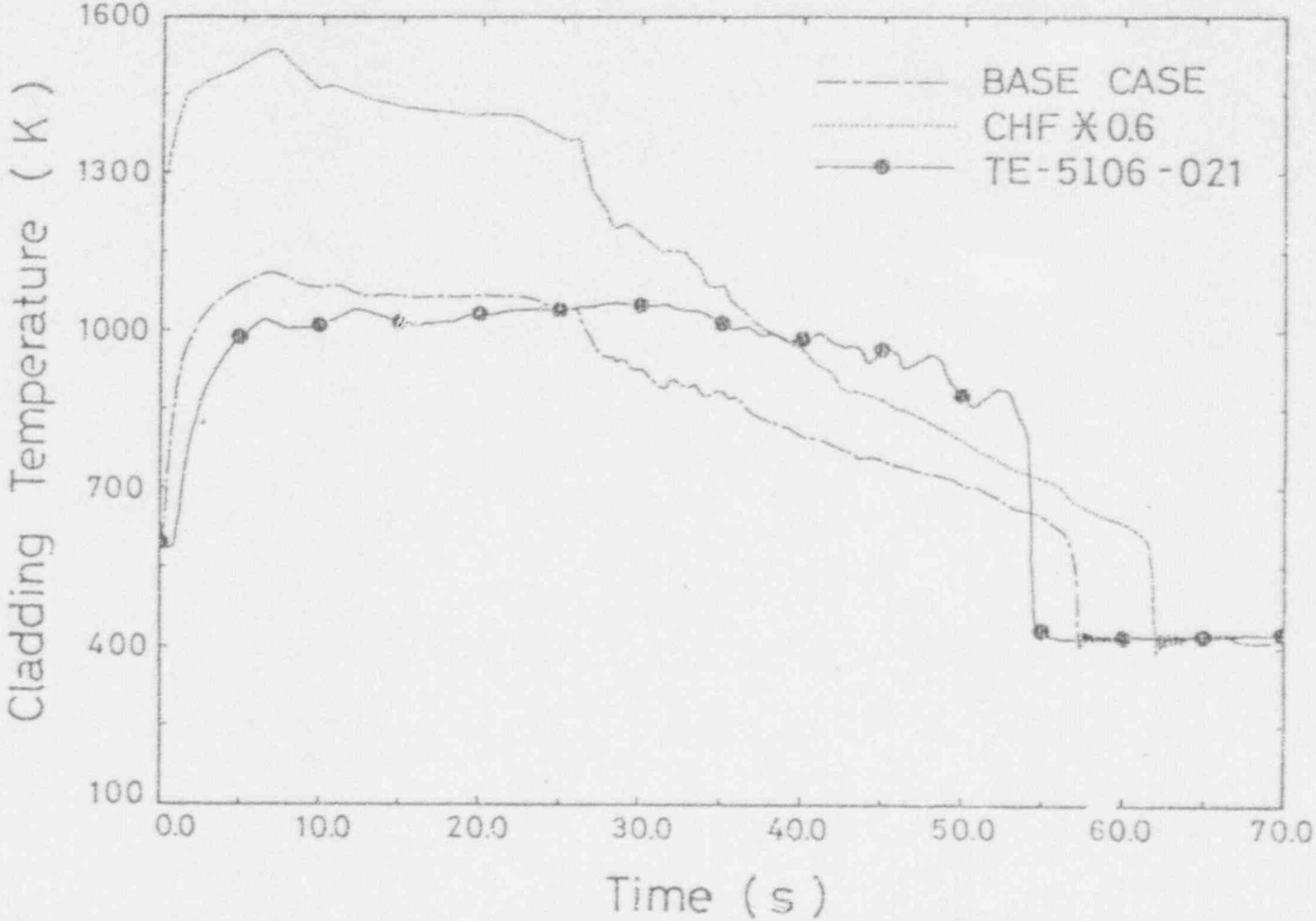


Figure 4.73 Comparison between Calculated Cladding Temperatures at Axial Level 3 of the BASE and CHF*0.6 Cases

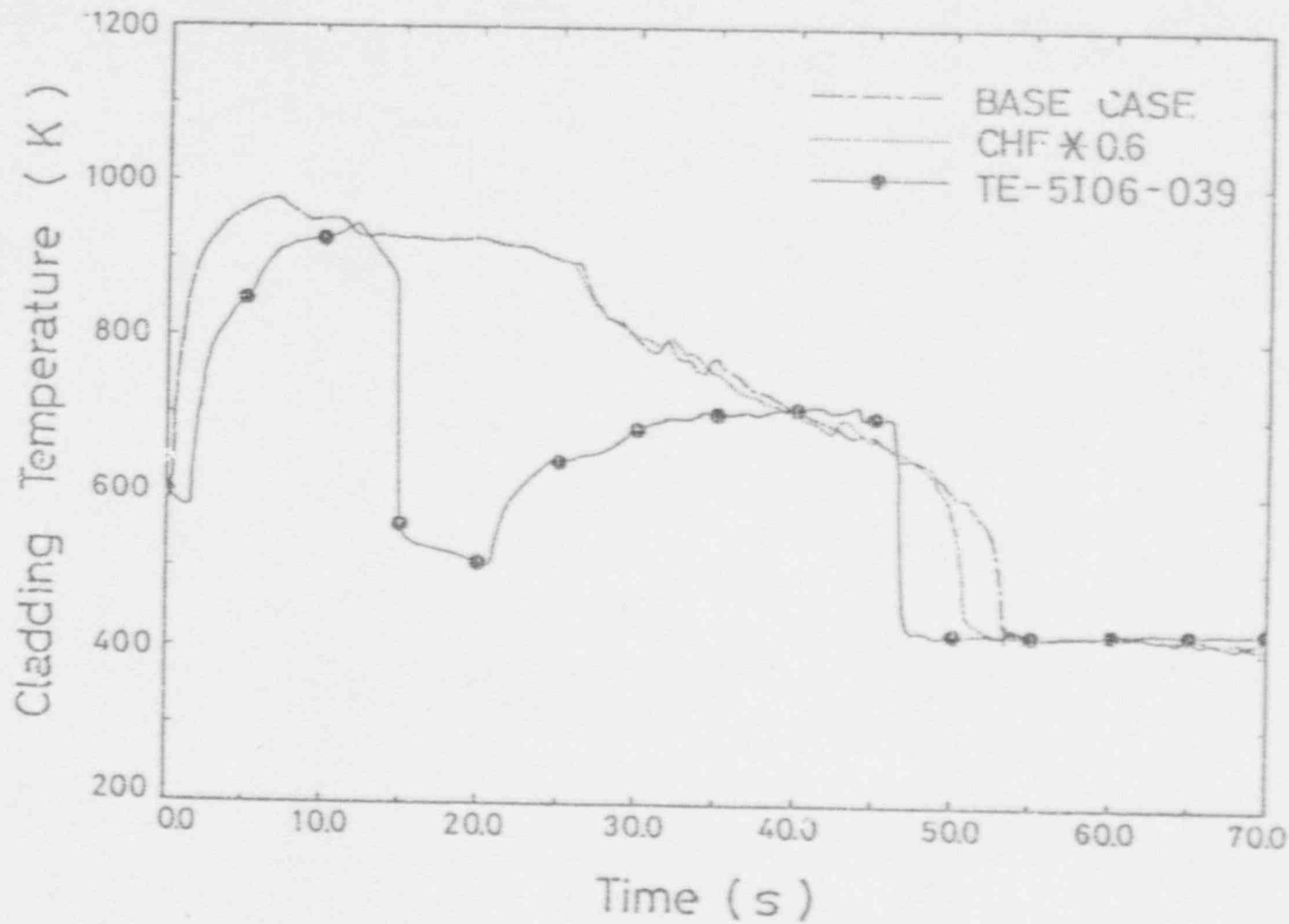


Figure 4.74 Comparison between Calculated Cladding Temperatures at Axial Level 4 of the BASE and CHF*0.6 Cases

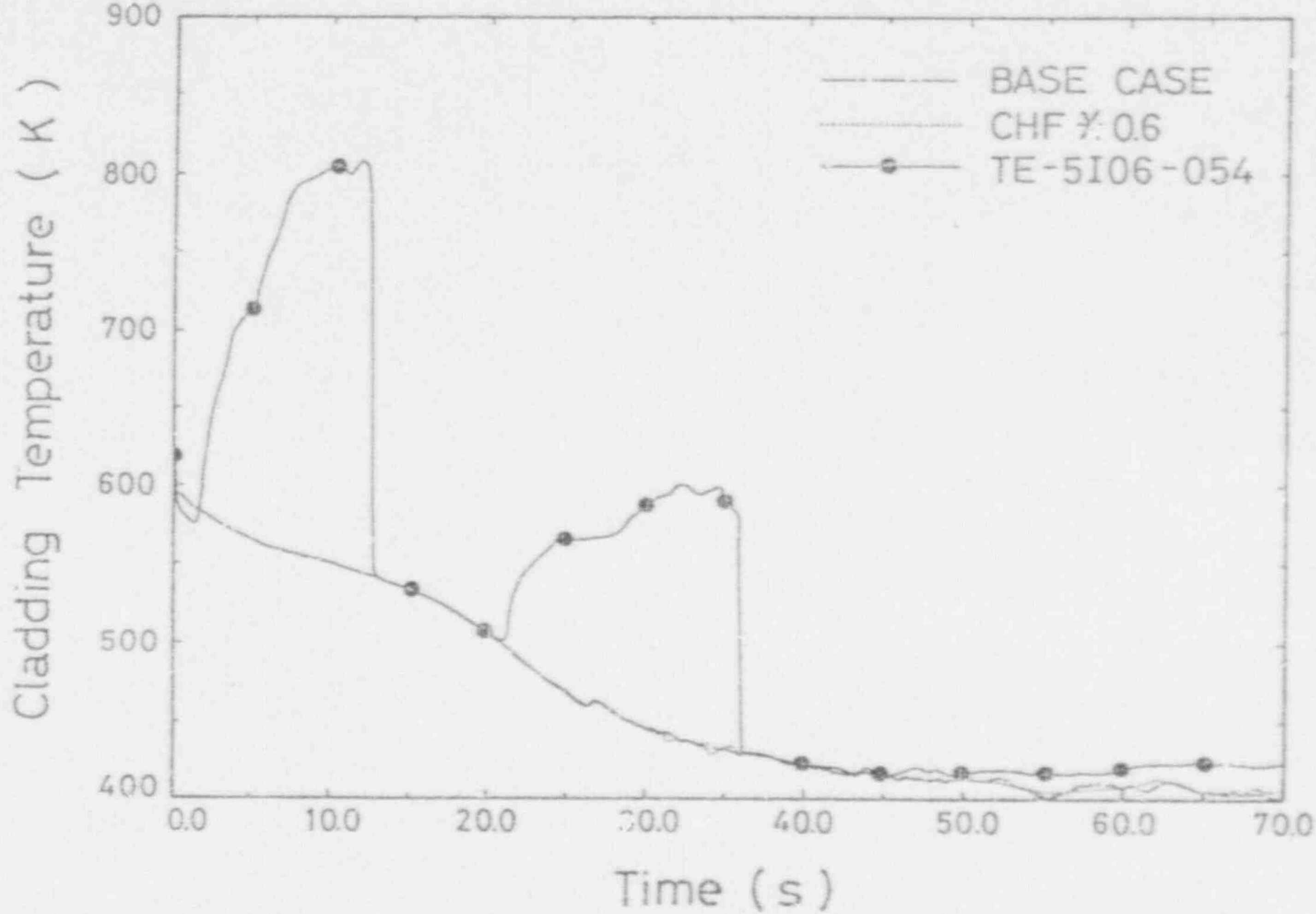


Figure 4.75 Comparison between Calculated Cladding Temperatures at Axial Level 5 of the BASE and CHF*0.6 Cases

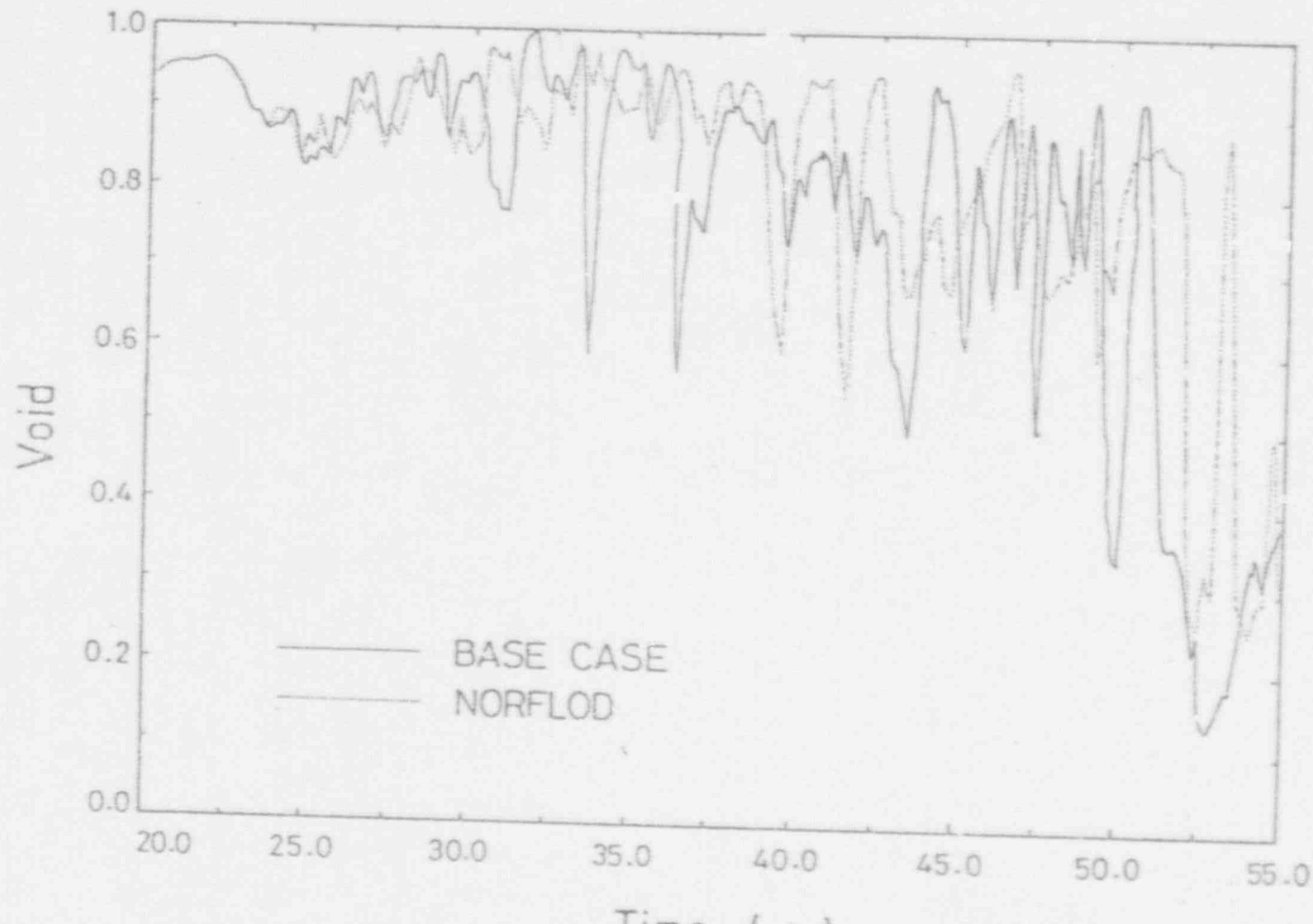


Figure 4.76 Comparison between Calculated Voids in Core Region of the BASE and NORFLOD Cases

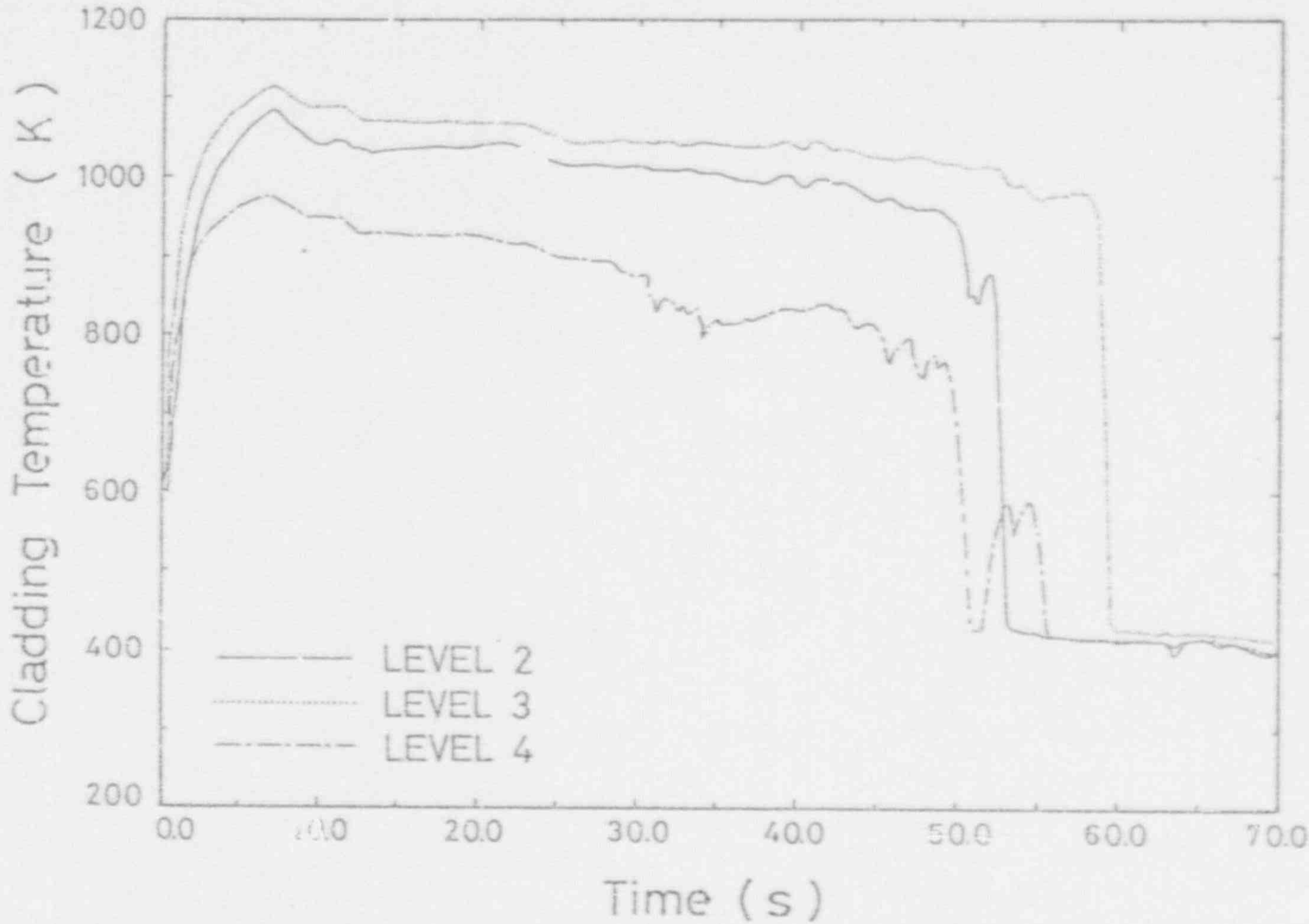


Figure 4.77 Calculated Cladding Temperatures at Hot Channel Hot Rod of the NORFLOD Case

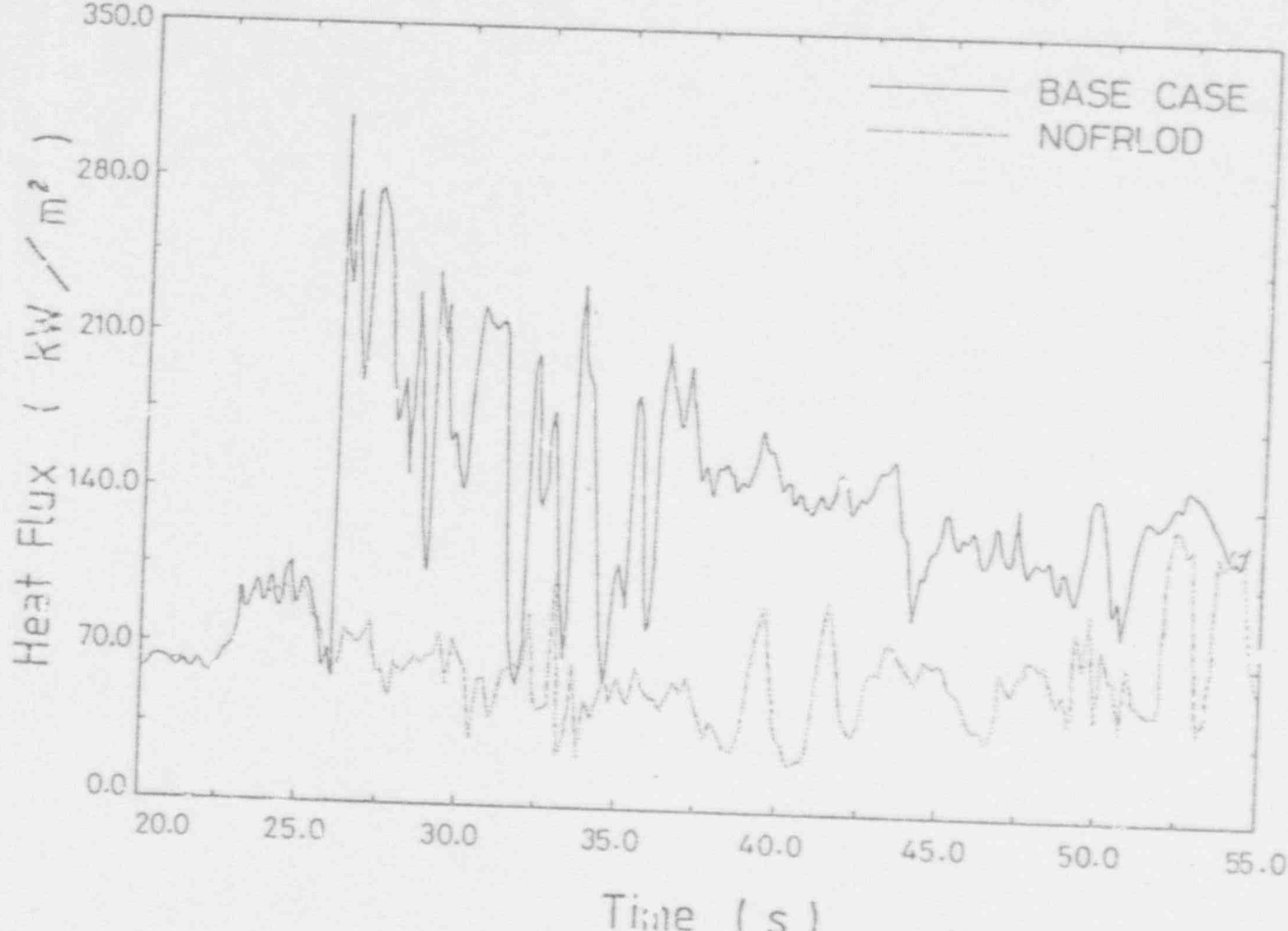


Figure 4.78 Comparison between Calculated Cladding Surface Heat Fluxes of the BASE and NORFLOD Cases

