NUREG/IA–0046

International Agreement Report

Assessment of RELAP5/MOD2 Using Semiscale Large Break Loss-of-Coolant Experiment S–06–3

Prepared by
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Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

April 1992

Prepared as part of
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NUREG/CR-0251
TREE-1123
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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-1

TEST S-06-3

(LOFT COUNTERPART TEST)

by

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EG&G IDAHO, INC.

July 1978

PREPARED FOR THE
U.S. NUCLEAR REGULATORY COMMISSION
AND THE
DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
UNDER CONTRACT NO. EY-76-C-07-1570

ABSTRACT

Recorded test data are presented for Test S-06-3 of the Semiscale Mod-1 LOFT counterpart test series. These tests are among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying an hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system. Test S-06-3 provided a data base for a Nuclear Regulatory Commission standard problem.

Test S-06-3 was conducted from initial conditions of 15 769 kPa and 563 K to investigate the response of the Semiscale Mod-1 system to a depressurization and reflood transient following a simulated double-ended offset shear of the broken loop cold leg piping. During the test, cooling water was injected into the cold leg of the intact loop to simulate emergency core coolant injection in a PWR. The heater rods in the electrically heated core were operated at an axial peak power density which was 75% of the maximum peak power density of 52.5 kW/m.

The purpose of this report is to make available the uninterpreted data from Test S-06-3 for future data analysis and test results reporting activities. The data, presented in the form of graphs in engineering units, have been analyzed only to the extent necessary to ensure that they are reasonable and consistent.

ABSTRACT

This report presents the results of the RELAP5/MOD2 posttest assessment utilizing a Semiscale large break loss-of-coolant experiment numbered S-06-3. Test S-06-3 is a 200% double ended cold leg break experiment performed in Semiscale Mod-1 facility in 1978 for the purpose of investigating the thermal and hydraulic phenomena accompanying a hypothetical large LOCA in a pressurized water reactor (PWR) system and providing a data base for a U.S. Nuclear Regulatory Commission standard problem. Through extensive comparisons between data and best-estimate RELAP5 calculations, the capabilities of RELAP5 to calculate the large LOCA accident were assessed. Emphasis was placed on the capability of the code to calculate break flow rates during system blowdown stage, emergency core cooling system (ECCS) injection bypass during refill stage, guenching during reflood stage, and the peak cladding temperature (PCT) behavior throughout the whole experiment. Besides, effects of several different modelings which include radial connections between core hot and average channels, maximum number of heat slab axial interval for 2-D reflod calculation, number of nodes representing the core, cross-flow junctions on vessel entrances, reflood calculation etc., were all investigated.

SUMMARY

This paper includes the results and conclusions of assessment studies which involve comparisons between data from Semiscale test S-06-3 and RELAP5/MOD2 code calculation, and important sensitivity studies investigating features of several different modelings and options. Semiscale S-06-3 test simulated a large cold-leg break LOCA with continuous reactor coolant pump (RCP) operation. RELAP5/MOD2 is an advanced, one-dimensional, thermal-hydraulic computer code used to calculate reactor transient and accident response. 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.

Test S-06-3 was performed as part of the Semiscale Program conducted by EG&G Idaho, Inc., for the United States Government. This test was part of the LOFT counterpart test series (Test Series 6) performed to investigate the response of the Mod-1 system to specific variations in the peak power densities of the heater rods to assist the LOFT Program in the planning of the first LOFT nuclear test series. The test objective specific to Test S-06-3 was to determine the maximum cladding temperature associated with a high powered rod peak power density of 39.4 kW/m, or 75% of the maximum high powered rod peak power density of 52.5 kW/m. In addition, Test S-06-3 was designated as a Nuclear Regulatory Commission standard problem.