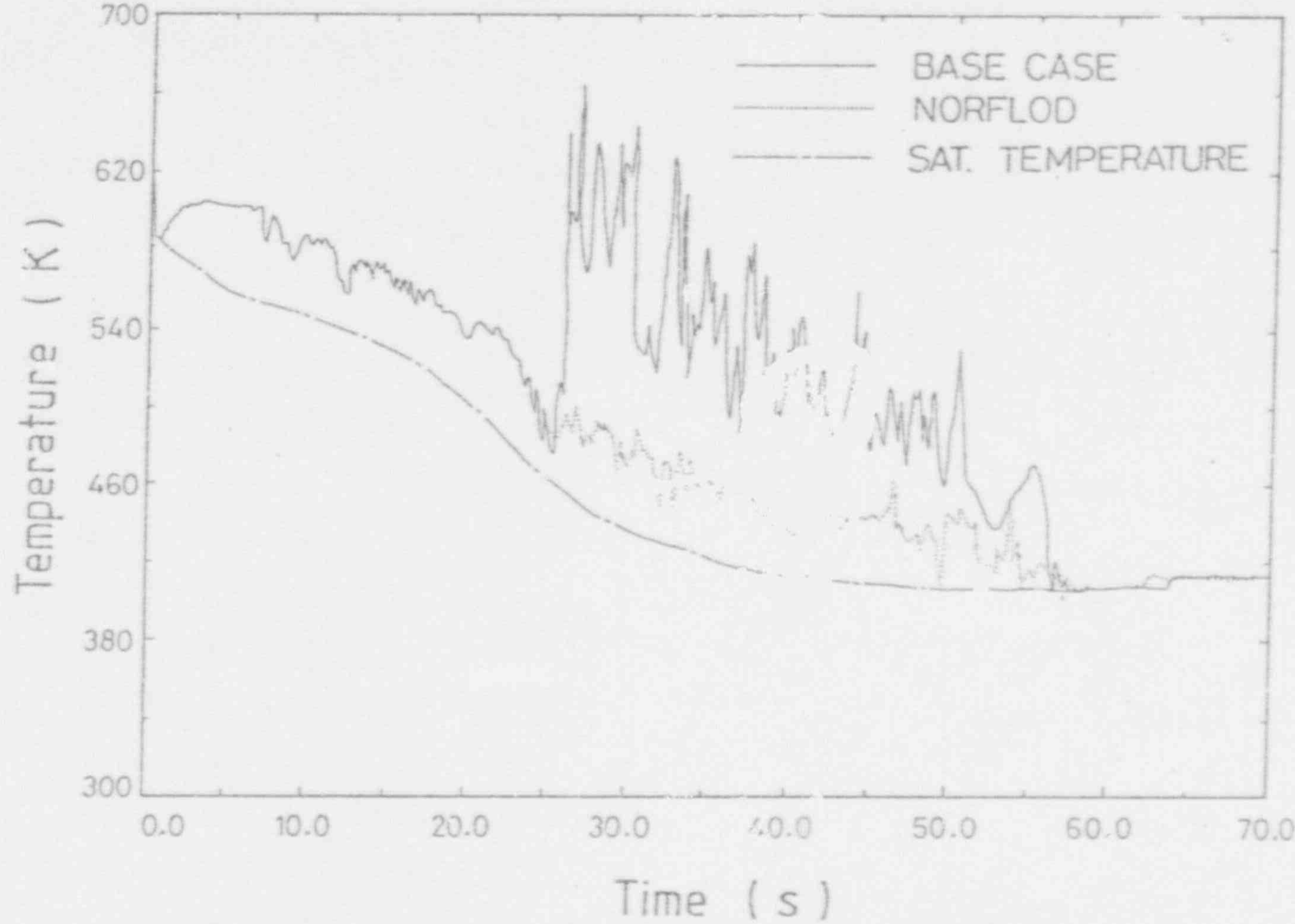


Figure 4.79 Comparison between Calculated Vapor Temperatures in Core Region of the BASE and NORFLOD Cases

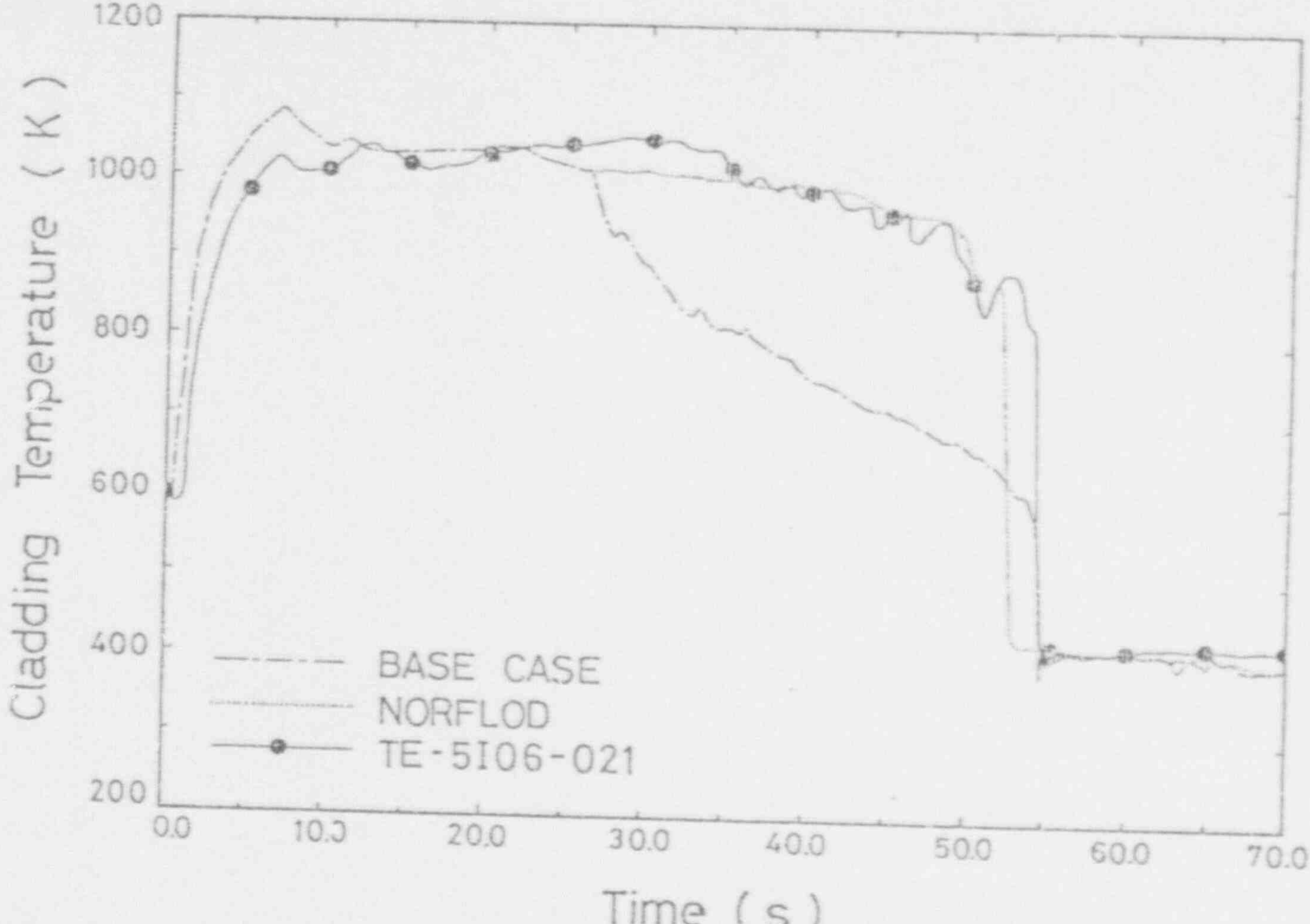


Figure 4.80 Comparison between Calculated Cladding Temperatures at Axial Level 2 of the BASE and NORFLOD Cases

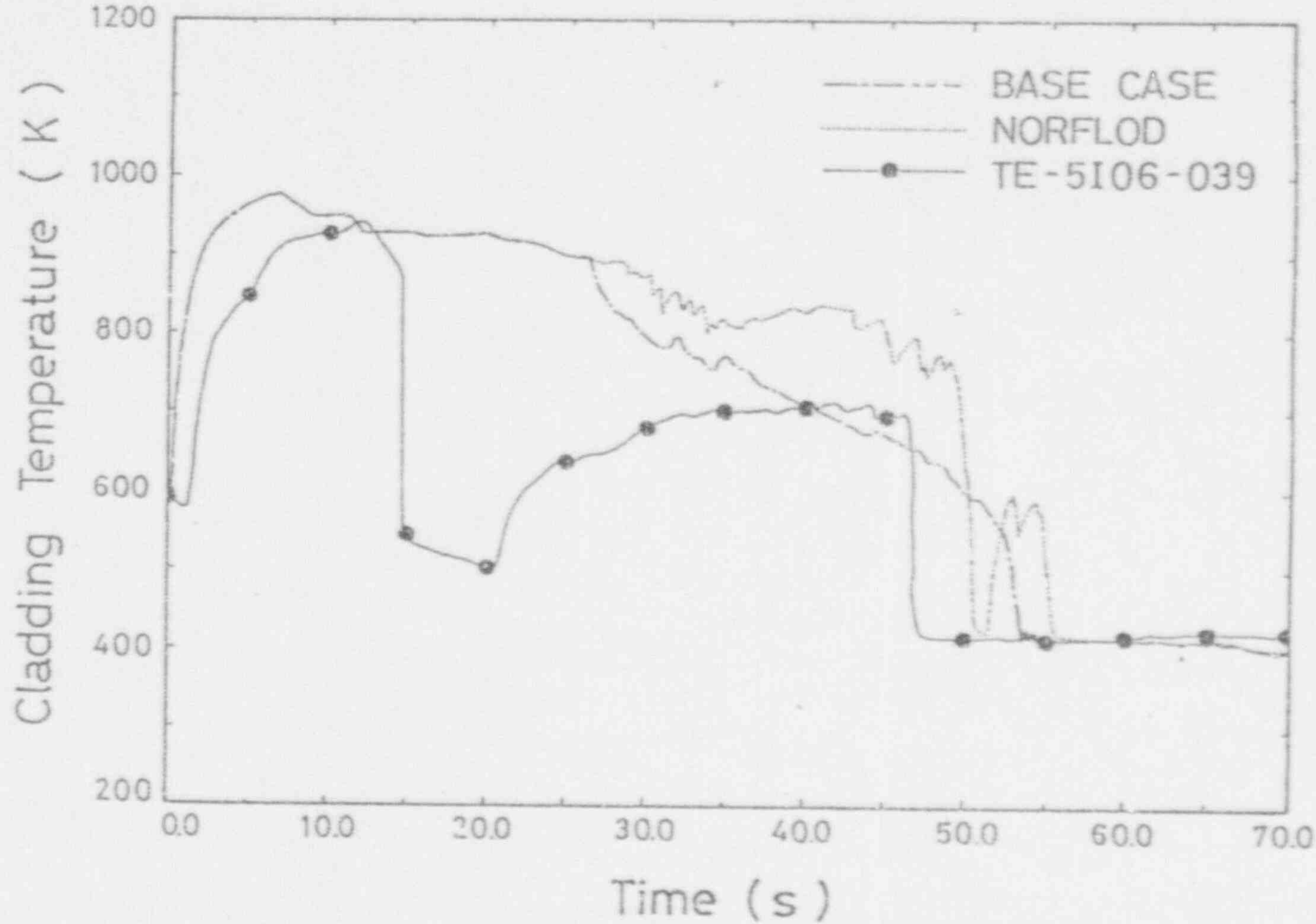


Figure 4.81 Comparison between Calculated Cladding Temperatures at Axial Level 4 of the BASE and NORFLOD Cases

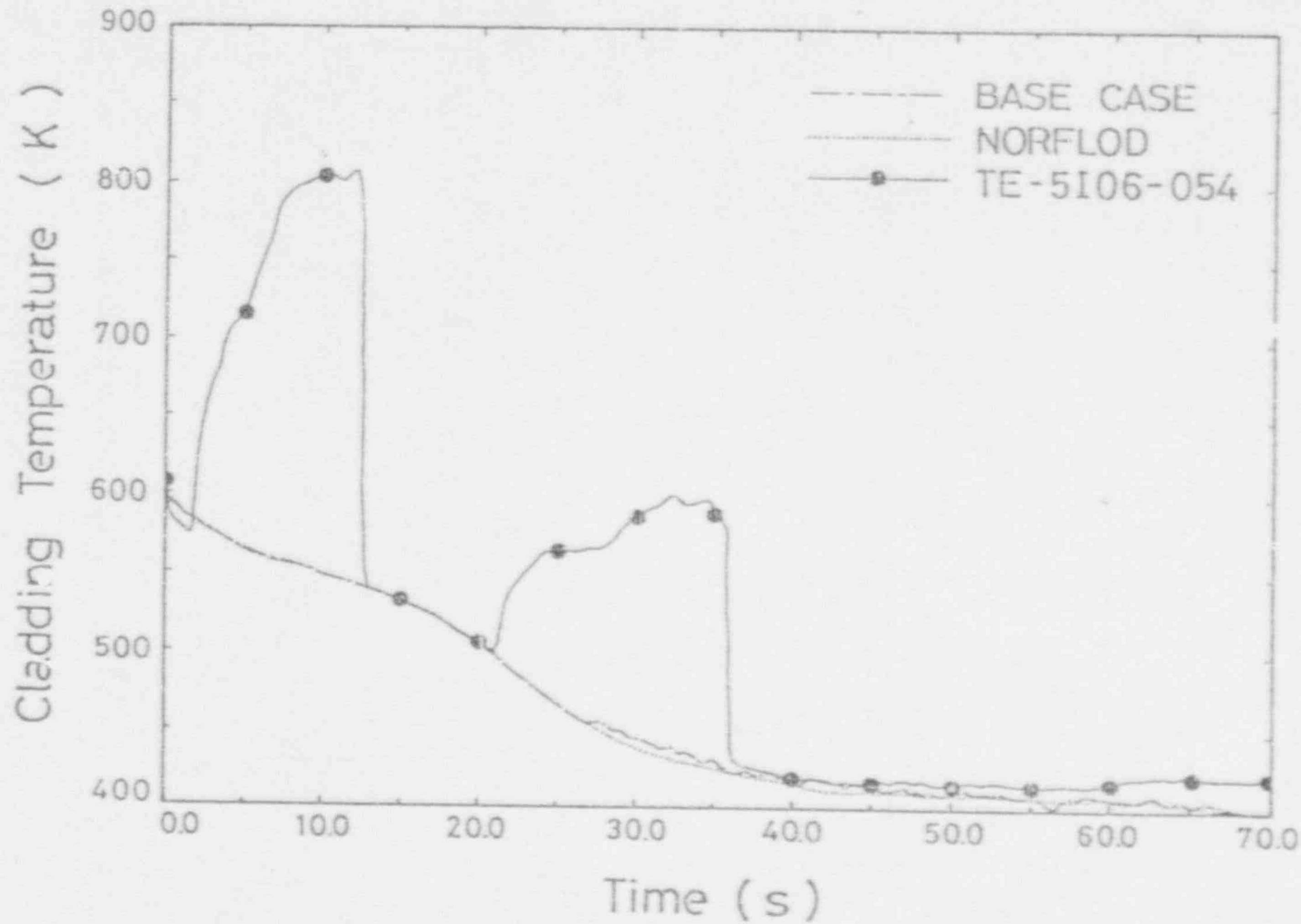


Figure 4.82 Comparison between Calculated Cladding Temperatures at Axial Level 5 of the BASE and NORFLOD Cases

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[16] M. Dillistone and C. G. Richards, "Counter-Current Flow Modelling in RELAP5," ICAP Meeting, Grenoble, France, March 1-3, 1988.

APPENDIX

```
****************************************************************************************
* LOFT MODEL FOR EXPERIMENT L2-5
****************************************************************************************
*   TWO-CHANNEL CORE AND SPLIT INLET ANNULUS AND DOWNCOMER
****************************************************************************************
0000100   NEW        TRANSNT
*000101   INP-CHK
0000105   5.0        10.0
0000110   NITROGEN
****************************************************************************************
*     TIME STEP CONTROL CARDS                                        * REQUIRED
****************************************************************************************
0000201   60.0       1.0-8      0.02       00002      10         500        500
****************************************************************************************
*   MINOR EDIT VARIABLES
****************************************************************************************
*   PRESSURES
****************************************************************************************
0000301   P          345010000              * PE-BL-001
0000302   P          310010000              * PE-BL-002
0000303   P          185010000              * PE-PC-001
0000304   P          100010000              * PE-PC-002
0000305   P          250010000              * PE-1UP-001A
0000306   P          215010000              * PE-1ST-001A
0000307   P          415060000              * PE-PC-004
0000308   P          510010000              * S.G.
****************************************************************************************
*   TEMPERATURES
****************************************************************************************
0000310   TEMPF      345010000              * TE-BL-001A,001B,001C
0000311   TEMPF      310010000              * TE-BL-002B
0000312   TEMPF      100010000              * TE-PC-002A,002B,002C
0000313   TEMPF      185010000              * TE-PC-001A,001B,001C
0000314   TEMPF      215010000              * TE-1ST-010
0000315   TEMPF      250010000              * TE-1UP-006
*
0000316   TEMPG      345010000              * TE-BL-001A,001B,001C
0000317   TEMPG      310010000              * TE-BL-002B
0000318   TEMPG      100010000              * TE-PC-002A,002B,002C
0000319   TEMPG      185010000              * TE-PC-001A,001B,001C
0000320   TEMPG      215010000              * TE-1ST-010
0000321   TEMPG      250010000              * TE-1UP-006
****************************************************************************************
*   DENSITIES
****************************************************************************************
0000322   RHO        345010000              * DE-BL-105
0000323   RHO        310010000              * DE-BL-002A,002C
0000324   RHO        180010000              * DE-PC-105
0000325   RHO        100010000              * DE-PC-205
****************************************************************************************
*   MASS FLOW RATES
****************************************************************************************
0000330   MFLOWJ     365000000              * BREAK PLANE BLCL: FR-BL-001
0000331   MFLOWJ     330000000              * BREAK PLANE BLHL: FR-BL-002
0000332   MFLOWJ     345020000              * DTT-RAKE BLCL
0000333   MFLOWJ     310020000              * DTT-RAKE BLHL
0000334   MFLOWJ     185020000              * DTT-RAKE ILCL
0000335   MFLOWJ     100020000              * DTT-RAKE ILHL
0000336   MFLOWJ     400010000              * PRES. SURGE LINE FLOW
0000337   MFLOWJ     500010000              * SEPR. STEAM OUTLET
0000338   MFLOWJ     550000000              * STEAM FLOW
****************************************************************************************
```

```
*    CLADDING TEMPRRATURES CONTROL MODULE
*******************************************************************************************
0000340   HTTEMP     236100110                    * AVG ROD AVG CH LEV 1
0000341   HTTEMP     236200110                    * AVG ROD AVG CH LEV 2
0000342   HTTEMP     236300110                    * AVG ROD AVG CH LEV 3
0000343   HTTEMP     236400110                    * AVG ROD AVG CH LEV 4
0000344   HTTEMP     236500110                    * AVG ROD AVG CH LEV 5
0000345   HTTEMP     236600110                    * AVG ROD AVG CH LEV 6
*
0000346   HTTEMP     237100110                    * AVG ROD HOT CH LEV 1
0000347   HTTEMP     237200110                    * AVG ROD HOT CH LEV 2
0000348   HTTEMP     237300110                    * AVG ROD HOT CH LEV 3
0000349   HTTEMP     237400110                    * AVG ROD HOT CH LEV 4
0000350   HTTEMP     237500110                    * AVG ROD HOT CH LEV 5
0000351   HTTEMP     237600110                    * AVG ROD HOT CH LEV 6
*
0000352   HTTEMP     238100110                    * HOT ROD HOT CH LEV 1
0000353   HTTEMP     238200110                    * HOT ROD HOT CH LEV 2
0000354   HTTEMP     238300110                    * HOT ROD HOT CH LEV 3
0000355   HTTEMP     238400110                    * HOT ROD HOT CH LEV 4
0000356   HTTEMP     238500110                    * HOT ROD HOT CH LEV 5
0000357   HTTEMP     238600110                    * HOT ROD HOT CH LEV 6
*******************************************************************************************
*    CORE HOT CHANNEL DENSITIES AND VOID FRACTIONS
*******************************************************************************************
0000360   RHO        233010000
0000361   RHO        234010000
0000362   RHO        235010000
0000363   RHO        236010000
0000364   RHO        237010000
0000365   RHO        238010000
0000366   VOIDG      233010000
0000367   VOIDG      234010000
0000368   VOIDG      235010000
0000369   VOIDG      236010000
0000370   VOIDG      237010000
0000371   VOIDG      238010000
*******************************************************************************************
*    CORE HOT SPOT MASS FLOWS
*******************************************************************************************
0000375   MFLOWJ     228010000                    * AVERAGE CHANNEL HOT SPOT
0000376   MFLOWJ     228020000                    * CROSSFLOW
0000377   MFLOWJ     234010000                    * HOT CHANNEL HOT SPOT
*******************************************************************************************
*    ECC SYSTEM MASS FLOWS
*******************************************************************************************
0000380   MFLOWJ     635000000                    * LPIS FLOW
0000381   MFLOWJ     640000000                    * HPIS FLOW
0000382   MFLOWJ     603000000                    * ACCUMULATOR FLOW
0000383   MFLOWJ     630000000                    * ECC FLOW INJECTED INTO 185
0000384   MFLOWJ     631000000                    * ECC FLOW INJECTED INTO 180
*******************************************************************************************
*    LIQUID LEVELS
*******************************************************************************************
0000385   CNTRLVAR  3                             * REACTOR VESSEL
0000386   CNTRLVAR  4                             * DOWNCOMER 1
0000387   CNTRLVAR  7                             * DOWNCOMER 2
0000388   CNTRLVAR  2                             * PRESSURIZER
*000389   CNTRLVAR  100                           * PRZR WATER LEVEL DEVIATION
*000390   MFLOWJ     910000000                    * PRZR WATER LEVEL CONTROL
*******************************************************************************************
*    DOWNCOMER MASS FLOWS
```

```
***********************************************************************
0000391   MFLOWJ   203000000          * DOWNCOMER 1 ENTRANCE
0000392   MFLOWJ   283000000          * DOWNCOMER 2 ENTRANCE
0000393   MFLOWJ   270000000          * CROSSFLOW UPPER IN ANN
0000394   MFLOWJ   272000000          * CROSSFLOW LOWER IN ANN
0000395   MFLOWJ   273000000          * CROSSFLOW DWM 1 AND 2
*
***********************************************************************
*     TRIPS
***********************************************************************
*********
***********************************************************************
*     ALWAYS TRUE
***********************************************************************
0000501   TIME     0         GE    NULL      0    -1.0      L -1.0
***********************************************************************
*     ALWAYS FALSE
***********************************************************************
0000502   TIME     0         LT    NULL      0    -1.0      N -1.0
***********************************************************************
*     BREAK INITIATION
***********************************************************************
0000510   TIME     0         GE    NULL      0    0.0       L -1.0
***********************************************************************
*     HPIS  INITIATION
***********************************************************************
0000513   TIME     0         GE    TIMEOF   510  23.9       L      -1.0
0000514   TIME     0         GE    TIMEOF   510  144.0      L      -1.0
0000614   513      AND       -514  N        -1.0
***********************************************************************
*     LPIS  INITIATION
***********************************************************************
0000535   TIME     0         GE    TIMEOF   510  37.32      L      -1.0
0000536   TIME     0         GE    TIMEOF   510  107.1      L      -1.0
0000615   535      AND       -535  N        -1.0
***********************************************************************
*     PCP TRIP
***********************************************************************
0000516   TIME     0         GE    TIMEOF   510  0.94       L -1.0*1 2-5
***********************************************************************
* LT  660  ACCUMULATOR VALVE       CARD 6120301
***********************************************************************
0000517   P        185010000 LT    NULL      0   4.2+6      L -1.0
0000518   VOIDF    615010000 LE    NULL      0   0.00001    L -1.0
0000519   MFLOWJ   615010000 GE    NULL      0   0.0        N -1.0
0000520   VOIDF    605010000 LE    NULL      0   0.00001    L -1.0
0000521   MFLOWJ   603000000 GE    NULL      0   0.0        N -1.0
0000659   517      AND       519      N -1.0
0000660  -518      AND       659      N -1.0
0000661   517      AND       521      N -1.0
0000662  -520      AND       661      N -1.0
***********************************************************************
* LT  580  ECC CHECK VALVE       CARD 6300301
***********************************************************************
0000580   P        600010000 GE  P    185010000 1.0+3     L      -1.0
***********************************************************************
* LT  691  PORV                  CARD 4250301
***********************************************************************
0000581   P        420010000 GT  NULL      0            1.620058+7 N -1.
0000582   P        420010000 LT  NULL      0            1.606269+7 N -1.
0000664   581      OR        691      N -1.0
0000691  -582      AND       664      N -1.0
```

```
*******
**********************************************************************
*******        HYDRAULIC COMPONENTS SIMULATION                 *******
**********************************************************************
*******
**********************************************************************
*   INTACT LOOP
**********************************************************************
**********************************************************************
* REACTOR VESSEL NOZZLE - INTACT LOOP HOT LEG
**********************************************************************
1000000   RUN-ILHL                BRANCH
1000001   2          0
1000101   0.0634     1.5373     0.0       0.0        0.0        0.0
1000102   4.0-5      0.0        00
1000200   000        14.935E6   1.4117E6  2.4613E6   1.7880-5
1001101   250010000  100000000  0.0634    1.10264    0.66160    00000
1002101   100010000  105000000  0.0       0.1        0.1        00000
1001201   4.4738     4.5765     0.0
1002201   4.4737     4.4863     0.0
**********************************************************************
* PRESSURIZER CONNECTION TEE REACTOR VESSEL SIDE
**********************************************************************
1050000   PZRT-RUS                BRANCH
1050001   1          0
1050101   0.0634     1.634      0.0       0.0        0.0        0.0
1050102   4.0-5      0.0        00
1050200   000        14.934E6   1.4117E6  2.4614E6   4.1779-6
1051101   105010000  110000000  0.0       0.1        0.1        00000
1051201   5.8318     5.8637     0.0
**********************************************************************
* PRESSURIZER CONNECTION TEE STEAM GENERATOR SIDE
**********************************************************************
1100000   PZRT-SGS                BRANCH
1100001   1          0
1100101   0.0        0.623      0.0303    0.0        0.0        0.0
1100102   4.0-5      0.0        00
1100200   000        14.928E6   1.4118E6  2.4615E6   2.1446-6
1101101   110010000  112000000  0.0       0.1        0.1        00000
1101201   5.8320     5.8242     0.0
**********************************************************************
* HOT LEG PIPING
**********************************************************************
1120000   HOTLEGPP                PIPE
1120001   2
1120101   0.0        2
1120201   0.0        1
1120301   1.4385     1
1120302   0.708      2
1120401   0.09       1
1120402   0.057      2
1120501   0.0        2
1120601   0.0        1
1120602   90.0       2
1120701   0.0        1
1120702   0.246      2
1120801   4.0-5      0.0        2
1120901   0.15       0.15       1
1121001   00         2
1121101   00000      1
1121201   000        14.931E6   1.4118E6  2.4615E6   5.5532-7   0.0       1
1121202   000        14.931E6   1.4118E6  2.4615E6   1.9745-7   0.0       2
```

```
1121300   0
1121301   4.5335     4.5325     0.0        01
****************************************************************************
* SG INLET PLENUM
****************************************************************************
1140000   SGINPLNM              BRANCH
1140001   2          0
1140101   0.0        0.63       0.335      0.0        90.0       0.513
1140102   4.0-5      0.0        00
1140200   000        14.921E6   1.4118E6   2.4617E6   1.7048-8
1141101   112010000  114000000  0.0512     1.10000    1.10000    00000
1142101   114010000  115000000  0.0        0.20000    0.20000    00000
1141201   5.5399     5.5567     0.0
1142201   1.8785     1.8792     0.0
****************************************************************************
* SG U-TUBES
****************************************************************************
1150000   SG-TUBES              PIPE
1150001   8
1150101   0.151      8
1150201   0.151      7
1150301   0.902      1
1150302   0.6096     3
1150303   0.4612     5
1150304   0.6096     7
1150305   0.902      8
1150401   0.0        8
1150501   0.0        8
1150601   90.0       4
1150602   -90.0      8
1150701   0.902      1
1150702   0.6096     3
1150703   0.3048     4
1150704   -0.3048    5
1150705   -0.6096    7
1150706   -0.902     8
1150801   1.27-7     0.01022    8
1150901   0.0        0.0        7
1151001   00         8
1151101   00000      7
1151201   000        14.914E6   1.3694E6   2.4618E6   3.2232-9   0.0        1
1151202   000        14.907E6   1.3352E6   2.4620E6   8.1280-10  0.0        2
1151203   003        14.901E6   1.3074E6   2.4621E6   2.0175-10  0.0        3
1151204   003        14.897E6   567.83     0.0        0.0        0.0        4
1151205   003        14.896E6   564.85     0.0        0.0        0.0        5
1151206   003        14.898E6   561.53     0.0        0.0        0.0        6
1151207   003        14.901E6   558.68     0.0        0.0        0.0        7
1151208   003        14.905E6   556.21     0.0        0.0        0.0        8
1151300   0
1151301   1.8310     1.8310     0.0        01
1151302   1.7961     1.7961     0.0        02
1151303   1.7698     1.7698     0.0        03
1151304   1.7534     1.7534     0.0        04
1151305   1.7396     1.7396     0.0        05
1151306   1.7249     1.7249     0.0        06
1151307   1.7128     1.7128     0.0        07
****************************************************************************
* SG OUTLET PLENUM
****************************************************************************
1160000   SGOTPLNM              BRANCH
1160001   2          0
1160101   0.0        0.63       0.335      0.0        -90.0      -0.513
```

```
1160102   4.0-5       0.0        00
1160200   003         14.910E6   556.21
1161101   115010000 116000000 0.0        0.20000    0.20000    00000
1162101   116010000 118000000 0.0512     1.10000    1.10000    00000
1161201   1.7026      1.7026     0.0
1162201   5.0213      5.0213     0.0
*********************************************************************
* PUMP SUCTION PIPING
*********************************************************************
1180000   PMPSUCPP               PIPE
1180001   3
1180101   0.0         2
1180102   0.0634      3
1180201   0.0         2
1180301   0.547       1
1180302   0.689       2
1180303   0.559       3
1180401   0.0437      1
1180402   0.0462      2
1180403   0.0         3
1180501   0.0         3
1180601   -90.        3
1180701   -0.498      1
1180702   -0.689      2
1180703   -0.356      3
1180801   4.0-5       0.0        3
1180901   0.083       0.083      1
1180902   0.104       0.104      2
1181001   00          3
1181101   00000       2
1181201   003         14.900E6   556.21     0.0        0.0        0.0        1
1181202   003         14.902E6   556.21     0.0        0.0        0.0        2
1181203   003         14.904E6   556.21     0.0        0.0        0.0        3
1181300   0
1181301   3.8342      3.8342     0.0        01
1181302   4.0551      4.0551     0.0        02
*********************************************************************
* PUMP SUCTION TEE
*********************************************************************
1200000   PMPSUCTE               BRANCH
1200001   3           0
1200101   0.0634      0.76       0.0        0.0        0.0        0.0
1200102   4.0-5       0.0        00
1200200   003         14.904E6   556.21
1201101   118010000 120000000 0.0        0.20000    0.200000   00000
1202101   120010000 125000000 0.0        0.5        0.5        00000
1203101   120010000 155000000 0.0        0.5        0.5        00000
1201201   4.0551      4.0551     0.0
1202201   2.1013      2.1013     0.0
1203201   2.1053      2.1053     0.0
*********************************************************************
* PUMP 1 SUCTION TEE OUTLET
*********************************************************************
1250000   PMPSUCTE               BRANCH
1250001   1           0
1250101   0.0         1.003      0.0613     0.0        90.0       0.521
1250102   4.0-5       0.0        00
1250200   003         14.906E6   556.21
1251101   125010000 130000000 0.0        0.0        0.0        00000
1251201   3.1053      3.1053     0.0
*********************************************************************
* PUMP 1 INLET
```

```
******************************************************************************
1300000   PMPINLET                SNGLVOL
1300101   0.0         0.457       0.0189     0.0        90.0       0.457
1300102   4.0-5       0.0         00
1300200   003         14.900E6    556.21
******************************************************************************
* PRIMARY COOLANT PUMP 1
******************************************************************************
1350000   PCPUMP1                 PUMP
1350101   0.0366      0.0         0.039      0.0        90.0       0.319
1350107   0
1350108   130010000 0.0           0.1        0.1        00000
1350109   140000000 0.0           0.1        0.1        00000
1350200   003         14.934E6    556.23
1350201   0           3.5087      3.5089     0.0
1350202   0           3.5088      3.5088     0.0
1350301     0    0    0           -1         -1         516        0
1350302   369.7       0.3541      0.3155     96.0       500.6      1.431
1350303   613.6       0.0         207.433    0.0444     19.5987    0.0
1350310   0.0         0.0         0.0
******************************************************************************
* PUMP 1 OUTLET PUMP SIDE
******************************************************************************
1400000   PMPOUTLT                SNGLVOL
1400101   0.0366      0.502       0.0        0.0        0.0        0.0
1400102   4.0-5       0.0         00
1400200   003         14.971E6    556.24
******************************************************************************
* PUMP 1 OUTLET PIP E TEE SID E
******************************************************************************
1450000   PMP1OUT                 BRANCH
1450001   2           0
1450101   0.0         1.4084      0.0633     0.0        0.0        0.0
1450102   4.0-5       0.0         00
1450200   003         14.972E6    556.24
1451101   140010000 145000000 0.0            0.0        0.0        00000
1452101   145010000 150000000 0.0366         0.40000    0.40000    00000
1451201   3.5086      3.5086      0.0
1452201   3.5086      3.5086      0.0
******************************************************************************
* PUMP OULET TEE
******************************************************************************
1500000   PMPOUT-T                BRANCH
1500001   2           0
1500101   0.0634      0.4966      0.0        0.0        0.0        0.0
1500102   4.0-5       0.0         00
1500200   003         14.967E6    556.24
1501101   170010000 150000000 0.0366         0.40000    0.40000    00000
1502101   150010000 175000000 0.0            0.0        0.0        00000
1501201   3.5154      3.5154      0.0
1502201   4.0549      4.0549      0.0
******************************************************************************
* PUMP 2  SUCTION TEE OUTLET
******************************************************************************
1550000   PUMP2SCT                BRANCH
1550001   1           0
1550101   0.0         1.003       0.0613     0.0        90.0       0.521
1550102   4.0-5       0.0         00
1550200   003         14.906E6    556.21
1551101   155010000 160000000 0.0            0.0        0.0        00000
1551201   3.1112      3.1112      0.0
******************************************************************************
```

```
* PUMP 2  INLET PIPE
************************************************************************
1600000   PMP2INLT               SNGLVOL
1600101   0.0        0.457       0.0189     0.0        90.0       0.457
1600102   4.0-5      0.0         00
1600200   003        14.900E6    556.21
************************************************************************
* PRIMARY COOLANT PUMP 2
************************************************************************
1650000   PCPUMP2                PUMP
1650101   0.0366     0.0         0.099      0.0        90.0       0.319
1650102   0
1650108   160010000 0.0          0.1        0.1        00000
1650109   170000000 0.0          0.1        0.1        00000
1650200   003        14.934E6    556.23
1650201   0          3.5156      3.5156     0.0
1650202   0          3.5155      3.5155     0.0
1650301   135  135   135         -1         -1         516        0
1650302   369.7      0.3541      0.3155     96.0       500.6      1.431
1650303   613.6      0.0         207.433    0.0444     19.5967    0.0
1650310   0.0        0.0         0.0
************************************************************************
* PUMP 2  OUTLET
************************************************************************
1700000   PMP2OUTT               BRANCH
1700001   0          0
1700101   0.0366     0.514       0.0        0.0        0.0        0.0
1700102   4.0-5      0.0         00
1700200   003        14.971E6    556.24
************************************************************************
* INTACT  LOOP COLD LEG PIPE
************************************************************************
1750000   ILCLP1     BRANCH
1750001   1          0
1750101   0.0634     0.559       0.0        0.0        0.0        0.0
1750102   4.0-5      0.0         00
1750200   003        14.967E6    556.24
1751101   175010000 176000000 0.0           0.0        0.0        00000
1751201   4.0549     4.0549      0.0
*
1760000   ILCLP2     BRANCH
1760001   0          0
1760101   0.0634     0.613       0.0        0.0        0.0        0.0
1760102   4.0-5      0.0         00
1760200   003        14.967E6    556.24
************************************************************************
* ECC CONNECTION TEE
************************************************************************
1800000   ECC-T                  BRANCH
1800001   1          0
1800101   0.0634     1.152       0.0        0.0        0.0        0.0
1800102   4.0-5      0.0         00
1800200   003        14.965E6    556.24
1801101   176010000 180000000 0.0           0.20700    0.20700    00000
1801201   4.0549     4.0549      0.0
************************************************************************
* REACTOR  VESSEL NOZZLE-INTACT LOOP  COLD LEG
************************************************************************
1850000   RVN-ILCL               BRANCH
1850001   2          0
1850101   0.0634     1.01        0.0        0.0        0.0        0.0
1850102   4.0-5      0.0         00
```

```
1850200   003        14.964E6  556.24
1851101   185010000 202000000 0.0634    1.43960   0.80400   00000
1852101   180010000 185000000 0.0       0.20700   0.20700   00000
1851201   4.0549     4.0549    0.0
1852201   4.0549     4.0549    0.0
*************************************************************
*  REACTOR VESSEL