In our assessment, RELAP5 calculation correctly catches all important thermal-hydraulic phenomena except the counter-current flow limit (CCFL) which takes place in the blowdown and refill periods and makes the latter-on calculated consequence deviated. The calculated break flow rates from both ends matched the data very well especially for the break near the pump side. When accumulator injection began, owing to the lack of CCFL model in RELAP5, emergency core cooling (ECC) water bypass phenomenon was not simulated well, which in turn caused more ECC water entering the vessel. Thus, early refill and reflood were noted in the calculation. As for the prediction of cladding temperature responses, good agreement was achieved between the test and calculation except the timing of rewetting. In our calculation, earlier rewet was clearly shown as compared to the test data. Two likely reasons contributed to this; one was the early refill depicted above, and the other was the overprediction of entrained water pulled up by the up-going vapor after reflood began. Besides, superheated steam observed in the test was also simulated qualitatively well.

The effects of several different modelings or options were also investigated, which include pressurizer modeling, radial connections between core average and hot channels, the maximum number of axial heat slab axial interval for 2-D reflood calculation, number of hydraulic volumes representing the core, the cross-flow junctions on reactor vessel entrances, and reflood calculation. Except the reflood calculation, effects of each individual modeling on the calculation of peak cladding temperature were quite negligible, but to some extent quench time calculations were affected. Generally speaking, modelings with in-core radial connection, larger number of heat slab axial interval for 2-D reflood calculation, larger number of axial hydraulic volumes representing the core, or cross-flow junctions on vessel entrances would postpone the fuel quench time. Basides, responses of cladding temperature on hot spot were heavily affected when defeating the reflood calculation, and it was identified that the usage of different heat transfer package majorly contributed to such difference instead of the two-dimensional conduction. Finally, the total CPU time used in the calculation with 22 axial volumes representing the core was about 3.4 times of that used in the base calculation in which 11 axial volumes were involved.

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ACKNOWLEDGMENTS

The anthors wish to gratefully acknowledge the assistance provided by R.G. Hanson, G.E. Wilson, Y.S. Chen, and D. Bessette in the course of this work. The authors also want to thank Ms. Y.F. Ju for her enduring effort in typing this report.

1. INTRODUCTION

The assessment study documented in this report is expected to contribute 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. In addition, the ICAP has the objective of providing the necessary data base for the qualitative characterization of computer code when applied in a best-estimate fashion to hypothetical accident scenarios.

This report includes the results and conclusions of assessment study involving comparisons between data from Semiscale Test S-06-3 [1] and RELAP5/MOD2 [2] code calculation. Test S-06-3 was performed as part of the Semiscale Mod-1 portion of the Semiscale Program conducted by EG&G Idaho, Inc., for the United States Government. This test was part of the LOFT counterpart test series (Test Series 6) performed to investigate the response of the Mod-1 system to specific variations in the peak power densities of the heater rods to assist the LOFT program in the planning of the first LOFT nuclear test series. The test objective specific to Test S-06-3 was to determine the maximum cladding temperature associated with a high powered rod peak power density of 39.4 kW/m, or 75% of the maximum high powered rod peak power density of 52.5 kW/m. In addition, Test S-06-3 was designated as a Nuclear Regulatory Commission standard problem.

The assessment of RELAP5/MOD2 using Test S-06-3 specifically focused in the area of system blowdown, in-vessel water level variations and fuel rewet. Particularly, since steam binding was observed in the downcomer during the early phase of the test, the effect of counter-current flow limit (CCFL) was also investigated. Also examined were the sensitivities of several different modelings which included the radial connections between core hot and average channels, cross-flow junctions on the vessel entrances, maximum number of heat slab axial interval for 2-D reflood calculation, number of axial hydraulic volumes representing the core, reflood calculation, and noding of pressurizer.

The following two sections of this report contain a description of the test and RELAP5/MOD2 modeling techniques employed in the calculation. The fourth section includes comparisons of calculated results to the test data and associated sensitivity studies. Before the final section of conclusions and recommendations is the run statistics statement.