*************************************************************
* INLET ANNULUS TOP VOL 'E 1
*************************************************************
2000000   INANTOP1             ANNULUS
2000001   1
2000101   0.0        1
2000301   0.33       1
2000401   0.0428     1
2000501   0.0        1
2000601   90.0       1
2000701   0.33       1
2000801   3.81-6     0.178     1
2001001   00         1
2001201   003        14.960E6  556.25    0.0       0.0       0.0       1
*************************************************************
* JUNCTION BETWEEN  UPPER INLET ANNULUS 1 AND  BOTTOM VOLUME 1
*************************************************************
2010000   J200-202             SNGLJUN
2010101   200000000 202000000 0.0       0.0       0.0       00000
2010201   0          -0.15613  -0.15613  0.0
*************************************************************
* INLET   ANNULUS   BOTTOM  VOLUME 1
*************************************************************
2020000   INANBOT1             ANNULUS
2020001   1
2020101   0.0        1
2020301   0.424      1
2020401   0.055      1
2020501   0.0        1
2020601   -90.0      1
2020701   -0.424     1
2020801   3.81-6     0.172     1
2021001   00         1
2021201   003        14.961E6  556.24    0.0       0.0       0.0       1
*************************************************************
* JUNCTION BETWEEN INLET ANNULUS BOTTOM VOLUME 1 AND DOWNCOMER 1
*************************************************************
2030000   J202-204             SNGLJUN
2030101   202010000 204000000 0.0       0.22632   0.20400   00000
2030201   0          3.0332    3.0332    0.0
*************************************************************
* DOWNCOMER 1
*************************************************************
*
* DOWNCOMER 1.1
*
2040000   DWNCR1.1             ANNULUS
2040001   1
2040101   0.071      1
2040301   0.958      1
2040401   0.0        1
2040501   0.0        1
2040601   -90.       1
2040701   -0.958     1
2040801   3.81-6     0.102     1
```

```
2041001   00        1
2041201   003       14.963E6  556.24    0.0       0.0       0.0       1
*
* JUNCTION BETWEEN  DOWNCOMER 1.1 AND  1.2
*
2050000   J1.1-1.2            SNGLJUN
2050101   204010000 206000000 0.0       0.0       0.0       00000
2050201   0         2.9165    2.9165    0.0
*
* DOWNCOMER 1.2
*
2060000   DWNCR1.2            ANNULUS
2060001   1
2060101   0.071     1
2060301   0.958     1
2060401   0.0       1
2060501   0.0       1
2060601   -90.0     1
2060701   -0.958    1
2060801   3.81-6    0.102     1
2061001   00        1
2061201   003       14.970E6  556.24    0.0       0.0       0.0       1
*
* JUNCTION BETWEEN  DOWNCOMER 1.2 AND  1.3
*
2070000   J1.2-1.3            SNGLJUN
2070101   206010000 208000000 0.0       0.0       0.0       00000
2070201   0         2.8162    2.8162    0.0
*
* DOWNCOMER 1.3
*
2080000   DWNCR1.3            ANNULUS
2080001   1
2080101   0.071     1
2080301   0.958     1
2080401   0.0       1
2080501   0.0       1
2080601   -90.0     1
2080701   -0.958    1
2080801   3.81-6    0.102     1
2081001   00        1
2081201   003       14.977E6  556.23    0.0       0.0       0.0       1
*
* JUNCTION BETWEEN  DOWNCOMER 1.3 AND  1.4
*
2090000   J1.3-1.4            SNGLJUN
2090101   208010000 210000000 0.0       0.0       0.0       00000
2090201   0         2.7403    2.7403    0.0
*
* DOWNCOMER 1.4
*
2100000   DWNCR1.4            ANNULUS
2100001   1
2100101   0.071     1
2100301   0.958     1
2100401   0.0       1
2100501   0.0       1
2100601   -90.0     1
2100701   -0.958    1
2100801   3.81-6    0.102     1
2101001   00        1
2101201   003       14.984E6  556.23    0.0       0.0       0.0       1
```

```
************************************************************************
* LOWER PLENUM TOP VOLUME
************************************************************************
2150000   LWRPLTOP             BRANCH
2150001   4          0
2150101   0.740      0.360     0.0          0.0       -90.      -0.360
2150102   3.81-6     0.0       00
2150200   003        14.989E6  55..23
2151101   210010000 215000000 0.0          0.72650   0.17160   00000
2152101   215010000 220000000 0.0          0.0       0.0       00000
2153101   215000000 225000000 0.15         1.40372   1.14100   00000
2154101   290010000 215000000 0.0          0.72650   0.17160   00000
2151201   2.9689     2.9689    0.0
2152201   2.7292-6   2.7292-6  0.0
2153201   1.7138     1.7138    0.0
2154201   0.65179    0.65179   0.0
************************************************************************
* LOWR PLENUM BOTTOM VOLUME
************************************************************************
2200000   LWRPLBOT             SNGLVOL
2200101   0.790      0.370     0.0          0.0       -90.      -0.370
2200102   3.81-6     0.0       00
2200200   003        14.992E6  559.38
************************************************************************
* LOWER CORE SUPPORT STRUCTURE
************************************************************************
2250000   LCORESUP             BRANCH
2250001   3          0
2250101   0.25       0.52      0.0          0.0       90.       0.52
2250102   3.81-6     0.095     00
2250200   003        14.984E6  556.23
2251101   225010000 226000000 0.0          1.46961   1.46961   00000
2252101   225010000 227000000 8.23260-2    0.60800   0.71330   00000
2253101   225010000 233000000 1.53281-2    0.69015   0.75490   00000
2251201   0.66670    0.66670   0.0
2252201   2.5488     2.5488    0.0
2253201   2.4289     2.7226    0.0
************************************************************************
* CORE BYPASS VOLUME
************************************************************************
2260000   COREBYPS             PIPE
2260001   3
2260101   0.015      3
2260201   0.0        2
2260301   0.559      2
2260302   0.657      3
2260401   0.0        3
2260501   0.0        3
2260601   90.        3
2260801   4.0-5      0.003     3
2260901   0.0        0.0       2
2261001   00         3
2261101   00000      2
2261201   003        14.979E6  556.23    0.0       0.0       0.0       1
2261202   003        14.973E6  556.23    0.0       0.0       0.0       2
2261203   003        14.967E6  556.23    0.0       0.0       0.0       3
2261300   0
2261301   0.66671    0.66671   0.0       01
2261302   0.66671    0.66671   0.0       02
*
************************************************************************
* ACTIVE  CORE
```

```
******************************************************************************************************
*
********  CORE AVERAGE CHANNEL (227,228,229,230,231,232 )
*
* BRANCH  (227)
*
2270000   AVCORE1    BRANCH
2270001   2          0
2270101   0.138436   0.27950    0.0        0.0        90.0
2270102   0.27950    1.27-7     0.012      00
2270200   003        14.979E6   561.80
2271101   227010000 228000000 0.121430   0.05320    0.05320    00000
2272101   233000000 227000000 0.239275   4.69       4.69       00003
2271201   1.7456     1.8880     0.0
2272201   -3.1096-3 -3.4875-3 0.0
*
* BRANCH  (228)
*
2280000   AVCORE2    BRANCH
2280001   2          0
2280101   0.138436   0.27950    0.0        0.0        90.0
2280102   0.27950    1.27-7     0.012      00
2280200   000        14.976E6   1.3019E6   2.4605E6   6.7600-4
2281101   228010000 229000000 0.121430   0.05320    0.05320    00000
2282101   234000000 228000000 0.239275   4.69       4.69       00003
2281201   1.7869     1.9737     0.0
2282201   5.5703-4   8.2698-4   0.0
*
* BRANCH  (229)
*
2290000   AVCORE3    BRANCH
2290001   2          0
2290101   0.138436   0.27950    0.0        0.0        90.0
2290102   0.27950    1.27-7     0.012      00
2290200   000        14.974E6   1.3467E6   2.4605E6   3.0013-3
2291101   229010000 230000000 0.121430   0.05320    0.05320    00000
2292101   235000000 229000000 0.239275   4.69       4.69       00003
2291201   1.8079     2.0028     0.0
2292201   -1.3281-2 -2.7326-2 0.0
*
* BRANCH  (230)
*
2300000   AVCORE4    BRANCH
2300001   2          0
2300101   0.138436   0.279[illegible]    0.0        0.0        90.0
2300102   0.27950    1.27-7     0.012      00
2300200   000        14.971E6   1.3817E6   2.4605E6   3.2853-3
2301101   230010000 231000000 0.121430   0.05320    0.05320    00000
2302101   236000000 230000000 0.239275   4.69       4.69       00003
23012[illegible]   1.8661     2.0884     0.0
23022[illegible]   1.1899-2   1.8866-2   0.0
*
* BRANCH  (231)
*
2310000   AVCORE5    BRANCH
2310001   2          0
2310101   0.138436   0.27950    0.0        0.0        90.0
2310102   0.27950    1.27-7     0.012      00
2310200   000        14.969E6   1.4010E6   2.4606E6   1.3774-3
2311101   231010000 232000000 0.121430   0.05320    0.05320    00000
2312101   237000000 231000000 0.239275   4.69       4.69       00003
2311201   1.8398     2.0123     0.0
```

```
2312201   -2.2904-2 -5.1744-2 0.0
*
* BRANCH  (232)
*
2320000   AVCORE6   BRANCH
2320001   2         0
2320101   0.138436  0.37750   0.0       0.0       90.0
2320102   0.37750   1.27-7    0.012     00
2320200   000       14.966E6  1.4093E6  2.4607E6  1.4438-3
2321101   232010000 240000000 9.78055-2 0.887340  0.887205  00000
2322101   238000000 232000000 0.239275  4.69      4.69      00003
2321201   2.4159    2.5666    0.0
2322201   5.2195-2  8.2698-2  0.0
*
********  CORE HOT  CHANNEL ( 233,234,235,236,237,238)
*
* BRANCH  (233)
*
2330000   HTCORE1   BRANCH
2330001   1         0
2330101   2.50439-2 0.27950   0.0       0.0       90.0
2330102   0.27950   1.27-7    0.012     00
2330200   000       14.979E6  1.2744E6  2.4604E6  3.5939-5
2331101   233010000 234000000 2.21109-2 0.04981   0.04981   00000
2331201   1.7548    1.9930    0.0
*
* BRANCH  (234)
*
2340000   HTCORE2   BRANCH
2340001   1         0
2340101   2.50439-2 0.27950   0.0       0.0       90.0
2340102   0.27950   1.27-7    0.012     00
2340200   000       14.976E6  1.3399E6  2.4605E6  1.7943-2
2341101   234010000 235000000 2.21109-2 0.04981   0.04981   00000
2341201   1.8382    2.0253    0.0
*
* BRANCH  (235)
*
2350000   HTCORE3   BRANCH
2350001   1         0
2350101   2.50439-2 0.27950   0.0       0.0       90.0
2350102   0.27950   1.27-7    0.012     00
2350200   000       14.974E6  1.3985E6  2.4605E6  4.9742-2
2351101   235010000 236000000 2.21109-2 0.04981   0.04981   00000
2351201   2.1092    2.3011    0.0
*
* BRANCH  (236)
*
2360000   HTCORE4   BRANCH
2360001   1         0
2360101   2.62243-2 0.27950   0.0       0.0       90.0
2360102   0.27950   1.27-7    0.012     00
2360200   000       14.971E6  1.4401E6  2.4606E6  6.8761-2
2361101   236010000 237000000 2.21109-2 0.04981   0.04981   00000
2361201   2.0708    2.4552    0.0
*
* BRANCH  (237)
*
2370000   HTCORE5   BRANCH
2370001   1         0
2370101   2.50439-2 0.27950   0.0       0.0       90.0
2370102   0.27950   1.27-7    0.012     00
```

```
2370200   000         14.969E6  1.4603E6  2.4606E6  6.0046-2
2371101   237010000 238000000 2.21109-2 0.04981   0.04981   00000
2371201   2.3519      2.9438    0.0
*
* BRANCH  (238)
*
2380000   HTCORE6     BRANCH
2380001   1           0
2380101   2.62243-2 0.37750   0.0       0.0       90.0
2380102   0.37750   1.[illegible]7-7    0.012     00
2380200   000         14.966E6  1.4705E6  2.4606E6  3.5[illegible]
2381101   238010000 240000000 1.50001-2 0.9958[illegible]  0.94[illegible]    00000
2381201   2.5780      4.6181    0.0
*
*******************************************************************************
* UPPER END BOXES  AND SUPPORT STRUCTURE
*******************************************************************************
2400000   UPRENDBX              BRANCH
2400001   1           0
2400101   0.297       0.559     0.0       0.0       90.       0.559
2400102   3.81-6      0.145     00
2400200   000         14.961E6  1.4114E6  2.4608E6  1.5489-3
2401101   226010000 240000000 0.0       2.93767   2.93767   00000
2401201   0.66672     0.74886   0.0
*******************************************************************************
* UPPER CORE SUPPORT STRUCTURE - CROSS FLOW REGION
*******************************************************************************
2450000   UPRCRSUP              BRANCH
2450001   2           0
2450101   0.297       0.559     0.0       0.0       90.       0.559
2450102   3.81-6      0.145     00
2450200   000         14.958E6  1.4117E6  2.4609E6  2.8155-4
2451101   240010000 245000000 0.0       0.0       0.0       00000
2452101   245010000 251000000 0.0       0.0       0.0       00000
2451201   0.95598     1.1248    0.0
2452201   4.5990-6    0.24995   0.0
*******************************************************************************
* UPPER FLOW SKIRT  REGION
*******************************************************************************
2500000   UFLWSKRT              BRANCH
2500001   1           0
2500101   0.114       0.843     0.0       0.0       90.0      0.843
2500102   3.81-6      0.131     00
2500200   000         14.951E6  1.4117E6  2.4610E6  7.1467-5
2501101   245010000 250000000 0.0       0.0       0.0       00000
2501201   2.4884      2.6192    0.0
*******************************************************************************
* DEAD END OF FUEL  MODULES
*******************************************************************************
2510000   DEFLMODS              SNGLVOL
2510101   0.183       0.700     0.0       0.0       90.0      0.700
2510102   3.81-6      0.214     00
2510200   000         14.954E6  1.4313E6  2.4610E6  2.6921-2
*******************************************************************************
* COMBINED UPPER PLENUM BOTTOM VOLUME
*******************************************************************************
2550000   UPRPLBOT              BRANCH
2550001   1           0
2550101   0.268       1.566     0.0       0.0       90.0      1.556
2550102   3.81-6      0.0       00
2550200   000         14.945E6  1.4156E6  2.4612E6  1.7143-3
2551101   250010000 255000000 0.0       0.006     0.006     00000
```

```
****************************************************************************
2820000   INANBOT2              ANNULUS
2820001   1
2820101   0.0        1
2820301   0.424      1
2820401   0.0550     1
2820501   0.0        1
2820601   -90.0      1
2820701   -0.424     1
2820801   3.81-6     0.172      1
2821001   00         1
2821201   003        14.958E6   556.25    0.0       0.0       0.0       1
****************************************************************************
* JUNCTION BETWEEN INLET ANNULUS BOTTOM VOLUME 2 AND DOWNCOMER 2
****************************************************************************
2830000   J282-284              SNGLJUN
2830101   282010000 284000000 0.0       0.22632   0.20490   00000
2830201   0          0.58777    0.58777   0.0
****************************************************************************
* DOWNCOMER 2
****************************************************************************
*
* DOWNCOMER 2.1
*
2840000   DWNCR2.1              ANNULUS
2840001   1
2840101   0.071      1
2840301   0.958      1
2840401   0.0        1
2840501   0.0        1
2840601   -90.0      1
2840701   -0.958     1
2840801   3.81-6     0.102      1
2841001   00         1
2841201   003        14.963E6   556.24    0.0       0.0       0.0       1
*
* JUNCTION BETWEEEN DOWNCOMER 2.1 AN D 2.2
*
2850000   J2.1-2.2              SNGLJUN
2850101   284010000 286000000 0.0       0.0       0.0       00000
2850201   0          0.70438    0.70438   0.0
*
* DOWNCOMER 2.2
*
2860000   DWNCR2.2              ANNULUS
2860001   1
2860101   0.071      1
2860301   0.958      1
2860401   0.0        1
2860501   0.0        1
2860601   -90.0      1
2860701   -0.958     1
2860801   3.81-6     0.102      1
2861001   00         1
2861201   003        14.970E6   556.23    0.0       0.0       0.0       1
*
* JUNCTION BETWEEEN DOWNCOMER 2.2 AN D 2.3
*
2870000   J2.2-2.3              SNGLJUN
2870101   286010000 288000000 0.0       0.0       0.0       00000
2870201   0          0.80458    0.80458   0.0
*
```

```
2551201    1.0411-6  0.17006   0.0
******************************************************************************
* CROSSFLOW JUNCTION BETWEEN UPPER INLET ANNULUS 1 AND 2
******************************************************************************
2700000    UINCR-FL                 SNGLJUN
2700101    200010000 280010000 5.86740-2 98.0000   18.0000   00003
2700201    0         0.34514   0.34514   0.0
******************************************************************************
* CROSSFLOW JUNCTION BETWEEN LOWER INLET ANNULUS 1 AND 2
******************************************************************************
2720000    LINCR-FL                 SNGLJUN
2720101    202000000 282000000 7.27937-2 98.0000   18.0000   00003
2720201    0         0.29508   0.29508   0.0
******************************************************************************
* CROSSFLOW JUNCTION BETWEEN DOWNCOMERS 1&2
******************************************************************************
*
* JUNCTION BETWEEN  DOWNCOMER 1.1 AND  2.1
*
2730000    CROSFLW1                 SNGLJUN
2730101    204000000 284000000 9.73328-2 98.0000   18.0000   00003
2730201    0         8.5077-2  8.5077-2  0.0
*
* JUNCTION BETWEEN  DOWNCOMER 1.2 AND  2.2
*
2750000    CROSFLW2                 SNGLJUN
2750101    206000000 286000000 9.73328-2 98.0000   18.0000   00003
2750201    0         7.3113-2  7.3113-2  0.0
*
* JUNCTION BETWEEN  DOWNCOMER 1.3 AND  2.3
*
2770000    CROSFLW3                 SNGLJUN
2770101    208000000 288000000 9.73328-2 98.0000   18.0000   00003
2770201    0         5.5365-2  5.5365-2  0.0
*
* JUNCTION BETWEEN  DOWNCOMER 1.4 AND  2.4
*
2790000    CROSFLW4                 SNGLJUN
2790101    210000000 290000000 9.73328-2 98.0000   18.0000   00003
2790201    0         -0.16678  -0.16678  0.0
******************************************************************************
* INLET ANNULUS TOP VOLUME  2
******************************************************************************
2800000    INANTOP2                 ANNULUS
2800001    1
2800101    0.0       1
2800301    0.33      1
2800401    0.0428    1
2800501    0.0       1
2800601    90.0      1
2800701    0.33      1
2800801    3.81-6    0.178     1
2801001    00        1
2801201    003       1[illegible].[illegible]55E6  556.26    0.0       0.0       0.0       1
***************        *******************************************************
* JUNCTION BET[illegible]   UPPER INLET ANNULUS 2 AND  BOTTOM VOLUME 2
**************  **************************************************************
2810000    J280-282                 SNGLJUN
2810101    280000000 282000000 0.0       0.0       0.0       00000
2810201    0         0.15614   0.15614   0.0
******************************************************************************
* INLET ANNULUS BOTTOM VOLUME 2
```

```
* DOWNCOMER 2.3
*
2880000    DWNCR2.3                 ANNULUS
2880001    1
28801^1    0.071      1
2880301    0.958      1
2880401    0.0        1
2880501    0.0        1
2880601    -90.0      1
2880701    -0.958     1
2880801    3.81-6     0.102      1
2881001    00         1
2881201    003        14.977E6   556.23     0.0        0.0        0.0        1
*
* JUNCTION BETWEEEN DOWNCOMER 2.3 AND 2.4
*
2890000    J2.3-2.4              SNGLJUN
2890101    288010000 290000000 0.0          0.0        0.0        00000
2890201    0          0.88045    0.88045    0.0
*
* DOWNCOMER 2.4
*
2900000    DWNCR2.5                 ANNULUS
2900001    1
2900101    0.071      1
2900301    0.958      1
2900401    0.0        1
2900501    0.0        1
2900601    -90.0      1
2900701    -0.958     1
2900801    3.81-5     0.102      1
2901001    00         1
2901201    003        14.984E6   556.22     0.0        0.0        0.0        1
**********************************************************************************
*      BROKEN LOOP
**********************************************************************************
* REACTOR  VESSEL NOZZLE - BROKEN LOOP HUT LEG
**********************************************************************************
3000000    RVN-BLHL                 BRANCH
3000001    2          0
3000101    0.0634     0.876      0.0        0.0        0.0        0.0
3000102    4.0-5      0.0        00
3000200    000        14.950E6   1.2768E6   2.4611E6   3.8315-7
3001101    250010000 300000000 0.0634       1.10264    0.66160    00000
3002101    300010000 305000000 0.0          0.10050    0.10050    00000
3001201    -6.4728-7 4.2262-2  0.0
3002201    1.6459-10 3.5352-7  0.0
**********************************************************************************
* HOT LEG  PIPE TO  REFLOOD ASSIST BYPASS TEE
**********************************************************************************
3050000    HLP-RABT                 BRANCH
3050001    1          0
3050101    0.0634     0.698      0.0        0.0        0.0        0.0
3050102    4.0-5      0.0        00
3050200    003        14.950E6   565.45
3051101    305010000 310000000 0.0          0.10050    0.10050    00000
3051201    2.1220-10 2.1220-10 0.0
**********************************************************************************
* BROKEN  LOOP HOT  LEG CONTRACTION -1.0
**********************************************************************************
3100000    BLH-CNTR                 BRANCH
3100001    2          0
```

```
3100101   0.0         1.424       0.0668      0.0         0.0         0.0
3100102   4.0-5       0.0         00
3100200   003         14.950E6    564.96
3101101   380010000 310000000 0.0388      1.24700     0.45760     00000
3102101   310010000 315000000 0.0         0.39605     0.75363     00000
3101201   -5.566-11 -6.503-11 0.0
3102201   8.4236-10 8.7407-10 0.0
*****************************************************************
* STEAM GENERATOR  AND PUMP  SIMULATOR
*****************************************************************
3150000   SG-PUMP                 PIPE
3150001   8
3150101   0.0         8
3150201   8.365-3     1
3150202   3.260-2     2
3150203   1.056-1     3
3150204   3.260-2     4
3150205   8.365-3     7
3150301   0.93100     1
3150302   2.05100     2
3150303   0.84950     4
3150304   2.05100     5
3150305   1.47300     6
3150306   1.03200     7
3150307   1.84200     8
3150401   7.788-3     1
3150402   1.725-1     2
3150403   8.980-2     4
3150404   1.725-1     5
3150405   2.030-2     6
3150406   4.560-2     7
3150407   1.980-2     8
3150601   90.0        3
3150602   -90.0       7
3150603   90.0        8
3150701   0.6150      1
3150702   2.0510      2
3150703   0.4570      3
3150704   -0.4570     4
3150705   -2.0510     5
3150706   -1.1143     6
3150707   -0.6860     7
3150708   1.2140      8
3150801   4.0-5       0.0         8
3150901   0.93596     0.93596     1
3150902   16.8777     16.8777     2
3150903   0.50000     0.50000     3
3150904   16.8777     16.8777     4
3150905   0.23025     0.23025     5
3150906   2.53400     2.53400     6
3150907   5.06900     5.06900     7
3151001   00          8
3151101   00000       7
3151201   003         14.948E6    564.86      0.0         0.0         0.0         1
3151202   003         14.908E6    560.98      0.0         0.0         0.0         2
3151203   003         14.929E6    560.98      0.0         0.0         0.0         3
3151204   003         14.929E6    559.98      0.0         0.0         0.0         4
3151205   003         14.938E6    558.98      0.0         0.0         0.0         5
3151206   003         14.950E6    556.98      0.0         0.0         0.0         6
3151207   003         14.957E6    556.98      0.0         0.0         0.0         7
3151208   003         14.955E6    556.98      0.0         0.0         0.0         8
3151300   0
```

```
3151301    8.3150-10 1.0084-9  0.0         01
3151302    1.5261-10 3.3970-10 0.0         02
3151303    3.7289-11 3.7270-11 0.0         03
3151304    8.9420-11 -9.763-11 0.0         04
3151305    1.1680-10 -1.511-10 0.0         05
3151306    8.7688-11 -2.121-11 0.0         06
3151307    2.6580-11 ^.2972-11 0.0         07
*******************************************************************************
* HOT LEG  BREAK PLANE
*******************************************************************************
3300000    HLBRKPL             VALVE
3300101    315010000 800000000 8.3650-3  0.95883   1.0+6     00100
3300102    1.00      1.00
3300201    0         .00000000 .00000000 0.0
3300300    TRPVLV
3300301    510
*******************************************************************************
* REACTOR  VESSEL NOZZLE - BROKEN LOOP COLD LEG
*******************************************************************************
3350000    RVN-BLPL            BRANCH
3350001    2         0
3350101    0.0634    0.[illegible]  0.0       0.0       0.0       0.0
3350102    4.0-5     0.0       00
3350200    003       14.956E6  554.31
3351101    282[illegible]00000 335000000 0.0634    0.80400   1.43960   00000
3352101    335010000 340000000 0.0       0.10050   0.10050   00000
3351201    -1.732-10 -1.483-10 0.0
3352201    -1.528-10 -1.528-10 0.0
*******************************************************************************
*COLD LEG  PIPE TO  REFLOOD ASSIST BYPASS TEE
*******************************************************************************
3400000    CLP-RABT            BRANCH
3400001    1         0
3400101    0.0634    0.698     0.0       0.0       0.0       0.0
3400102    4.0-5     0.0       00
3400200    003       14.956E6  554.09
3401101    340010000 345000000 0.0       0.10050   0.10050   00000
3401201    -1.338-10 -1.338-10 0.0
*******************************************************************************
* BROKEN  LOOP COLD LEG CONTRACTION -1.0
*******************************************************************************
3450000    BLC-CNTR            BRANCH
3450001    2         0
3450101    0.0634    0.700     0.0       0.0       0.0       0.0
3450102    4.0-5     0.0       00
3450200    003       14.956E6  553.99