2. TEST FACILITY AND TRANSIENT DESCRIPTION

2.1 Test Facility

The Semiscale Mod-1 system used for this test consisted of a pressure vessel with internals, including a 40-rod core with 36 electrically heated rods; an intact loop with steam generator, pump, and pressurizer; a broken loop with simulated steam generator, simulated pump, simulated reflood bypass lines, LOFT counterpart nozzles, and two rupture assemblies; a coolant injection accumulator for the intact loop; high and low pressure coolant injection pumps for the intact loop; and a pressure suppression system with a suppression tank, and heated steam supply system. Semiscale Mod-1 experimental system configuration information is provided in Reference 3. Figure 2-1 shows the system configuration for Test S-06-3.

For Test S-06-3, the 40-rod electrically heated core as shown in Figures 2-2 and 2-3, was operated at an axial peak power density which was 75% of the maximum peak power density (52.5 kW/m). Four rods (Rods D-4, D-5, E-4, and E-5) were operated at approximately 39.4 kW/m, 32 rods were operated at approximately 24.9 kW/m, and four rods (Rods C-4, D-6, E-3, and G-6) were unpowered to simulate LOFT passive rod locations. This configuration yielded a peaked power profile which simulates that of LOFT and provides a total core power of approximately 1.004 MW.

To achieve the desired objectives during the LOFT counterpart test series, it is necessary that the Mod-1 electrical heater rods behave in a manner that will produce the same results as those expected from the LOFT nuclear rod. To accomplish this, the Mod-1 core power must be controlled to compensate for differences between the electrical and nuclear rod thermal-physical properties. This control is based on analytical results obtained from the LOFT RELAP4/MOD5 "Hot Pin" model calculations [4]. From these results two parameters (heat transfer coefficient and fluid temperature) are used as boundary conditions for a one dimensional heat conduction model of a Mod-1 electrical rod. The Mod-1 core power is then iterated upon until a core power transient is found that will produce, within a certain accuracy, the same cladding temperature (and consequently surface heat flux) as that calculated by the LOFT "Hot Pin" model.

The Mod-1 system broken loop was subjected to simulating a double-ended cold leg break through two rupture assemblies and two LOFT counterpart nozzles, each having a break area of 0.000243 m^2. In this broken loop, the pump and steam generator were simulated with due resistances. For example, the broken loop pump was simulated with an orifice having loss coefficient equal to 8.97.

The performance of the system during test was monitored by 224 detectors. The data obtained were recorded on both digital and analog data acquisition systems. Processing analysis has been performed only to the extent necessary to obtain appropriate engineering units and to ensure that the data are reasonable and consistent. In all cases, in converting transducer output to engineering units, a homogeneous fluid was assumed. Further interpretation and analysis should consider that sudden decompre-ssion processes such as those occurring during blowdown may have subjected the measuremnt devices to nonhomogeneous fluid conditions.

2.2 Transient Description

Test S-06-3 was performed as part of the Semiscale Mod-1 portion of the Semiscale Program conducted by EG&G Idaho, Inc., for the United States Government. This test was part of the LOFT counterpart test series (Test Series 6) performed to investigate the response of the Mod-1 system to specific variations in the peak power densities of the heater rods to assist the LOFT program in the planning of the first LOFT nuclear test series. Hardware configuration and test parameters were selected to yield a system response that simulates the response of the LOFT nuclear facility during the first nuclear test series.

The test was conducted from initial conditions of 15769 kPa and 563 K (at the intact loop cold leg vessel inlet) with a simulated full size (200%) double-ended offset shear of the broken loop cold leg piping at an initial core power level of 1.004 MW, and an initial core inlet flow rate of 6.68 l/s. The instantaneous offset shear of the broken loop cold leg piping was simulated by simultaneous (within 10 ms) actuation of the rupture assemblies. After initiation of blowdown, power to the heated core was reduced to simulate the predicted heat flux response of nuclear fuel rods during a loss-of-coolant accident. Blowdown was accompanied by simulated emergency core coolant injection into the cold leg piping of the intact loop. Coolant injection from the high pressure injection system pump began at blowdown and continued until test termination. Coolant injection from the accumulator started approximately 18.5 seconds after rupture at a system pressure of 4200 kPa and continued to depletion at 68 seconds after blowdown. Low pressure coolant injection began 25.5 seconds after rupture at a system pressure of 1900 kPa and continued until test termination. The core power was tripped off at 300 seconds after rupture and the test was terminated.

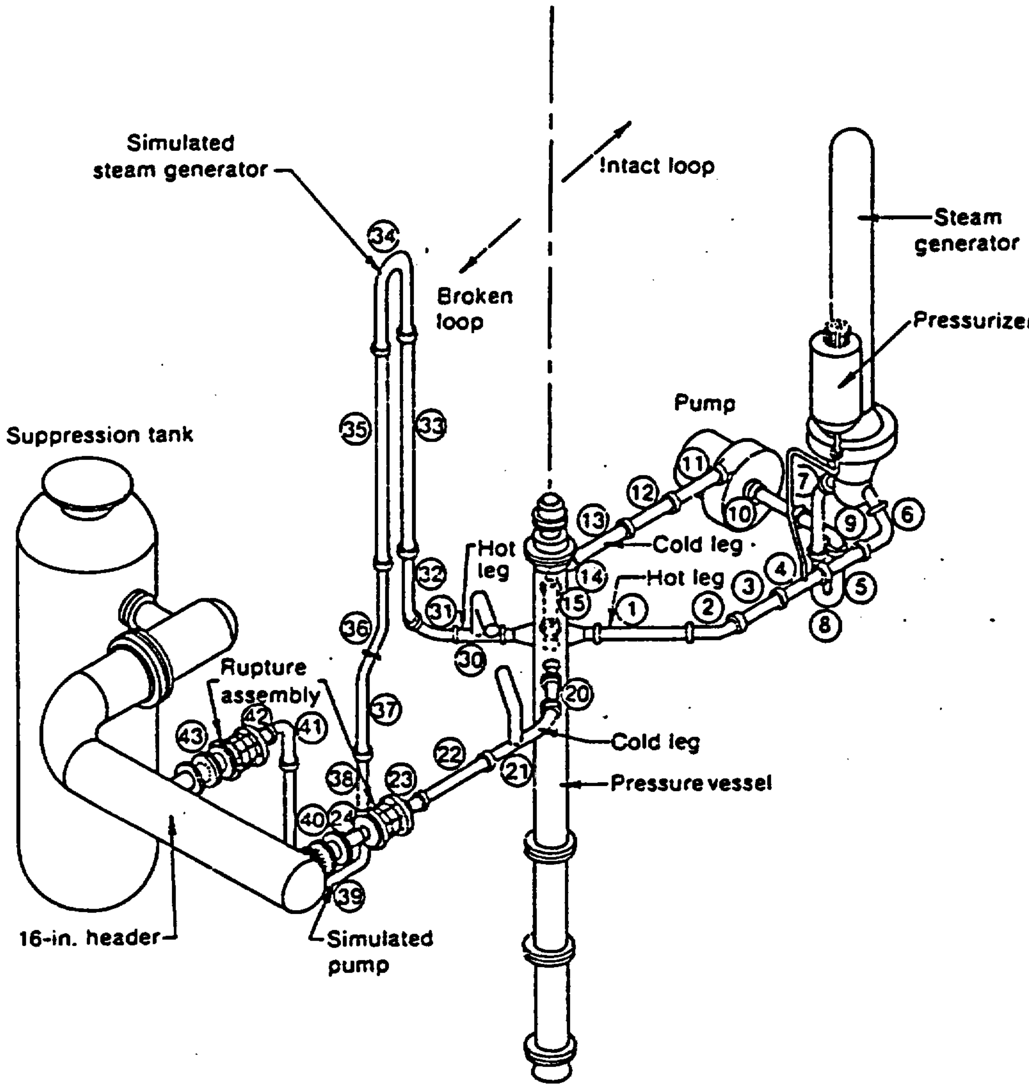

Fig. 2-1. Semiscale Mod-1 System for Cold Leg Break Configuration-Isometric