3451101    345000000 370000000 0.0388    0.45760   1.24700   00000
3452101    345010000 350000000 0.0634    9.01672   19.3560   00000
3451201    -1.719-10 -1.501-10 0.0
3452201    -9.748-12 -1.115-11 0.0
*******************************************************************************
* BREAK SPOOL PIECE
*******************************************************************************
3500000    BRK-SP    SNGLVOL
3500101    0.0       0.762     0.023360  0.0       0.0       0.0
3500102    4.0-5     0.0       00
3500200    003       14.956E6  552.47
*******************************************************************************
*COLD LEG  BREAK PLANE
*******************************************************************************
3650000    CLBRKPL             VALVE
3650101    350010000 805000000 8.3650-3  0.41500   1.0+6     00100
```

```
3650102   0.84       0.84
3650201   0          .00000000 .00000000 0.0
3650300   TRPVLV
3650301   510
*************************************************************************************
* REFLOOD  ASSIST BYPASS PIPING--COLD  LEG SIDE
*************************************************************************************
3700000   RABS-C-L             PIPE
3700001   3
3700101   0.0388     2
3700102   0.0776     3
3700201   0.0388     2
3700301   0.0        3
3700401   0.0279     1
3700402   0.070      2
3700403   0.1165     3
3700601   90.        1
3700602   0.0        3
3700701   0.64       1
3700702   0.0        3
3700801   4.0-5      0.0       3
3700901   0.28       0.28      1
3700902   0.84       0.84      2
3701001   00         3
3701101   00000      2
3701201   003        14.954E6  565.96    0.0       0.0       0.0       1
3701202   003        14.952E6  565.96    0.0       0.0       0.0       2
3701203   003        14.952E6  565.97    0.0       0.0       0.0       3
3701300   0
3701301   -1.491-10 -1.393-10 0.0       01
3701302   -9.301-11 -9.301-11 0.0       02
*************************************************************************************
* REFLOOD  ASSIST BYPASS VALVE
*************************************************************************************
3750000   RAB-VLV              VALVE
3750101   370010000 380000000 0.-       0.0       0.0       00000
3750201   0          .00000000 .00000000 0.0
3750300   TRPVLV
3750301   502
*************************************************************************************
* REFLOOD  ASSIST BYPASS PIPING - HOT  LEG SIDE
*************************************************************************************
3800000   RABS-H-L             PIPE
3800001   3
3800101   0.0776     1
3800102   0.0388     3
3800201   0.0388     2
3800301   0.0        3
3800401   0.1165     1
3800402   0.023      2
3800403   0.0489     3
3800601   0.0        1
3800602   0.0        2
3800603   -90.       3
3800701   0.0        1
3800702   0.0        2
3800703   -0.64      3
3800801   4.0-5      0.0       3
3800901   0.84       0.84      1
3800902   0.28       0.28      2
3801001   00         3
3801101   00000      2
```

```
3801201   003        14.946E6  565.97    0.0       0.0       0.0       1
3801202   003        14.946E6  565.97    0.0       0.0       0.0       2
3801203   003        14.948E6  565.96    0.0       0.0       0.0       3
3801300   0
3801301   -3.448-11 -3.448-11 0.0        01
3801302   -4.128-11 -5.256-11 0.0        02
**************************************************************************
* PRESSURIZER
**************************************************************************
* SURGE LINE PCS SIDE
**************************************************************************
4000000   SRGLPCS              BRANCH
4000001   2         0
4000101   0.00145   2.300     0.0       0.0       90.0      0.54
4000102   4.0-5     0.0       00
4000200   003       14.938E6  614.60
4001101   110000000 400000000 0.0       0.93000   0.93000   00100
4002101   400010000 405000000 0.0       0.93000   0.93000   00000
4001201   -5.9858-3 -8.8060-3 0.0
4002201   -5.9860-3 -5.9860-3 0.0
**************************************************************************
* PRESSURIZER SURGE LINE
**************************************************************************
4050000   SRG-PZR              PIPE
4050001   2
4050101   0.00145   2
4050201   0.00145   1
4050301   2.30      2
4050401   0.0       2
4050601   90.0      2
4050701   0.30      2
4050801   4.0-5     0.0       2
4050901   0.930000  0.930000  1
4051001   00        2
4051101    00000    1
4051201   003       14.935E6  614.41    0.0       0.0       0.0       1
4051202   003       14.934E6  614.42    0.0       0.0       0.0       2
4051300   0
4051301   -5.9860-3 -5.9860-3 0.0       01
**************************************************************************
* PRESSURIZER SURGE LINE VALVE
**************************************************************************
4100000   PZR-VLV              VALVE
4100101   405010000 415000000 0.0       0.93000   0.93000   00100
4100201   0         -5.9861-3 -5.9861-3 0.0
4100300   TRPVLV
4100301   501
**************************************************************************
* PRESSURIZER VESSEL
**************************************************************************
4150000   PZRVESEL             PIPE
4150001   7
4150101   0.0       2
4150102   0.5653    5
4150103   0.0       7
4150201   0.0       6
4150301   0.1815    1
4150302   0.1524    2
4150303   0.3967    3
4150304   0.5289    4
4150305   0.3967    5
4150306   0.1943    6
```

```
4150307    0.1029     7
4150401    0.0684     1
4150402    0.0838     2
4150403    0.0        5
4150404    0.0732     6
4150405    0.0142     7
4150501    0.0        7
4150601    90.0       7
4150801    4.0-5      0.0        7
4151001    00         7
4151101    00000      6
4151201    003        14.932E6   614.42     0.0        0.0        0.0        1
4151202    000        14.931E6   1.5835E6   2.4615E6   1.6479-9   0.0        2
4151203    000        14.930E6   1.5837E6   2.4615E6   5.5001-7   0.0        3
4151204    000        14.927E6   1.5836E6   2.4616E6   0.22596    0.0        4
4151205    000        14.926E6   1.5834E6   2.4616E6   1.0        0.0        5
4151206    000        14.925E6   1.5834E6   2.4616E6   1.0        0.0        6
4151207    000        14.925E6   1.5834E6   2.4616E6   1.0        0.0        7
4151300    0
4151301    1.0230-6   3.0885-5   0.0        01
4151302    7.0120-7   7.0512-3   0.0        02
4151303    6.2771-7   0.32550    0.0        03
4151304    -0.23616   9.3043-6   0.0        04
4151305    -1.1303-3  3.1549-6   0.0        05
4151306    -3.4390-3  8.6127-6   0.0        06
*************************************************************************
* TOP VOLUME PRESSURIZER
*************************************************************************
4200000    TOPV-PZR              BRANCH
4200001    1          0
4200101    0.0        0.1029     0.0142     0.0        90.0       0.1029
4200102    4.0-5      0.0        00
4200200    000        14.925E6   1.5834E6   2.4616E6   1.0
4201101    415010000  420000000  0.0        0.0        0.0        00000
4201201    -6.7300-4  8.6127-6   0.0
*************************************************************************
* PORV
*************************************************************************
4250000    POR-VLV               VALVE
4250101    420010000  810000000  9.0-5      0.0        0.0        00100
4250201    0          .00000000  .00000000  0.0
4250300    TRPVLV
4250301    691
*******
*************************************************************************
*  STEAM  GENERATOR  SECONDARY SIDE
*************************************************************************
* TOP OF  DOWNCOMER  (OUTLET OF PRIMARY SEPRATOR)
*************************************************************************
5000000    SPR-OUT               SEPARATR
5000001    3          0
5000101    0.0        0.8288     1.0277     0.0        90.0       0.8288
5000102    4.0-5      0.7697     00
5000200    000        5.5192E6   1.1789E6   2.5936E6   0.95637
5001101    500010000  520000000  0.0        0.0        0.0        00100
5002101    500000000  505000000  0.0        0.0        0.0        00100
5003101    515010000  500000000  0.196      0.0        0.0        00100
5001201    0.88915    2.4000     0.0
5002201    0.45877    -0.77061   0.0
5003201    2.4507     2.9618     0.0
*************************************************************************
* LOWER SEPRATOR SECTION -1.0
```

```
*******************************************************************************
5050000   LWR-SEPR                BRANCH
5050001   1          0
5050101   0.0        0.8288    1.0085     0.0        -90.0      -0.8288
5050102   4.0-5      0.72845   00
5050200   003        5.5227E6  543.31
5051101   505010000  507000000 0.0        0.0        0.0        00100
5051201   0.13345    0.13345   0.0
*******
5070000   LWR-SEPR                BRANCH
5070001   1          0
5070101   0.0        0.8288    1.0085     0.0        -90.0      -0.8288
5070102   4.0-5      0.72845   00
5070200   003        5.5290E6  543.31
5071101   507010000  505000000 0.0        0.0        0.0        00100
5071201   0.44778    0.44778   0.0
*******************************************************************************
* FEED INLET VOLUME
*******************************************************************************
5080000   FEIN-VOL                BRANCH
5080001   1          0
5080101   0.0        0.6096    0.22107    0.0        -90.0      -0.6096
5080102   4.0-5      0.163697  00
5080200   003        5.5343E6  535.37
5081101   508010000  510000000 0.0        0.0        0.0        00100
5081201   0.79141    0.79141   0.0
*******************************************************************************
* STEAM GENERATOR  DOWNCOMER
*******************************************************************************
5100000   SGTR-DMR                ANNULUS
5100001   3
5100101   0.232      3
5100201   0.0        2
5100301   0.6096     3
5100401   0.0        3
5100601   -90.0      3
5100701   -0.6096    3
5100801   4.0-5      0.10793   3
5100901   0.0        0.0       2
5101001   00         3
5101101   00000      2
5101201   003        5.5388E6  535.41     0.0        0.0        0.0        1
5101202   003        5.5434E6  535.46     0.0        0.0        0.0        2
5101203   003        5.5481E6  535.50     0.0        0.0        0.0        3
5101300   0
5101301   0.79148    0.79148   0.0        01
5101302   0.79155    0.79155   0.0        02
*******************************************************************************
* JUNTION  FROM DOWNSOMER TO  BOILER
*******************************************************************************
5130000   DNMR-BLR                SNGLJUN
5130101   510010000  515000000 0.0        17.5       17.5       00000
5130201   0          0.79161   1.0727     0.0
*******************************************************************************
* STEAM GENERATOR  BOILER
*******************************************************************************
5150000   BOILER                  PIPE
5150001   6
5150101   0.2776     4
5150102   0.31299    5
5150103   0.291864   6
5150201   0.0        5
```

```
5150301   1.8288     4
5150302   0.8288     6
5150401   0.0        6
5150601   60.0       4
5150602   90.0       6
5150701   0.6096     4
5150702   0.8288     6
5150801   4.0-5      0.0234     4
5150802   4.0-5      0.587423   5
5150803   4.0-5      0.6096     6
5150901   4.05       4.05       4
5150902   0.0        0.0        5
5151001   00         6
5151101   00000      5
5151201   000        5.5443E6  1.1728E6  2.5934E6  0.36177   0.0       1
5151202   000        5.5397E6  1.1790E6  2.5935E6  0.57986   0.0       2
5151203   000        5.5347E6  1.1797E6  2.5935E6  0.68895   0.0       3
5151204   000        5.5289E6  1.1795E6  2.5936E6  0.74821   0.0       4
5151205   000        5.5237E6  1.1792E6  2.5936E6  0.76686   0.0       5
5151206   000        5.5219E6  1.1791E6  2.5936E6  0.77299   0.0       6
5151300   0
5151301   1.0245     1.3191    0.0       01
5151302   1.4999     2.0197    0.0       02
5151303   1.9438     2.7519    0.0       03
5151304   2.3241     3.2080    0.0       04
5151305   2.4073     2.9755    0.0       05
******************************************************************
* TOP OF  RISER(INSIDE SHROND,ABOVE TUBES)
******************************************************************
5200000   SEPAR-IN             BRANCH
5200001   1          0
5200101   0.27871    0.718     0.0       0.0       90.0      0.718
5200102   4.0-5      1.0827    00
5200200   002        5.5189E6  1.0
5201101   520010000 525000000 0.0       0.0       0.0       00100
5201201   2.2848     2.4001    0.0
******************************************************************
* BELOW MIST EXTRACTOR ,ABOVE TOP OF  SHROND IN STEAM DOME
******************************************************************
5250000   BOTSTMDM             BRANCH
5250001   1          0
5250101   1.5886     0.762     0.0       0.0       90.0      0.762
5250102   4.0-5      0.64417   00
5250200   002        5.5187E6  1.0
5251101   525010000 530000000 0.0       0.8       0.8       00000
5251201   7.8662     14.433    0.0
******************************************************************
* MIST EXTRACTOR  AND STEAM  GEN OUTLET PIPE TO SCV
******************************************************************
5300000   STDM/PIP             SNGLVOL
5300101   0.04635    25.07     0.0       0.0       0.0       0.0
5300102   4.0-5      0.0       00
5300200   000        5.5111E6  1.1785E6  2.5936E6  0.99999
****************************
***  STEAM CONTROL VALVE  ***
****************************
5500000   STCOVA     SNGLJUN
5500101   530010000 555000000 0.003667  0.0       0.0       01000
5500201   0          69.717    182.67    0.0
********************************
***  PIPE DOWNSTREAM OF SCV  ***
********************************
```

```
5550000   CND-INLT  SNGLVOL
5550101   0.06557   54.44     0.0       0.0       0.0       0.0
5550102   4.E-5     0.0       00
5550200   000       5.5085E6  1.1783E6  2.5937E6  0.99960
*****************************************
***  FLOW PATH TO THE AIR COOLED CONDENSER  ***
*****************************************
5600000   CDACCO    SNGLJUN
5600101   555010000 565000000 0.0       0.0       0.0       01100
5600201   0         0.87374   10.225    0.0
******************************
***  AIR COOLED CONDENSER  ***
******************************
5650000   CONDNSR   TMDPVOL
5650101   0.21677   17.67     0.0       0.0       0.0       0.0
5650102   4.E-5     0.02      00
5650200   002       510
5650201   -0.0      5.5072E6  1.0
5650202   0.0       5.5072E6  1.0
5650203   0.51724   5.5104E6  1.0
5650204   0.68966   5.5234E6  1.0
5650205   1.03448   5.5364E6  1.0
5650206   1.55172   5.5559E6  1.0
5650207   1.89655   5.5657E6  1.0
5650208   2.41379   5.5754E6  1.0
5650209   2.75862   5.5754E6  1.0
5650210   2.93103   5.5722E6  1.0
5650211   3.10345   5.5657E6  1.0
5650212   3.62069   5.5527E6  1.0
5650213   4.13793   5.5364E6  1.0
5650214   4.82759   5.5104E6  1.0
5650215   5.17241   5.4909E6  1.0
5650216   5.68966   5.4779E6  1.0
5650217   6.37931   5.4421E6  1.0
5650218   6.89655   5.4226E6  1.0
5650219   7.58621   5.4096E6  1.0
5650220   8.44828   5.3966E6  1.0
5650221   9.31034   5.3933E6  1.0
5650222   10.6897   5.4031E6  1.0
5650223   11.2069   5.3998E6  1.0
5650224   12.5862   5.3901E6  1.0
5650225   13.6207   5.3803E6  1.0
5650226   15.0000   5.3706E6  1.0
5650227   17.5862   5.3673E6  1.0
5650228   20.0000   5.3608E6  1.0
5650229   22.5862   5.3576E6  1.0
5650230   25.0000   5.3511E6  1.0
5650231   27.4138   5.3478E6  1.0
5650232   30.0000   5.3446E6  1.0
5650233   120.000   5.2196E6  1.0
******************************
***  MAIN FEED WATER VALVE  ***
******************************
5700000   MAINFWVA  TMDPJUN
5700101   575000000 508000000 0.05
5700200   1         510
5700201   -0.0      18.824    0.0       0.0
5700202   0.0       18.824    0.0       0.0
5700203   0.17341   18.824    0.0       0.0
5700204   0.34682   14.743    0.0       0.0
5700205   0.52023   9.6836    0.0       0.0
5700206   0.69364   7.2827    0.0       0.0
```

```
5700207   0.86705   3.7906    0.0       0.0
5700208   1.04046   3.1557    0.0       0.0
5700209   1.21387   2.2033    0.0       0.0
5700210   1.38728   1.5684    0.0       0.0
5700211   1.73410   0.93349   0.0       0.0
5700212   2.08092   0.77476   0.0       0.0
5700213   2.60116   0.61603   0.0       0.0
5700214   5.02890   0.45730   0.0       0.0
5700215   7.63006   0.45730   0.0       0.0
5700216   120.000   0.45730   0.0       0.0
********************************
***  MAKE UP FEED STORAGE TANK  ***
********************************
5750000   FED-TANK  TMDPVOL
5750101   29.81     3.048     0.0       0.0       0.0       0.0
5750102   4.E-5     0.0       00
5750200   001       510
5750201   -0.0      478.0     0.0
5750202   0.0       478.0     0.0
5750203   120.0     478.0     0.0
****************************************************************
*  ECCS   SYSTEM
****************************************************************
* ECCS PIPING TO PCS
****************************************************************
6000000   ECCS-PCS            BRANCH
6000001   0         1
6000101   9.009-3   8.8776    0.0       0.0       -90.0     -3.2
6000102   4.0-5     0.0       00
6000200   003       4.7738E6  307.22
****************************************************************
* ACCUMULATOR CHECK VALVE
****************************************************************
6030000   ACCHKVLV            VALVE
6030101   605010000 600000000 1.93221-3 2.98310   2.98310   00000
6030201   0         0.0       0.0       0.0
6030300   TRPVLV
6030301   662
****************************************************************
* ACCUMULATOR PIPE  1
****************************************************************
6050000   ACCPIPE1            BRANCH
6050001   1         0
6050101   0.014582  9.4891    0.0       0.0       0.0       0.0
6050102   4.0-5     0.0       00
6050200   003       4.2190E6  307.20
6051101   610010000 605000000 0.0       0.7       0.7       00000
6051201   0.0       0.0       0.0
****************************************************************
* ACCUMUATOR PIPE  2
****************************************************************
6100000   ACCPIPE2            SNGLVOL
6100101   0.018638  7.55998   0.0       0.0       0.0       0.0
6100102   4.0-5     0.0       00
6100200   003       4.2190E6  307.21
****************************
***  ACCUMULATOR VESSEL  ***
****************************
 150000   ACCUMTOR  ACCUM
*
*6150101   1.0905    1.8041    0.0       0.0       90.0      1.8041
*6150102   4.0E-5    0.0       10
```

```
*6150200   4.20E6    306.0     0.0
*6151101   610000000 0.003167  1.6       1.6       00000
*6152200   0.0       1.20      60.0      0.0       0.04445   0    0    0
*
6150101    1.613734  2.33      0.0       0.0       90.0      2.33
6150102    4.0E-5    0.0       10
6150200    4.20E6    306.0     0.0
6151101    610000000 0.003167  1.6       1.6       00000
6152200    2.85      0.0       60.0      0.0       0.04445   0    0    0
*************************************************************************
* BWST LPIS
*************************************************************************
6200000    BWST-LP             TMDPVOL
6200101    20.44     5.0       0.0       0.0       90.       5.0
6200102    4.0-5     0.0       00
6200200    003
6200201    0.0       1.00+5    303.0
*************************************************************************
* BWST HPIS
*************************************************************************
6250000    BWST-HP             TMDPVOL
6250101    20.44     5.0       0.0       0.0       90.       5.0
6250102    4.0-5     0.0       00
6250200    003
6250201    0.0       1.00+5    303.0
*************************************************************************
* ECC SYSTEM VALVE
*************************************************************************
6300000    ECCALVE1            VALVE
6300101    600010000 185000000 5.989-3   0.0       0.0       00100
6300201    0         .00000000 .00000000 0.0
6300300    TRPVLV
6300301    580
*
6310000    ECCALVE2            VALVE
6310101    600010000 180010000 5.989-3   0.0       0.0       00100
6310201    0         .00000000 .00000000 0.0
6310300    TRPVLV
6310301    580
*************************************************************************
* LOW PRESSURE INJECTION SYSTEM
*************************************************************************
6350000    LPIS                TMDPJUN
6350101    620000000 600000000 0.0
6350200    1         615       P         185010000
6350201    -1.0      0.0       0.0       0.0
6350202    0.0       7.500     0.0       0.0
6350203    8.483+4   7.045     0.0       0.0
6350204    4.297+5   6.091     0.0       0.0
6350205    7.745+5   5.045     0.0       0.0
6350206    9.448+5   4.313     0.0       0.0
6350207    1.119+6   3.454     0.0       0.0
6350208    1.186+6   3.173     0.0       0.0
6350209    1.257+6   2.673     0.0       0.0
6350210    1.326+6   2.159     0.0       0.0
6350211    1.395+6   1.536     0.0       0.0
6350212    1.464+6   0.718     0.0       0.0
6350213    1.517+6   0.000     0.0       0.0
*************************************************************************
* HIGH PRESSURE INJECTION SYSTEM
*************************************************************************
6400000    HPIS                TMDPJUN
```

```
6400101   625000000 600000000 0.0
6400200   1         614       P         1.5010000
6400201   -1.0      0.0       0.0       0.0
6400202   0.0       1.58528   0.0       0.0
6400203   0.9000+6  1.58528   0.0       0.0
6400204   5.0000+6  1.30435   0.0       0.0
6400205   15.060+6  0.31533   0.0       0.0
6400206   50.000+6  0.00000   0.0       0.0
**************************************************************
* CONTAINMENT
**************************************************************
* CONTAINMENT BROKEN LOOP HOT LEG
**************************************************************
8000000   CONTBLHL            TMDPVOL
8000101   0.05200   0.0       3.15005   0.0       0.0       0.0
8000102   0.0       0.0       00
8000200   003       510
8000201   -1.0      1.00000+5 293.000
8000202   0.0       1.00000+5 293.000
8000203   2.0       1.24110+5 359.111
8000204   7.0       1.55827+5 365.222
8000205   17.7      2.36499+5 398.556
8000206   20.       2.52357+5 400.222
8000207   22.5      2.62700+5 401.889
8000208   25.       2.72353+5 403.000
8000209   30.       2.81316+5 404.111
8000210   32.5      2.84074+5 404.667
8000211   35.       2.86143+5 404.667
8000212   37.5      2.86832+5 404.667
8000213   40.       2.86832+5 404.667
8000214   45.       2.86143+5 404.667
8000215   50.       2.83385+5 404.111
8000216   70.       3.50000+5 404.111
8000217   100.      3.10000+5 404.111
8000218   150.      3.10000+5 404.111
8000219   1.0+5     1.00000+5 293.000
**************************************************************
* CONTAINMENT BROKEN LOOP COLD LEG
**************************************************************
8050000   CONTBLHL            TMDPVOL
8050101   0.05200   0.0       4.08155   0.0       0.0       0.0
8050102   0.0       0.0       00
8050200   003       510
8050201   -1.0      1.00000+5 293.000
8050202   0.0       1.00000+5 293.000
8050203   2.0       1.24110+5 359.111
8050204   7.0       1.55827+5 365.222
8050205   17.7      2.36499+5 398.556
8050206   20.       2.52357+5 400.222
8050207   22.5      2.62700+5 401.889
8050208   25.       2.72353+5 403.000
8050209   30.       2.81316+5 404.111
8050210   32.5      2.84074+5 404.667
8050211   35.       2.86143+5 404.667
8050212   37.5      2.86832+5 404.667
8050213   40.       2.86832+5 404.667
8050214   45.       2.86143+5 404.667
8050215   50.       2.83385+5 404.111
8050216   70.       3.50000+5 404.111
8050217   100.      3.10000+5 404.111
8050218   150.      3.10000+5 404.111
8050219   1.0+5     1.00000+5 293.000
```

```
************************************************************************
* CONTAINMENT POWER OPERATED RELIEF  VALVE
************************************************************************
8100000   CONTPORV              TMDPVOL
8100101   0.0       1.0         0.1       0.0       0.0       0.0
8100102   0.0       0.0         00
8100200   003       510
8100201   -1.0      1.00000+5 293.000
8100202   0.0       1.00000+5 293.000
8100203   1000.0    1.00000+5 293.000
************************************************************************
* BOUNDARY VALVE INTACT LOOP HOT LEG
************************************************************************
*9000000  BOUNDVLV              VALVE
*9000101  420010000 905000000 0.0       0.0       0.0       00100
*9000201  0         0.0         0.0       0.0
*9000300  TRPVLV
*9000301  501
************************************************************************
* BOUNDARY VOLUME INTACT LOOP HOT LEG
************************************************************************
*9050000  BOUNDVOL              TMDPVOL
*9050101  0.0       1.0         0.1       0.0       0.0       0.0
*9050102  0.0       0.0         00
*9050200  001
*9050201  0.0       614.88      1.0
*9050202  1000.0    614.88      1.0
************************************************************************
* BOUNDARY JUNCTION FOR PREZ WATER LEVEL
************************************************************************
*9100000  BOUNDTJ   TMDPJUN
*9100101  915000000 415000000 0.0
*9100200  1         501         CNTRLVAR  100
*9100201  -10.0     0.0         0.0       0.0
*9100202  -10.0     -500.0      0.0       0.0
*9100203  0.0       0.0         0.0       0.0
*9100204  10.0      500.0       0.0       0.0
************************************************************************
* BOUNDARY VOLUME FOR PREZ WATER LEVEL
************************************************************************
*9150000  BOUNDTV   TMDPVOL
*9150101  0.0       1.0         0.1       0.0       0.0       0.0
*9150102  0.0       0.0         00
*9150200  001       501         TEMPF     415010000
*9150201  -0.0      613.55      0.0
*9150202  0.0       0.0         0.0
*9150203  700.0     700.0       0.0
************************************************************************
*  REACTOR VESSEL HEAT STRUCTURE
************************************************************************
* REACTOR VESSEL WALL HEAT  STRUCTURES
************************************************************************
* REACTOR VESSEL FILLER BLOCKS HEAT STRUCTURES
************************************************************************
* INLET ANNULUS TOP VOLUME  1
* STATION  264 TO 2 77
************************************************************************
12000000  1         21          2         1         0.508
12000100  0         1
12000101  20        0.7264
12000201  4         20
12000301  0.0       20
```

```
12000401  559.75     21
12000501  200010000 0        1         1         0.165     1
12000601  0          0        0         1         0.165     1
12000701  0          0.0      0.0       0.0       1
12000801  0          0.1524   0.3245    0.33      1
***********************************************************************
* INLET ANNULUS TOP VOLUME  2
* STATION  264 TO 277
***********************************************************************
12001000  1          21       2         1         0.508
12001100  0          1
12001101  20         0.7264
12001201  4          20
12001301  0.0        20
12001401  559.77     21
12001501  280010000 0        1         1         0.165     1
12001601  0          0        0         1         0.165     1
12001701  0          0.0      0.0       0.0       1
12001801  0          0.1524   0.3245    0.33      1
***********************************************************************
* INLET ANNULUS LOWER VOLUME 1
* STATION 247.3 TO  264.0
***********************************************************************
12020000  1          21       2         1         0.501
12020100  0          1
12020101  20         0.7264
12020201  4          20
12020301  0.0        20
12020401  559.68     21
12020501  202010000 0        1         1         0.212     1
12020601  0          0        0         1         0.212     1
12020701  0          0.0      0.0       0.0       1
12020801  0          0.1524   0.3245    0.424     1
***********************************************************************
* INLET ANNULUS LOWER VOLUME 2
* STATION 247.3 TO  264.0
***********************************************************************
12021000  1          21       2         1         0.501
12021100  0          1
12021101  20         0.7264
12021201  4          20
12021301  0.0        20
12021401  559.75     21
12021501  282010000 0        1         1         0.212     1
12021601  0          0        0         1         0.212     1
12021701  0          0.0      0.0       0.0       1
12021801  0          0.1524   0.3245    0.424     1
***********************************************************************
* DOWNCOMER 1 AND LOW PLENUM
* STATION 67.7  TO  247.3
***********************************************************************
12100000  6          21       2         1         0.47
12100100  0          1
12100101  20         0.7264
12100201  4          20
12100301  0.0        20
12100401  545.0      21
12100501  204010000 2000000  1         1         0.479     4
12100502  215010000 0        1         1         0.36      5
12100503  220010000 0        1         1         0.37      6
12100601  -939       0        3949      1         0.479     4
12100602  -939       0        3949      1         0.36      5
```

```
12100603  -939       0          3949       1          0.37       6
12100701  0          0.0        0.0        0.0        6
12100801  0          0.1016     0.2155     0.958      4
12100802  0          0.1016     0.2155     0.36       5
12100803  0          0.1016     0.2155     5.00       6
*****************************************************************************
* DOWNCOMER 2
*****************************************************************************
12101000  4          21         2          1          0.47
12101100  0          1
12101101  20         0.7264
12101201  4          20
12101301  0.0        20
12101401  545.0      21
12101501  284010000  2000000    1          1          0.479      4
12101601  -939       0          3949       1          0.479      4
12101701  0          0.0        0.0        0.0        4
12101801  0          0.1016     0.2155     0.958      4
*****************************************************************************
* CORE SUPPORT BARREL (SECTION 1)
* STATION 96.44 TO  277
*****************************************************************************
12150000  6          11         2          1          0.381
12150100  0          1
12150101  10         0.419
12150201  4          10
12150301  0.0        10
12150401  559.60     11
12150501  0          0          0          1          0.165      1
12150502  0          0          0          1          0.212      2
12150503  0          0          0          1          0.479      6
12150601  200010000  0          1          1          0.165      1
12150602  202010000  0          1          1          0.212      2
12150603  204010000  2000000    1          1          0.479      6
12150701  0          0.0        0.0        0.0        6
12150901  0          0.1016     0.2155     0.330      1
12150902  0          0.1016     0.2155     0.424      2
12150903  0          0.1016     0.2155     0.958      6
*****************************************************************************
* CORE SUPPORT BARREL (SECTION 2)
* STATION 96.44 TO  277
*****************************************************************************
12151000  6          11         2          1          0.381
12151100  0          1
12151101  10         0.419
12151201  4          10
12151301  0.0        10
12151401  559.65     11
12151501  0          0          0          1          0.165      1
12151502  0          0          0          1          0.212      2
12151503  0          0          0          1          0.479      6
12151601  280010000  0          1          1          0.165      1
12151602  282010000  0          1          1          0.212      2
12151603  284010000  2000000    1          1          0.479      6
12151701  0          0.0        0.0        0.0        6
12151901  0          0.1016     0.2155     0.330      1
12151902  0          0.1016     0.2155     0.424      2
12151903  0          0.1016     0.2155     0.958      6
*****************************************************************************
* FLOW SKIRT - CORE FILLER  ASSEMBLY
* STATION 96.44 TO  261.13
*****************************************************************************
```

```
12250000  10          5          2          [illegible]  0.3
12250100  0           1
12250101  4           0.38
12250201  4           4
12250301  0.0         4
12250401  575.0       5
12250501  225010000 0          1          1          0.5200    1
12250502  227010000 1000000    1          1          0.2795    6
12250503  232010000 0          1          1          0.3775    7
12250504  240010000 5000000    1          1          0.5590    9
12250505  250010000 0          1          1          0.8430    10
12250601  0           0          0          1          0.5200    1
12250602  0           0          0          1          0.2795    6
12250603  0           0          0          1          0.3775    7
12250604  0           0          0          1          0.5590    9
12250605  0           0          0          1          0.8430    10
12250701  0           0.0        0.0        0.0        10
12250801  0           0.6        0.0        0.520      1
12250802  0           0.6        0.0        0.2795     6
12250803  0           0.6        0.0        0.3775     7
12250804  0           0.6        0.0        0.5590     9
12250805  0           0.6        0.0        0.8430     10
*************************************************************************
* LOWER CORE SUPPORT STRUCTURE
* STATION  96.44 TO 116.91
* INCLUDES CORE SUPPORT BARREL LIP,LOWER CORE SUPPORT
* STRUCTURE AND FUEL MODULE LOWER END  BOXES
*************************************************************************
12251000  1           7          2          1          0.282
12251100  0           1
12251101  6           0.3
12251201  4           6
12251301  0.0         6
12251401  559.64      7
12251501  225010000 0          1          1          0.52      1
12251601  0           0          0          1          0.52      1
12251701  0           0.0        0.0        0.0        1
12251801  0           0.095      0.095      0.52       1
*************************************************************************
* ACTIVE  CORE
* STATION 116.91 TO 182.94
*************************************************************************
* AVERAGE  FUEL RODS IN AVERAGE CHANNEL(AXIAL LEVEL 1)
*************************************************************************
12361000  1           10         2          1          0.0
+         1           1          8
12361100  0           1
12361101  5           4.66893-3
12361102  1           4.74351-3
12361103  3           5.36265-3
12361201  1           5
12361202  -2          6
12361203  -3          9
12361301  1.0         5
12361302  0.0         9
12361401  1080.3      1
12361402  1065.4      2
12361403  1022.3      3
12361404  954.05      4
12361405  864.85      5
12361406  760.66      6
12361407  616.54      7
```

```
12361408  610.30     8
12361409  604.29     9
12361410  598.48     10
12361501  0          0          0          1          306.222    1
12361601  227010000  0          1          1          306.222    1
12361701  900        0.127545   0.0        0.0        1
12361901  0          0.013633   0.0        0.2795     1
*
* AVERAGE  FUEL RODS IN AVERAGE CHANNEL(AXIAL LEVEL 2)
*
12362000  1          10         2          1          0.0
+         1          1          8
12362100  0          1
12362101  5          4.68060-3
12362102  1          4.74415-3
12362103  3          5.36341-3
12362201  1          5
12362202  -2         6
12362203  -3         9
12362301  1.0        5
12362302  0.0        9
12362401  1402.1     1
12362402  1374.7     2
12362403  1294.5     3
12362404  1168.5     4
12362405  1005.1     5
12362406  826.87     6
12362407  644.72     7
12362408  635.29     8
12362409  626.18     9
12362410  617.36     10
12362501  0          0          0          1          306.222    1
12362601  228010000  0          1          1          306.222    1
12362701  900        0.197174   0.0        0.0        1
12362901  0          0.013633   0.0        0.2795     1
*
* AVERAGE  FUEL RODS IN AVERAGE CHANNEL(AXIAL LEVEL 3)
*
12363000  1          10         2          1          0.0
+         1          1          8
12363100  0          1
12363101  5          4.68112-3
12363102  1          4.74424-3
12363103  3          5.36350-3
12363201  1          5
12363202  -2         6
12363203  -3         9
12363301  1.0        5
12363302  0.0        9
12363401  1424.6     1
12363402  1396.2     2
12363403  1313.2     3
12363404  1183.0     4
12363405  1014.6     5
12363406  831.04     6
12363407  646.30     7
12363408  636.66     8
12363409  627.34     9
12363410  618.32     10
12363501  0          0          0          1          306.222    1
12363601  229010000  0          1          1          306.222    1
12363701  900        0.201827   0.0        0.0        1
```

```
12363901  0          0.013633  0.0       0.2795    1
*
* AVERAGE  FUEL RODS IN AVERAGE CHANNEL(AXIAL LEVEL 4)
*
12364000  1          10        2         1         0.0
+         1          1         8
12364100  0          1
12364101  5          4.67304-3
12364102  1          4.74412-3
12364103  3          5.36335-3
12364201  1          5
12364202  -2         6
12364203  -3         9
12364301  1.0        5
12364302  0.0        9
12364401  1199.4     1
12364402  1180.6     2
12364403  1125.4     3
12364404  1037.1     4
12364405  925.42     5
12364406  795.98     6
12364407  638.27     7
12364408  6[illegible].06   8
12364409  624.10     9
12364410  617.38     10
12364501  0          0         0         1         306.222   1
12364601  230010000  0         1         1         306.222   1
12364701  900        0.150138  0.0       0.0       1
12364901  0          0.013633  0.0       0.2795    1
*
* AVERAGE  FUEL RODS IN AVERAGE CHANNEL(AXIAL LEVEL 5)
*
12365000  1          10        2         1         0.0
+         1          1         8
12365100  0          1
12365101  5          4.66378-3
12365102  1          4.74379-3
12365103  3          5.36299-3
12365201  1          5
12365202  -2         6
12365203  -3         9
12365301  1.0        5
12365302  0.0        9
12365401  920.10     1
12365402  911.62     2
12365403  886.56     3
12365404  845.91     4
12365405  791.96     5
12365406  726.87     6
12365407  623.37     7
12365408  619.27     8
12365409  615.33     9
12365410  611.53     10
12365501  0          0         0         1         306.222   1
12365601  231010000  0         1         1         306.222   1
12365701  900        0.084338  0.0       0.0       1
12365901  0          0.013633  0.0       0.2795    1
*
* AVERAGE  FUEL RODS IN AVERAGE CHANNEL(AXIAL LEVEL 6)
*
12366000  1          10        2         1         0.0
+         1          1         8
```

```
12366100  0           1
12366101  5           4.65917-3
12366102  1           4.74339-3
12366103  3           5.36250-3
12366201  1           5
12366202  -2          6
12366203  -3          9
12366301  1.0         5
12366302  0.0         9
12366401  665.18      1
12366402  663.63      2
12366403  658.99      3
12366404  651.33      4
12366405  640.74      5
12366406  627.34      6
12366407  599.70      7
12366408  598.70      8
12366409  597.74      9
12366410  596.81      10
12366501  0           0          0          1          306.222    1
12366601  232010000   0          1          1          306.222    1
12366701  900         0.020229   0.0        0.0        1
12366901  0           0.013633   0.0        0.2795     1
*
* AVERAGE  FUEL RODS IN HOT  CHANNEL     (AXIAL  LEVEL 1)
*
12371000  1           10         2          1          0.0
+         1           1          8
12371100  0           1
12371101  5           4.67914-3
12371102  1           4.74659-3
12371103  3           5.36552-3
12371201  1           5
12371202  -2          6
12371203  -3          9
12371301  1.0         5
12371302  0.0         9
12371401  1396.3      1
12371402  1369.4      2
12371403  1291.0      3
12371404  1167.7      4
12371405  1007.5      5
12371406  832.22      6
12371407  643.06      7
12371408  633.82      8
12371409  624.88      9
12371410  616.24      10
12371501  0           0          0          1          54.7624    1
12371601  233010000   0          1          1          54.7624    1
12371701  900         3.45563-2  0.0        0.0        1
12371901  0           0.013633   0.0        0.2795     1
*
* AVERAGE  FUEL RODS IN HOT   CHANNEL    (AXIAL  LEVEL 2)
*
12372000  1           10         2          1          0.0
+         1           1          8
12372100  0           1
12372101  5           4.69746-3
12372102  1           4.74708-3
12372103  3           5.36610-3
12372201  1           5
12372202  -2          6
```

```
12372203  -3          9
12372301  1.0         5
12372302  0.0         9
12372401  1855.5      1
12372402  1807.9      2
12372403  1667.1      3
12372404  1444.1      4
12372405  1165.5      5
12372406  870.55      6
12372407  661.11      7
12372408  647.03      8
12372409  633.36      9
12372410  620.08      10
12372501  0           0           0           1           54.7624    1
12372601  234010000   0           1           1           54.7624    1
12372701  900         5.33355-2   0.0         0.0         1
12372901  0           0.013633    0.0         0.2795      1
*
* AVERAGE  FUEL RODS IN HOT   CHANNEL     (AXIAL  LEVEL 3)
*
12373000  1           10          2           1           0.0
+         1           1           8
12373100  0           1
12373101  5           4.69770-3
12373102  1           4.74714-3
12373103  3           5.36616-3
12373201  1           5
12373202  -2          6
12373203  -3          9
12373301  1.0         5
12373302  0.0         9
12373401  1861.3      1
12373402  1813.5      2
12373403  1672.0      3
12373404  1447.8      4
12373405  1167.7      5
12373406  871.21      6
12373407  661.84      7
12373408  647.72      8
12373409  634.01      9
12373410  620.70      10
12373501  0           0           0           1           54.7624    1
12373601  235010000   0           1           1           54.7624    1
12373701  900         5.35414-2   0.0         0.0         1
12373901  0           0.013633    0.0         0.2795      1
*
* AVERAGE  FUEL RODS IN HOT   CHANNEL     (AXIAL  LEVEL 4)
*
12374000  1           10          2           1           0.0
+         1           1           8
12374100  0           1
12374101  5           4.68411-3
12374102  1           4.74696-3
12374103  3           5.36594-3
12374201  1           5
12374202  -2          6
12374203  -3          9
12374301  1.0         5
12374302  0.0         9
12374401  1504.5      1
12374402  1472.8      2
12374403  1380.4      3
```

```
12374404  1234.8     4
12374405  1049.2     5
12374406  846.83     6
12374407  650.05     7
12374408  639.69     8
12374409  629.67     9
12374410  619.95     10
12374501  0          0          0          1          54.7624   1
12374601  236010000  0          1          1          54.7624   1
12374701  900        3.89479-2  0.0        0.0        1
12374901  0          0.013633   0.0        0.2795     1
*
* AVERAGE  FUEL RODS IN HOT   CHANNEL    (AXIAL  LEVEL 5)
*
12375000  1          10         2          1          0.0
+         1          1          8
12375100  0          1
12375101  5          4.66963-3
12375102  1          4.74674-3
12375103  3          5.36570-3
12375201  1          5
12375202  -2         6
12375203  -3         9
12375301  1.0        5
12375302  0.0        9
12375401  1094.0     1
12375402  1079.3     2
12375403  1036.7     3
12375404  969.44     4
12375405  881.49     5
12375406  778.20     6
12375407  635.57     7
12375408  629.61     8
12375409  623.86     9
12375410  618.32     10
12375501  0          0          0          1          54.7624   1
12375601  237010000  0          1          1          54.7624   1
12375701  900        2.21880-2  0.0        0.0        1
12375901  0          0.013633   0.0        0.2795     1
*
* AVERAGE  FUEL RODS IN HOT   CHANNEL    (AXIAL  LEVEL 6)
*
12376000  1          10         2          1          0.0
+         1          1          8
12376100  0          1
12376101  5          4.66100-3
12376102  1          4.74638-3
12376103  3          5.36527-3
12376201  1          5
12376202  -2         6
12376203  -3         9
12376301  1.0        5
12376302  0.0        9
12376401  750.24     1
12376402  746.98     2
12376403  737.27     3
12376404  721.29     4
12376405  699.34     5
12376406  671.97     6
12376407  620.33     7
12376408  618.47     8
12376409  616.67     9
```

```
12376410  614.94     10
12376501  0          0          0          1          54.7624   1
12376601  238010000  0          1          1          54.7624   1
12376701  900        0.68731-2  0.0        0.0        1
12376901  0          0.013633   0.0        0.2795     1
*
*   HOT    FUEL RODS IN HOT   CHANNEL    (AXIAL  LEVEL 1)
*
12381000  1          10         2          1          0.0
+         1          1          8
12381100  0          1
12381101  5          4.67914-3
12381102  1          4.74659-3
12381103  3          5.36552-3
12381201  1          5
12381202  -2         6
12381203  -3         9
12381301  1.0        5
12381302  0.0        9
12381401  1501.4     1
12381402  1470.3     2
12381403  1379.6     3
12381404  1236.6     4
12381405  1053.9     5
12381406  854.07     6
12381407  646.82     7
12381408  636.62     8
12381409  626.75     9
12381410  617.18     10
12381501  0          0          0          1          2.23520   1
12381601  233010000  0          1          1          2.23520   1
12381701  900        1.56176-3  0.0        0.0        1
12381901  0          0.013633   0.0        0.2795     1
*
*   HOT    FUEL RODS IN HOT   CHANNEL    (AXIAL  LEVEL 2)
*
12382000  1          10         2          1          0.0
+         1          1          8
12382100  0          1
12382101  5          4.69[illegible]46-3
12382102  1          4.74[illegible]08-3
12382103  3          5.366[illegible]-3
12382201  1          5
12382202  -2         6
12382203  -3         9
12382301  1.0        5
12382302  0.0        9
12382401  2006.5     1
12382402  1953.3     2
12382403  1796.4     3
12382404  1544.0     4
12382405  1227.3     5
12382406  891.39     6
12382407  665.18     7
12382408  649.86     8
12382409  634.98     9
12382410  620.51     10
12382501  0          0          0          1          2.23520   1
12382601  234010000  0          1          1          2.23520   1
12382701  900        2.37504-3  0.0        0.0        1
12382901  0          0.013633   0.0        0.2795     1
*
```

```
*    HOT     FUEL RODS IN HOT    CHANNEL     (AXIAL  LEVEL 3)
*
12383000  1          10         2          1          0.0
+         1          1          8
12383100  0          1
12383101  5          4.69770-3
12383102  1          4.74714-3
12383103  3          5.36616-3
12383201  1          5
12383202  -2         6
12383203  -3         9
12383301  1.0        5
12383302  0.0        9
12383401  2002.1     1
12383402  1949.0     2
12383403  1792.5     3
12383404  1540.9     4
12383405  1225.2     5
12383406  890.56     6
12383407  665.60     7
12383408  650.32     8
12383409  635.48     9
12383410  621.06     10
12383501  0          0          0          1          2.23520    1
12383601  235010000  0          1          1          2.23520    1
12383701  900        2.37012-3  0.0        0.0        1
12383901  0          0.013633   0.0        0.2795     1
*
*    HOT     FUEL RODS IN HOT    CHANNEL     (AXIAL  LEVEL 4)
*
12384000  1          10         2          1          0.0
+         1          1          8
12384100  0          1
12384101  5          4.68411-3
12384102  1          4.74696-3
12384103  3          5.36594-3
12384201  1          5
12384202  -2         6
12384203  -3         9
12384301  1.0        5
12384302  0.0        9
12384401  1593.1     1
12384402  1557.7     2
12384403  1454.4     3
12384404  1291.9     4
12384405  1086.8     5
12384406  863.28     6
12384407  652.66     7
12384408  641.51     8
12384409  630.71     9
12384410  620.23     10
12384501  0          0          0          1          2.23520    1
12384601  236010000  0          1          1          2.23520    1
12384701  900        1.71484-3  0.0        0.0        1
12384901  0          0.013633   0.0        0.2795     1
*
* HOT FUEL ROD IN HOT CHANNEL (AXIAL LEVEL5)
*
12385000  1          10         2          1          0.0
+         1          1          8
12385100  0          1
12385101  5          4.66963-3
```

```
12385102  1          4.74674-3
12385103  3          5.36570-3
12385201  1          5
12385202  -2         6
12385203  -3         9
12385301  1.0        5
12385302  0.0        9
12385401  1139.7     1
12385402  1123.5     2
12385403  1075.6     3
12385404  1000.7     4
12385405  903.61     5
12385406  790.08     6
12385407  637.14     7
12385408  630.72     8
12385409  624.53     9
12385410  618.55     10
12385501  0          0          0          1          2.23520   1
12385601  237010000  0          1          1          2.23520   1
12385701  900        0.97663-3  0.0        0.0        1
12385901  0          0.013633   0.0        0.2795     1
*
* HOT FUEL ROD IN HOT CHANNEL (AXIAL LEVEL 6)
*
12386000  1          10         2          1          0.0
+         1          1          8
12386100  0          1
12386101  5          4.66100-3
12386102  1          4.74638-3
12386103  3          5.36527-3
12386201  1          5
12386202  -2         6
12386203  -3         9
12386301  1.0        5
12386302  0.0        9
12386401  771.60     1
12386402  767.79     2
12386403  756.45     3
12386404  737.83     4
12386405  712.35     5
12386406  680.55     6
12386407  621.74     7
12386408  619.61     8
12386409  617.56     9
12386410  615.58     10
12386501  0          0          0          1          2.23520   1
12386601  23[illegible]010000  0          1          1          2.23520   1
12386701  900        0.32091-3  0.0        0.0        1
12386901  0          0.013633   0.0        0.2795     1
***********************************************************************
* UPPER CORE SUPPORT STRUCTURE
* STATION 190.5 TO 234.5
***********************************************************************
12400000  2          7          2          1          0.282
12400100  0          1
12400101  6          0.31
12400201  4          6
12400301  0.0        6
12400401  592.68     7
12400501  240010000  5000000    1          1          0.559     2
12400601  0          0          0          1          0.559     2
12400701  0          0.0        0.0        0.0        2
```

```
12400801  0         0.56      0.0       1.118     2
**************************************************************************
* FUEL MODULES
* STATION 187.6 TO 258.4
**************************************************************************
12510000  1         5         1         1         0.0
12510100  0         1
12510101  4         0.01
12510201  4         4
12510301  0.0       4
12510401  592.73    5
12510501  250010000 0         1         1         1.8       1
12510601  251010000 0         1         1         1.8       1
12510701  0         0.0       0.0       0.0       1
12510801  0         0.0       0.0       1.8       1
12510901  0         0.0       0.0       1.8       1
**************************************************************************
*UPPER PLENUM INTERNALS
**************************************************************************
12551000  2         5         1         1         0.0
12551100  0         1
12551101  4         0.005
12551201  4         4
12551301  0.0       4
12551401  590.62    5
12551501  255010000 0         1         1         1.0       2
12551601  0         0         0         1         1.0       2
12551701  0         0.0       0.0       0.0       2
12551801  0         0.0       0.0       1.0       2
**************************************************************************
* CORE SUPPORT BARREL - UPPER PLENUM LOWER VOLUME
* STATION 264 TO 297.6
**************************************************************************
12552000  1         11        2         1         0.381
12552100  0         1
12552101  10        0.419
12552201  5         10
12552301  0.0       10
12552401  590.62    11
12552501  255010000 0         1         1         0.854     1
12552601  0         0         0         1         0.854     1
12552701  0         0.0       0.0       0.0       1
12552801  0         0.762     0.0       0.854     1
**************************************************************************
* CORE SUPPORT BARREL - UPPER PLENUM TOP VOLUME
* STATION 297.6 TO 325
**************************************************************************
12601000  1         21        2         1         0.381
12601100  0         1
12601101  20        0.728
12601201  5         20
12601301  0.0       20
12601401  590.62    21
12601501  255010000 0         1         1         0.712     1
12601601  0         0         0         1         0.712     1
12601701  0         0.0       0.0       0.0       1
12601801  0         0.762     0.0       0.712     1
**************************************************************************
* UPPER HEAD TOP PLATE
* STATION 325
**************************************************************************
12602000  1         21        1         1         0.0
```

```
12602100  0          1
12602101  20         0.474
12602201  5          20
12602301  0.0        20
12602401  575.50     21
12602501  255010000 0          1          1          0.712      1
12602601  -939       0          3949       1          0.712      1
12602701  0          0.0        0.0        0.0        1
12602801  0          0.0        0.0        0.712      1
**********************************************************************
*
*  STEAM GENERATOR HEAT STRUCTURES
*
**********************************************************************
* TUBING
**********************************************************************
10060000  8          8          2          1          0.0051054
10060100  0          1
10060101  7          6.348984-3
10060201  6          7
10060301  0.0        7
10060401  559.65     1
10060402  558.37     2
10060403  557.09     3
10060404  556.16     4
10060405  555.12     5
10060406  553.83     6
10060407  552.68     7
10060408  551.56     8
10060501  115010000 10000      1          1          1124.71    3
10060502  115040000 10000      1          1          849.063    5
10060503  115060000 10000      1          1          1124.71    8
10060601  515010000 10000      1          1          1124.71    3
10060602  515040000 0          1          1          849.063    4
10060603  515040000 0          1          1          849.063    5
10060604  515030000 -10000     1          1          1124.71    8
10060701  0          0.0        0.0        0.0        8
10060801  0          0.0468     0.0        0.0        8
10060901  0          0.0        0.0        0.0        8
**********************************************************************
* SHROUD - UPPER SECTION -1.0
**********************************************************************
15000000  2          4          2          1          0.3048
15000100  0          1
15000101  3          0.3143
15000201  5          3
15000301  0.0        3
15000401  546.76     4
15000501  515060000 0          1          0          1.58726    1
15000502  515050000 0          1          1          0.92736    2
15000601  505010000 0          1          0          1.63672    1
15000602  507010000 0          1          1          0.92736    2
15000701  0          0.0        0.0        0.0        2
15000801  0          0.0        0.0        0.0        2
15000901  0          0.0        0.0        0.0        2
**********************************************************************
* SHROUD - LOWER SECTION -1.0
**********************************************************************
15100000  4          4          2          1          0.6445
15100100  0          1
15100101  3          0.6572
15100201  5          3
```

```
15100301  0.0        3
15100401  542.5      4
15100501  515040000 0         1         1         0.646354  1
15100502  515030000 -10000    1         0         2.46853   4
15100601  508010000 0         1         1         0.646354  1
15100602  510010000 10000     1         0         2.51723   4
15100701  0         0.0       0.0       0.0       4
15100801  0         0.0       0.0       0.0       4
15100901  0         0.0       0.0       0.0       4
********
****************************************************************
* HEAT STRUCTURE THERMAL PROPERTY DATA
****************************************************************
********
20100100  TBL/FCTN  1         1         * UO2
20100200  TBL/FCTN  1         1         * GAP
20100300  TBL/FCTN  1         1         * ZR
20100400  TBL/FCTN  1         1         * S-STELL
20100500  C-STEEL
20100600  TBL/FCTN  1         1         * INCONEL 600
20100700  TBL/FCTN  1         1         * MGO
20100800  TBL/FCTN  1         1         * NICR
****************************************************************
* UO2 - THERMAL CONDUCTIVITY
****************************************************************
20100101  2.7315E2  8.44
20100102  4.1667E2  6.46
20100103  5.3315E2  5.782785
20100104  6.99817E2 4.633177
20100105  8.66483E2 3.880307
20100106  1.03315E3 3.351625
20100107  1.08871E3 3.155129
20100108  1.19982E3 2.983787
20100109  1.28315E3 2.836674
20100110  1.36648E3 2.713792
20100111  1.53315E3 2.521680
20100112  1.61648E3 2.448990
20100113  1.69982E3 2.391875
20100114  1.97759E3 2.289762
20100115  2.25537E3 2.307069
20100116  2.53315E3 2.433413
20100117  2.81093E3 2.661870
20100118  3.08871E3 2.994171
****************************************************************
* UO2 - VOLUMETRIC HEAT CAPACITY
****************************************************************
20100151  2.73150E2 2.310427E6
20100152  3.23150E2 2.571985E6
20100153  3.73150E2 2.746357E6
20100154  6.73150E2 3.138694E6
20100155  1.37315E3 3.443844E6
20100156  1.77315E3 3.531030E6
20100157  1.97315E3 3.792588E6
20100158  2.17315E3 4.228518E6
20100159  2.37315E3 4.882412E6
20100160  2.67315E3 6.015829E6
20100161  2.77315E3 6.320980E6
20100162  2.87315E3 6.582538E6
20100163  2.97315E3 6.713317E6
20100164  3.11315E3 6.800503E6
20100165  4.69982E3 6.800503E6
****************************************************************
```

```
* GAP--THERMAL CONDUCTIVITY
********************************************************************************
20100201  273.15     0.14
20100202  590.0      0.24
20100203  810.0      0.29
20100204  1090.0     0.36
20100205  1370.0     0.42
20100206  3260.0     0.75
********************************************************************************
* GAP - VOLUMETRIC HEAT CAPACITY
********************************************************************************
20100251  273.15     5.[illegible]
20100252  3260.0     5.4
********************************************************************************
* ZIRCALOY-4 - THERMAL CONDUCTIVITY                        FROM MATPRO
********************************************************************************
20100301  300.0      12.7
20100302  380.4      13.6
20100303  469.3      14.6
20100304  577.6      15.8
20100305  685.9      17.3
20100306  774.8      18.4
20100307  872.0      19.8
20100308  973.2      21.8
20100309  1073.2     23.2
20100310  1123.2     25.4
20100311  1152.3     24.2
20100312  1232.2     25.5
20100313  1331.2     26.6
20100314  1404.2     28.2
20100315  1576.2     33.0
20100316  1625.2     36.7
20100317  1755.2     41.2
20100318  2273.2     55.0
********************************************************************************
*  ZIRCALOY-4 VOLUMETRIC HEAT CAPACITY                     FROM MATPRO
********************************************************************************
20100351  300.0      1.841E6
20100352  400.0      1.978+6
20100353  640.0      2.168E6
20100354  1090.0     2.456E6
201 0355  1093.0     3.288E6
20100356  1113.0     3.865E6
20100357  1133.0     4.028E6
20100358  1153.0     4.709E6
20100359  1173.0     5.345E6
20100360  1193.0     5.044E6
20100361  1213.0     4.054E6
20100362  1233.0     3.072E6
20100363  1243.0     2.332E6
20100364  3000.0     2.332E6
********************************************************************************
* S-STEEL - THERMAL CONDUCTIVITY
********************************************************************************
20100401  273.15     12.98
20100402  1199.82    25.1
********************************************************************************
* S-STEEL - VOLUMETRIC HEAT CAPACITY
********************************************************************************
20100451  273.15     3.83E6
20100452  366.5      3.83E6
20100453  477.59     4.190E6
```

```
20100454  588.59    4.336E6
20100455  699.82    4.504E6
20100456  810.93    4.639E6
20100457  922.04    4.773E6
20100458  1144.26   5.076E6
20100459  1366.5    5.376E6
20100460  1477.59   5.54[illegible]E6
*******************************************************************
* INCONEL-600 -THERMAL CONDUCTIVITY
*******************************************************************
20100601  366.5     13.85
20100602  477.6     15.92
20100603  588.7     18.17
20100604  700.0     20.42
20100605  810.9     22.50
20100606  922.0     24.92
20100607  1033.2    26.83
20100608  1144.3    29.42
20100609  1477.6    36.06
*******************************************************************
* INCONEL-600 - VOLUMETRIC HEAT CAPACITY
*******************************************************************
20100651  366.5     3.908+6
20100652  477.6     4.084+6
20100653  588.7     4.260+6
20100654  700.0     4.436+6
20100656  810.9     4.665+6
20100657  922.0     4.929+6
20100658  1033.2    5.105+6
20100659  1477.6    5.727+6
*******************************************************************
* MAGNESIUM OXIDE - THERMAL CONDUCTIVITY
*******************************************************************
20100701  373.15    0.2451
20100702  422.04    0.2405
20100703  477.59    0.2352
20100704  533.15    0.2300
20100705  588.71    0.2249
20100706  644.26    0.2196
20100707  699.82    0.2143
20100708  755.37    0.2091
20100709  810.93    0.2039
20100710  866.48    0.1987
20100711  922.04    0.1934
20100712  977.59    0.1882
20100713  1033.15   0.1830
20100714  1088.71   0.1777
20100715  1144.26   0.1725
20100716  1199.82   0.1673
20100717  1255.37   0.1621
20100718  1310.93   0.1568
20100719  1366.48   0.1516
20100720  1422.04   0.1464
20100721  1477.59   0.1412
20100722  1533.15   0.1359
20100723  1588.71   0.1307
20100724  1644.26   0.1255
20100725  1699.82   0.1203
20100726  1755.37   0.1150
20100727  1810.93   0.1098
20100728  1866.48   0.1046
20100729  1922.04   0.0993
```

```
20100730  5000.00   0.0993
****************************************************************************************
* MAGNESIUM OXIDE - VOLUMETRIC HEAT CAPACITY
****************************************************************************************
20100731  373.15     2033.52
20100752  422.04     2004.59
20100753  477.59     1971.74
20100754  533.15     1938.87
20100755  588.71     1906.01
20100756  644.26     1873.15
20100757  699.82     1840.29
20100758  755.37     1807.43
20100759  810.93     1774.56
20100760  866.48     1741.70
20100761  922.04     1708.84
20100762  977.59     1675.96
20100763  1033.15    1643.11
20100764  1088.71    1610.25
20100765  1144.26    1577.39
20100766  1199.82    1544.53
20100767  1255.37    1511.67
20100768  1310.93    1478.80
20100769  1366.48    1445.94
20100770  1422.04    1413.08
20100771  1477.59    1380.22
20100772  1533.15    1347.35
20100773  1588.71    1314.49
20100774  1644.26    1281.63
20100775  1699.82    1248.77
20100776  1755.37    1215.90
20100777  1810.93    1183.04
20100778  1866.48    1150.18
20100779  1922.04    1117.32
20100780  5000.00    1117.32
****************************************************************************************
* NICHROME - THERMAL CONDUCTIVITY
****************************************************************************************
20100801  373.15     1.1163
20100802  1922.04    1.1163
20100803  5000.00    1.1163
****************************************************************************************
* NICHROME - VOLUMETRIC HEAT CAPACITY
****************************************************************************************
20100851  373.15     2180.80
20100852  1922.04    2180.80
20100853  5000.00    2180.80
****************************************************************************************
* GENERAL TABLE DATA
****************************************************************************************
* TABLE
* NUMBER        DESCRIPTION -1.0
* ------        -----------
* 900           REACTOR POWER VS. TIME AFTER SCRAM
****************************************************************************************
20290000  POWER      510       1.0       36.0+6                        * L2-5
20290001  0.0        1.0
20290002  0.1        0.900689            * FROM L2-3 POSTTEST
20290003  0.2        0.274300
20290004  0.3        0.153171
20290005  0.4        0.110821
20290006  0.5        0.091625
20290007  0.6        0.083212
```

```
20290008  0.8        0.073556
20290009  1.0        0.064777
20290010  1.5        0.0[illegible]3089
20290011  2.0        0.059854
20290012  3.0        0.057265
20290013  4.0        0.055204
20290014  6.0        0.052085
20290015  8.0        0.049776
20290016  10.0       0.047947
20290017  15.0       0.0[illegible]4575
20290018  20.0       0.042176
20290019  30.0       0.038783
20290020  40.0       0.036348
20290021  60.0       0.031546
20290022  1.+5       0.001460 * FROM LTR  LD-05-81-173
*****************************************************************
* ENVIRONMENTAL HEAT LOSS BOUNDARY TEMPERATURE
*****************************************************************
20293900  TEMP
20293901  0.0        311.00
*****************************************************************
* REACTOR VESSEL ENVIORNMENTAL LOSS HEATXFER COEFFICIENT
*****************************************************************
20294900  HTC-T
20294901  0.0        10.0
*****************************************************************
* PUMP DATA
*****************************************************************
* SINGLE PHASE HEAD CURVES
*****************************************************************
* HEAD CURVE NO. 1
*****************************************************************
1351100   1              1
1351101   0.000000E+00          1.403600+00
1351102   1.906100E-01          1.363600+00
1351103   3.896300E-01          1.318600+00
1351104   5.939600E-01          1.232800+00
1351105   7.902000E-01          1.133600+00
1351106   1.000000E+00          1.000000+00
*****************************************************************
* HEAD CURVE NO.2
*****************************************************************
1351200   1                     2
1351201   0.000000E+00          -6.700000E-01
1351202   2.000000E-01          -5.000000E-01
1351203   4.000000E-01          -2.500000E-01
1351204   5.755400E-01          0.000000E+00
1351205   7.443200E-01          2.583000E-01
1351206   7.734800E-01          3.778000E-01
1351207   8.631300E-01          6.326000E-01
1351208   1.000000E+00          1.000000E+00
*****************************************************************
* HEAD CURVE NO.3
*****************************************************************
1351300   1                     3
1351301   -1.000000E+00         2.472200E+00
1351302   -8.057400E-01         2.047400E+00
1351303   -6.069000E-01         1.831000E+00
1351304   -4.068300E-01         1.624000E+00
1351305   -2.001710E-01         1.470500E+00
1351306   0.000000E+00          1.403600E+00
*****************************************************************
```

```
* HEAD CURVE NO.4
*******************************************************************************
1351400   1                     4
1351401   -1.000000E+00         2.472200E+00
1351402   -8.229700E-01         1.996800E+00
1351403   -6.333200E-01         1.589700E+00
1351404   -4.553400E-01         1.327900E+00
1351405   -2.710900E-01         1.194900E+00
1351406   -1.771600E-01         1.060500E+00
1351407   -9.073000E-02         1.015600E+00
1351408   0.000000E+00          9.342790E-01
*******************************************************************************
* HEAD CURVE NO.5
*******************************************************************************
1351500   1                     5
1351501   0.000[illegible]E+00  2.500000E-01
1351502   2.000000E-01          2.800000E-01
1351503   4.000000E-01          3.400000E-01
1351504   4.113000E-01          2.768000E-01
1351505   5.976300E-01          4.584000E-01
1351506   7.934670E-01          6.992000E-01
1351507   1.000000E+00          1.000000E+00
*******************************************************************************
* HEAD CURVE NO.6
*******************************************************************************
1351600   1                     6
1351601   0.000000E+00          9.342790E-01
1351602   9.109900E-02          [illegible]229000E-01
1351603   1.865090E-01          8.963000E-01
1351604   2.717620E-01          8.750000E-01
1351605   4.558720E-01          8.433000E-01
1351606   5.744060E-01          8.355000E-01
1351607   7.405760E-01          8.466000E-01
1351608   7.666190E-01          8.469000E-01
1351609   8.71[illegible]710E-01  8.838000E-01
1351610   1.000000E+00          1.000000E+00
*******************************************************************************
* HEAD CURVE NO.7
*******************************************************************************
1351700   1                     7
1351701   -1.000000E+00         -1.000000E+00
1351702   -8.000000E-01         -6.000000E-01
1351703   -6.000000E-01         -3.000000E-01
1351704   -4.000000E-01         -5.000000E-02
1351705   -2.000000E-01         1.500000E-01
1351706   0.000000E+00          2.500000E-01
*******************************************************************************
* HEAD CURVE NO.8
*******************************************************************************
1351800   1                     8
1351801   -1.000000E+00         -1.000000E+00
1351802   -8.000000E-01         -9.700000E-01
1351803   -6.000000E-01         -9.500000E-01
1351804   -4.000000E-01         -8.800000E-01
1351805   -2.000000E-01         -8.000000E-01
1351806   0.000000E+00          -6.700000E-01
*******************************************************************************
* SINGLE  PHASE TORQUE DATA
*******************************************************************************
* TORQUE  CURVE NO.1
*******************************************************************************
1351900   2                     1
```

```
1351901   0.000000E+00          6.032000E-01
1351902   1.930000E-01          6.325000E-01
1351903   3.930000E-01          7.369000E-01
1351904   5.955200E-01          8.331000E-01
1351905   7.978200E-01          9.229000E-01
1351906   1.000000E+00          1.000000E+00
****************************************************************************
* TORQUE  CURVE NO.2
****************************************************************************
1352000   2                     2
1352001   0.000000E+00          -6.700000E-01
1352002   4.000000E-01          -2.500000E-01
1352003   5.000000E-01          1.500000E-01
1352004   7.372550E-01          5.265860E-01
1352005   7.660490E-01          6.065940E-01
1352006   8.672300E-01          7.436600E-01
1352007   1.000000E+00          1.000000E+00
****************************************************************************
* TORQUE  CURVE NO.3
****************************************************************************
1352100   2                     3
1352101   -1.000000E+00         1.984300E+00
1352102   -8.009600E-01         1.394000E+00
1352103   -6.063800E-01         1.097500E+00
1352104   -0.40686              0.82200
1352105   -1.992800E-01         6.648000E-01
1352106   0.000000E+00          6.032000E-01
****************************************************************************
* TORQUE  CURVE NO.4
****************************************************************************
1352200   2                     4
1352201   -1.000000E+00         1.984300E+00
1352202   -8.223400E-01         1.830800E+00
1352203   -6.337100E-01         1.682400E+00
1352204   -4.585300E-01         1.557000E+00
1352205   -2.670230E-01         1.406200E+00
1352206   -1.761070E-01         1.387900E+00
1352207   -8.931000E-02         1.348100E+00
1352208   0.000000E+01          1.233610E+00
****************************************************************************
* TORQUE  CURVE NO.5
****************************************************************************
1352300   2                     5
1352301   0.000000E+00          -4.500000E-01
1352302   4.000000E-01          -2.500000E-01
1352303   5.000000E-01          0.000000E+00
1352304   1.000000E+00          3.569000E-01
****************************************************************************
* TORQUE  CURVE NO.6
****************************************************************************
1352400   2                     6
1352401   0.000000E+00          1.233610E+00
1352402   9.064300E-02          1.196500E+00
1352403   1.885690E-01          1.109600E+00
1352404   2.734700E-01          1.041600E+00
1352405   4.586690E-01          8.958000E-01
1352406   5.744800E-01          7.807000E-01
1352407   7.381600E-01          6.134000E-01
1352408   7.685200E-01          5.849000E-01
1352409   8.700570E-01          4.877000E-01
1352410   1.000000E+00          3.569000E-01
****************************************************************************
```

```
* TORQUE  CURVE NO.7
**********************************************************************
1352500    2                    7
1352501    -1.000000E+00        -1.000000E+00
1352502    -3.000000E-01        -9.000000E-01
1352503    -1.000000E-01        -5.000000E-01
1352504    0.000000E+00         -4.500000E-01
**********************************************************************
* TORQUE  CURVE NO.8
**********************************************************************
1352600    2                    8
1352601    -1.000000E+00        -1.000000E+00
1352602    -2.500000E-01        -9.000000E-01
1352603    -8.000000E-02        -5.000000E-01
1352604    0.000000E+00         -6.700000E-01
**********************************************************************
* TWO-PHA SE MULTIPLIER DATA L 3-6 TEST DATA
**********************************************************************
* HEAD    CURVE
**********************************************************************
1353000    0
1353001    0.000000E+00         0.000000E+00
1353002    1.000000E-01         0.000000E+00
1353003    2.000000E-01         1.000000E-01
1353004    3.000000E-01         2.000000E-01
1353005    3.500000E-01         3.000000E-01
1353006    4.000000E-01         6.000000E-01
1353007    5.000000E-01         6.000000E-01
1353008    6.000000E-01         6.000000E-01
1353009    7.000000E-01         6.000000E-01
1353010    8.000000E-01         5.000000E-01
1353011    9.000000E-01         3.000000E-01
1353012    1.000000E+00         0.000000E+00
**********************************************************************
* TORQUE  CURVE
**********************************************************************
1353100    0
1353101    0.000000E+00         0.000000E+00
1353102    1.000000E-01         0.000000E+00
1353103    2.000000E-01         1.000000E-01
1353104    3.000000E-01         3.000000E-01
1353105    3.500000E-01         5.000000E-01
1353106    4.000000E-01         7.500000E-01
1353107    5.000000E-01         7.500000E-01
1353108    6.000000E-01         7.500000E-01
1353109    7.000000E-01         7.500000E-01
1353110    8.000000E-01         7.500000E-01
1353111    9.000000E-01         5.000000E-01
1353112    1.000000E+00         0.000000E+00
**********************************************************************
* PUMP TWO-PHASE DIFFERENCE DATA
**********************************************************************
*  HEAD   CURVE NO. 1
**********************************************************************
1354100    1                    1
1354101    0.000000E+00         1.000000+00
1354102    1.000000E+00         1.000000+00
**********************************************************************
*  HEAD   CURVE NO. 2
**********************************************************************
1354200    1                    2
1354201    0.000000E+00         1.000000+00
```

```
1354202   1.000000E+00        1.000000+00
****************************************************************************
*  HEAD   CURVE NO. 3
****************************************************************************
1354300   1                   3
1354301   - .000000E+00       -1.160000+00
1354302   -9.000000E-01       -1.240000+00
1354303   -8.000000E-01       -1.770000+00
1354304   -7.000000E-01       -2.360000+00
1354305   -6.000000E-01       -2.790000+00
1354306   -5.000000E-01       -2.910000+00
1354307   -4.000000E-01       -2.670000+00
1354308   -2.500000E-01       -1.690000+00
1354309   -1.000000E-01       -5.000000-01
1354310   0.000000E+00        0.000000+00
****************************************************************************
*  HEAD   CURVE NO. 4
****************************************************************************
1354400   1                   4
1354401   -1.000000E+00       -1.160000+00
1354402   -9.000000E-01       -7.800000-01
1354403   -8.000000E-01       -5.000000-01
1354404   -7.000000E-01       -3.100000-01
1354405   -6.000000E-01       -1.700000-01
1354406   -5.000000E-01       -8.000000-02
1354407   -3.500000E-01       0.000000+00
1354408   -2.000000E-01       5.000000-02
1354409   -1.000000E-01       8.000000-02
1354410   0.000000E+00        1.100000-01
****************************************************************************
*  HEAD   CURVE NO. 5
****************************************************************************
1354500   1                   5
1354501   0.000000E+00        0.000000E+00
1354502   2.000000E-01        -3.400000E-01
1354503   4.000000E-01        -6.500000E-01
1354504   6.000000E-01        -9.300000E-01
1354505   8.000000E-01        -1.190000E+00
1354506   1.000000E+00        -1.470000E+00
****************************************************************************
*  HEAD   CURVE NO. 6
****************************************************************************
1354600   1                   6
1354601   0.000000E+00        1.100000E-01
1354602   1.000000E-01        1.300000E-01
1354603   2.500000E-01        1.500000E-01
1354604   4.000000E-01        1.300000E-01
1354605   5.000000E-01        7.000000E-02
1354606   6.000000E-01        -4.000000E-02
1354607   7.000000E-01        -2.300000E-01
1354608   8.000000E-01        -5.100000E-01
1354609   9.000000E-01        -9.100000E-01
1354610   1.000000E+00        -1.470000E+00
****************************************************************************
*  HEAD   CURVE NO. 7
****************************************************************************
1354700   1                   7
1354701   -1.000000E+00       0.000000E+00
1354702   0.000000E+00        0.000000E+00
****************************************************************************
*  HEAD   CURVE NO. 8
****************************************************************************
```

```
1354800    1                      8
1354801    -1.000000E+00          0.000000E+00
1354802    0.000000E+00           0.000000E+00
****************************************************************
* TORQUE  CURVE NO. 1
****************************************************************
1354900    2                      1
1354901    0.000000E+00           1.000000E+00
1354902    1.000000E+00           1.000000E+00
****************************************************************
* TORQUE  CURVE NO. 2
****************************************************************
1355000    2                      2
1355001    0.000000E+00           1.000000E+00
1355002    1.000000E+00           1.000000E+00
****************************************************************
* TORQUE  CURVE NO. 3
****************************************************************
1355100    2                      3
1355101    -1.000000E+00          1.984300E+00
1355102    -8.009600E-01          1.394000E+00
1355103    -6.063800E-01          1.097500E+00
1355104    -0.40686               0.82200
1355105    -1.992800E-01          6.648000E-01
1355106    0.000000E+00           6.032000E-01
****************************************************************
* TORQUE  CURVE NO. 4
****************************************************************
1355200    2                      4
1355201    -1.000000E+00          1.984300E+00
1355202    -8.223400E-01          1.830800E+00
1355203    -6.337100E-01          1.682400E+00
1355204    -4.585300E-01          1.557000E+00
1355205    -2.670230E-01          1.436200E+00
1355206    -1.761070E-01          1.387900E+00
1355207    -8.931000E-02          1.348100E+00
1355208    0.000000E+00           1.233610E+00
****************************************************************
* TORQUE  CURVE NO. 5
****************************************************************
1355300    2                      5
1355301    0.000000E+00           -4.500000E-01
1355302    4.000000E-01           -2.500000E-01
1355303    5.000000E-01           0.000000E+00
1355304    1.000000E+00           3.569000E-01
****************************************************************
* TORQUE  CURVE NO. 6
****************************************************************
1355400    2                      6
1355401    0.000000E+00           1.233610E+00
1355402    9.064300E-02           1.196500E+00
1355403    1.885690E-01           1.109600E+00
1355404    2.734700E-01           1.041600E+00
1355405    4.586690E-01           8.958000E-01
1355406    5.744800E-01           7.807000E-01
1355407    7.381600E-01           6.134000E-01
1355408    7.685200E-01           5.849000E-01
1355409    8.700570E-01           4.877000E-01
1355410    1.000000E+00           3.569000E-01
****************************************************************
* TORQUE  CURVE NO. 7
****************************************************************
```

```
1355500   2                     7
1355501   -1.000000E+00         -1.000000E+00
1355502   -3.000000E-01         -9.000000E-01
1355503   -1.000000E-01         -5.000000E-01
1355504   0.000000E+00          -4.500000E-01
********************************************************************************
* TORQUE  CURVE NO. 8
********************************************************************************
1355600   2                     8
1355601   -1.000000E+00         -1.000000E+00
1355602   -2.500000E-01         -9.000000E-01
1355603   -8.000000E-02         -8.000000E-01
1355604   0.000000E+00          -6.700000E-01
********************************************************************************
*         CONTROL VARIABLES
********************************************************************************
*   001 - 007 LEVEL CALCULATORS
********************************************************************************
* 001 STEAM GENERATOR LEVEL
********************************************************************************
20500100  SGLVL      SUM        1.0       0.0        1
20500101  0.0        0.8288     VOIDF     500010000
20500102             0.8288     VOIDF     505010000
20500103             0.8288     VOIDF     507010000
20500104             0.6096     VOIDF     508010000
20500105             0.6096     VOIDF     510010000
20500106             0.6096     VOIDF     510020000
20500107             0.6096     VOIDF     510030000
********************************************************************************
* 002     PRESSURIZER     LEVEL
********************************************************************************
20500200  PZRLVL     SUM        1.0       0.0        1
20500201  0.0        0.1815     VOIDF     415010000
20500202             0.1524     VOIDF     415020000
20500203             0.3967     VOIDF     415030000
20500204             0.5289     VOIDF     415040000
20500205             0.3967     VOIDF     415050000
20500206             0.1943     VOIDF     415060000
20500207             0.1029     VOIDF     415070000
20500208             0.1029     VOIDF     420010000
********************************************************************************
* 003     REACTOR VESSEL LEVEL
********************************************************************************
20500300  RXCLVL     SUM        1.0       0.0        1
20500301  0.0        1.566      VOIDF     255010000
20500302             0.843      VOIDF     250010000
20500303             0.559      VOIDF     245010000
20500304             0.559      VOIDF     240010000
20500305             0.375      VOIDF     232010000
20500306             0.2795     VOIDF     231010000
20500307             0.2795     VOIDF     230010000
20500308             0.2795     VOIDF     229010000
20500309             0.2795     VOIDF     228010000
20500310             0.2795     VOIDF     227010000
20500311             0.520      VOIDF     225010000
20500312             0.360      VOIDF     215010000
20500313             0.370      VOIDF     220010000
********************************************************************************
* 004     REACTOR VESSEL DOWNCOMER 1 LEVEL
********************************************************************************
20500400  DCMR1LVL   SUM        1.0       0.0        1
20500401  0.0        0.330      VOIDF     200010000
```

```
20500402             0.424      VOIDF      202010000
20500403             0.958      VOIDF      204010000
20500404             0.958      VOIDF      206010000
20500405             0.958      VOIDF      208010000
20500406             0.958      VOIDF      210010000
20500407             0.360      VOIDF      215010000
20500408             0.370      VOIDF      220010000
************************************************************************
* 005      LOOP SEAL   UPSTREAM      LEVEL
************************************************************************
20500500  LPSLUP     SUM         1.0        0.0        1
20500501  0.0        0.284175    VOIDF      120010000
20500502             0.356       VOIDF      118030000
20500503             0.689       VOIDF      118020000
20500504             0.498       VOIDF      118010000
************************************************************************
* 006      LOOP SEAL   DOWNSTREAM    LEVEL
************************************************************************
20500600  LPSLDWN    SUM         1.0        0.0        1
20500601  0.0        0.284175    VOIDF      120010000
20500602             0.2605      VOIDF      125010000
20500603             0.2285      VOIDF      130010000
20500604             0.2605      VOIDF      155010000
20500605             0.2285      VOIDF      160010000
************************************************************************
* 007      REACTOR VESSEL DOWNCOMER 2 LEVEL
************************************************************************
20500700  DCMR2LVL   SUM         1.0        0.0        1
20500701  0.0        0.330       VOIDF      280010000
20500702             0.424       VOIDF      282010000
20500703             0.958       VOIDF      284010000
20500704             0.958       VOIDF      286010000
20500705             0.958       VOIDF      288010000
20500706             0.958       VOIDF      290010000
20500707             0.360       VOIDF      215010000
20500708             0.370       VOIDF      220010000
************************************************************************
* 061-075  PRIMARY SYSTEM MASS CALCULATOR
************************************************************************
* 061      INTACT LOOP HOT LEG  MASS
************************************************************************
20506100   ILHLMASS  SUM          1.0       0.0        1
20506101   0.0       9.74648-2    RHO       100010000
20506102             0.1035956    RHO       105010000
20506103             3.03000-2    RHO       110010000
20506104             9.00000-2    RHO       112010000
20506105             5.70000-2    RHO       112020000
************************************************************************
* 062      STEAM GENEATOR PRIMARY MASS
************************************************************************
20506200   SGPRMASS  SUM          1.0       0.0        1
20506201   0.0       0.335000     RHO       114010000
20506202             0.136202     RHO       115010000
20506203             9.20496-2    RHO       115020000
20506204             9.20496-2    RHO       115030000
20506205             6.96412-2    RHO       115040000
20506206             6.96412-2    RHO       115050000
20506207             9.20496-2    RHO       115060000
20506208             9.20496-2    RHO       115070000
20506209             0.136202     RHO       115080000
20506210             0.335000     RHO       116010000
************************************************************************
```

```
* 063      PUMP SUCTION PIPING   MASS
****************************************************************************
20506300   PMPSUASS   SUM         1.0       0.0           1
20506301   0.0        4.37000-2   RHO       118010000
20506302              4.62000-2   RHO       118020000
20506303              3.54406-2   RHO       118030000
20506304              4.81840-2   RHO       120010000
20506305              6.13000-2   RHO       125010000
20506306              1.89000-2   RHO       130010000
20506307              6.13000-2   RHO       155010000
20506308              1.89000-2   RHO       160010000
****************************************************************************
* 064      INTACT LOOP COLD LEG  MASS
****************************************************************************
20506400   ILCLMASS   SUM         1.0       0.0           1
20506401   0.0        9.90000-2   RHO       135010000
20506402              1.83732-2   RHO       140010000
20506403              6.33000-2   RHO       145010000
20506404              3.14844-2   RHO       150010000
20506405              9.90000-2   RHO       165010000
20506406              1.88124-2   RHO       170010000
20506407              3.54406-2   RHO       175010000
20506408              3.88642-2   RHO       176010000
20506409              7.30368-2   RHO       180010000
20506410              6.40340-2   RHO       185010000
****************************************************************************
* 065      DOWNCOMER/LOWER PLENUM MASS
****************************************************************************
20506500   DCLPMASS   SUM         1.0       0.0           1
20506501   0.0        4.28000-2   RHO       200010000
20506502              4.28000-2   RHO       280010000
20506503              5.50000-2   RHO       202010000
20506504              5.50000-2   RHO       282010000
20506505              6.80180-2   RHO       204010000
20506506              6.80180-2   RHO       284010000
20506507              6.80180-2   RHO       206010000
20506508              6.80180-2   RHO       286010000
20506509              6.80180-2   RHO       208010000
20506510              6.80180-2   RHO       288010000
20506511              6.80180-2   RHO       210010000
20506512              6.80180-2   RHO       290010000
20506513              2.66400-1   RHO       215010000
20506514              2.92300-1   RHO       220010000
****************************************************************************
* 067      AVERAGE/CORE UPPER PLENUM MASS
****************************************************************************
20506700   ACUPMASS   SUM         1.0       0.0           1
20506701   0.0        1.30000-1   RHO       225010000
20506702              3.86929-2   RHO       227010000
20506703              3.86929-2   RHO       228010000
20506704              3.86929-2   RHO       229010000
20506705              3.86929-2   RHO       230010000
20506706              3.86929-2   RHO       231010000
20506707              5.22596-2   RHO       232010000
20506708              8.38500-3   RHO       226010000
20506709              8.38500-3   RHO       226020000
20506710              9.85500-3   RHO       226030000
20506711              1.66023-1   RHO       240010000
20506712              1.66023-1   RHO       245010000
20506713              9.61020-2   RHO       250010000
20506714              1.28100-1   RHO       251010000
20506715              4.19680-1   RHO       255010000
```

```
*****************************************************************************
* 068       BROKEN LOOP HOT LEG  MASS(TO BREAK PLANE)
*****************************************************************************
20506800    BLHLMASS   SUM          1.0        0.0        1
20506801    0.0        5.55384-2    RHO        300010000
20506802               4.42532-2    RHO        305010000
20506803               6.68000-2    RHO        310010000
20506804               7.78800-3    RHO        315010000
20506805               1.72500-1    RHO        315020000
20506806               8.98000-2    RHO        315030000
20506807               8.98000-2    RHO        315040000
20506808               1.72500-1    RHO        315050000
20506809               2.00000-2    RHO        315060000
20506810               4.56000-2    RHO        315070000
20506811               1.98000-2    RHO        315080000
20506812               1.16500-1    RHO        380010000
20506813               2.30000-2    RHO        380020000
20506814               4.89000-2    RHO        380030000
*****************************************************************************
* 069       BROKEN LOOP COLD LEG  MASS(TO BREAK PLANE)
*****************************************************************************
20506900    BLCLMASS   SUM          1.0        0.0        1
20506901    0.0        4.75183-2    RHO        335010000
20506902               4.42532-2    RHO        340010000
20506903               4.43800-2    RHO        345010000
20506904               2.33600-2    RHO        350010000
20506905               2.79000-2    RHO        370010000
20506906               7.00000-2    RHO        370020000
20506907               1.16500-1    RHO        370030000
*****************************************************************************
* 070       PRESSURIZ ER            MASS
*****************************************************************************
20507000    PZERMASS   SUM          1.0        0.0        1
20507001    0.0        3.33500-3    RHO        400010000
20507002               3.33500-3    RHO        405010000
20507003               3.33500-3    RHO        405020000
20507004               6.84000-2    RHO        415010000
20507005               8.38000-2    RHO        415020000
20507006               2.24255-1    RHO        415030000
20507007               2.98987-1    RHO        415040000
20507008               2.24255-1    RHO        415050000
20507009               7.32000-2    RHO        415060000
20507010               1.42000-2    RHO        415070000
20507011               1.42000-2    RHO        420010000
*****************************************************************************
* 077       TOTAL COR E/UPPER PLE NUM MASS
*****************************************************************************
20507700    TCUPMASS   SUM          1.0        0.0        1
20507701    0.0        6.99977-3    RHO        233010000
20507702               6.99977-3    RHO        234010000
20507703               6.99977-3    RHO        235010000
20507704               6.99977-3    RHO        236010000
20507705               6.99977-3    RHO        237010000
20507706               9.45407-3    RHO        238010000
20507707               1.0          CNTRLVAR   067
*****************************************************************************
* 078       REACTOR VESSEL TOTAL MASS
*****************************************************************************
20507800    RCVEMASS   SUM          1.0        0.0        1
20507801    0.0        1.0          CNTRLVAR   65
20507802               1.0          CNTRLVAR   67
* 079       PCS TOTAL  MASS
```

```
20507900   PCSTMASS   SUM          1.0        0.0       1
20507901   0.0          1.0        CNTRLVAR  61
20507902                1.0        CNTRLVAR  62
20507903                1.0        CNTRLVAR  63
20507904                1.0        CNTRLVAR  64
20507905                1.0        CNTRLVAR  68
20507906                1.0        CNTRLVAR  69
20507907                1.0        CNTRLVAR  70
20507908                1.0        CNTRLVAR  78
*****************************************************************************
* 073-076   STEAM GENERATOR MASS  CALCULATOR
*****************************************************************************
* 073       STEAM GENERATOR DOWNCOMER MASS
20507300   CGDCMASS   SUM          1.0        0.0       1
20507301   0.0          1.02770    RHO        500010000
20507302                1.00850    RHO        505010000
20507303                1.00850    RHO        507010000
20507304                2.21070-1  RHO        508010000
20507305                1.41427-1  RHO        510010000
20507306                1.41427-1  RHO        510020000
20507307                1.41427-1  RHO        510030000
*****************************************************************************
* 074       STEAM GENERATOR BOILER MASS
*****************************************************************************
20507400   CGBLMASS   SUM          1.0        0.0       1
20507401   0.0          5.07675-1  RHO        515010000
20507402                5.07675-1  RHO        515020000
20507403                5.07675-1  RHO        515030000
20507404                5.07675-1  RHO        515040000
20507405                2.59406-1  RHO        515050000
20507406                2.41897-1  RHO        515060000
20507407                2.00114-1  RHO        520010000
*****************************************************************************
* 075       STEAM GENERATOR DOME MASS
*****************************************************************************
20507500   SGDMMASS   SUM          1.0        0.0       1
20507501   0.0          1.210513   RHO        525010000
20507502                1.162180   RHO        5[illegible]0010000
*****************************************************************************
* 076       STEAM GENERATOR TOTAL MASS
*****************************************************************************
20507600   SGTLMASS   SUM          1.0        0.0       1
205076[illegible]   0.0   1.0      CNTRLVAR  73
*********[illegible]    1.0        CNTRLVAR  74
* 100       PRESS[illegible]   1.0   CNTRLVAR  75
*****************************************************************************
*0510000   PZRLCNTL   [illegible]EVEL CONTROL
*0510001   -1.14        1.0        -1.0       0.0       1
*****************************************************  CNTRLVAR   2
. . . . . . . . . . . . .  RELAP END [illegible]ARD . . . . . . . . . . . . .
```

```
20507900   PCSTMASS   SUM         1.0        0.0        1
20507901   0.0        1.0         CNTRLVAR   61
20507902              1.0         CNTRLVAR   62
20507903              1.0         CNTRLVAR   63
20507904              1.0         CNTRLVAR   64
20507905              1.0         CNTRLVAR   68
20507906              1.0         CNTRLVAR   69
20507907              1.0         CNTRLVAR   70
20507908              1.0         CNTRLVAR   78
******************************************************************
* 073-076   STEAM GENERATOR MASS  CALCULATOR
******************************************************************
* 073       STEAM GENERATOR DOWNCOMER MASS
20507300   CGDCMASS   SUM         1.0        0.0        1
20507301   0.0        1.02770     RHO        500010000
20507302              1.00850     RHO        505010000
20507303              1.00850     RHO        507010000
20507304              2.21070-1   RHO        508010000
20507305              1.41427-1   RHO        510010000
20507306              1.41427-1   RHO        510020000
20507307              1.41427-1   RHO        510030000
******************************************************************
* 074       STEAM GENERATOR BOILER MASS
******************************************************************
20507400   CGBLMASS   SUM         1.0        0.0        1
20507401   0.0        5.07675-1   RHO        515010000
20507402              5.07675-1   RHO        515020000
20507403              5.07675-1   RHO        515030000
20507404              5.07675-1   RHO        515040000
20507405              2.59406-1   RHO        515050000
20507406              2.41897-1   RHO        515060000
20507407              2.00114-1   RHO        520010000
******************************************************************
* 075       STEAM GENERATOR DOME MASS
******************************************************************
20507500   SGDMMASS   SUM         1.0        0.0        1
20507501   0.0        1.210513    RHO        525010000
20507502              1.162180    RHO        530010000
******************************************************************
* 076       STEAM GENERATOR TOTAL MASS
******************************************************************
20507600   SGTLMASS   SUM         1.0        0.0        1
20507601   0.0        1.0         CNTRLVAR   73
20507602              1.0         CNTRLVAR   74
20507603              1.0         CNTRLVAR   75
******************************************************************
* 100       PRESSURIZER LEVEL CONTROL
******************************************************************
*0510000   PZRLCNTL     SUM          -1.0        0.0        1
*0510001   -1.14        1.0          CNTRLVAR    2
******************************************************************
* . . . . . . . . . . . . . RELAP END CARD . . . . . . . . . . . . . . . *
```

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11. ABSTRACT (200 words or less)

This report documents the results and conclusions of the RELAP5/MOD2 code assessment in the analysis of LOCE Test L2-5. The objective of this assessment study is to provide systematic assessment of RELAP5/MOD2 Code relative to code development, code improvement and the enhancement of user guidelines.

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