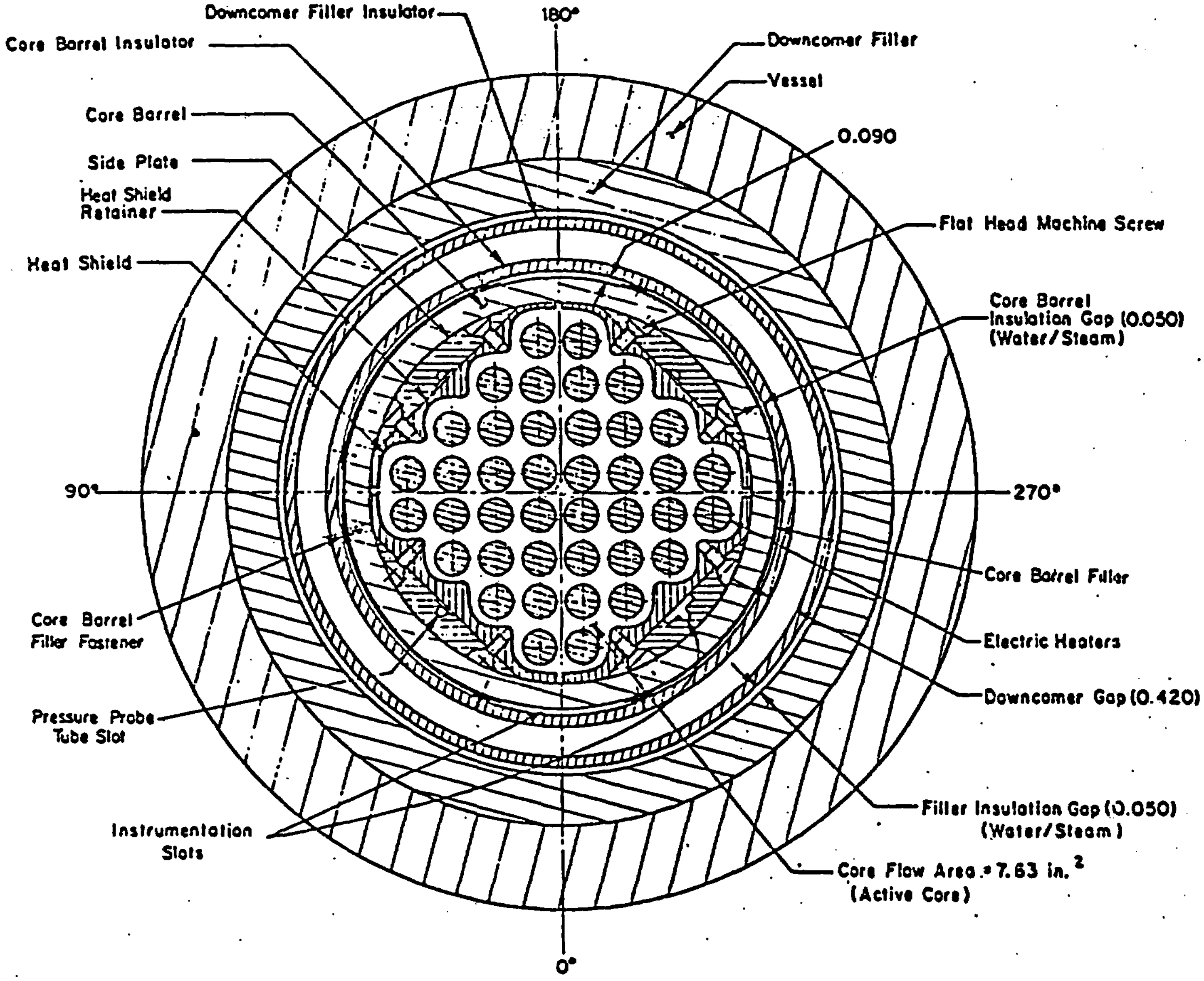

Fig. 2-2. Electric Heater Rod Matrix for Mod-1 Core

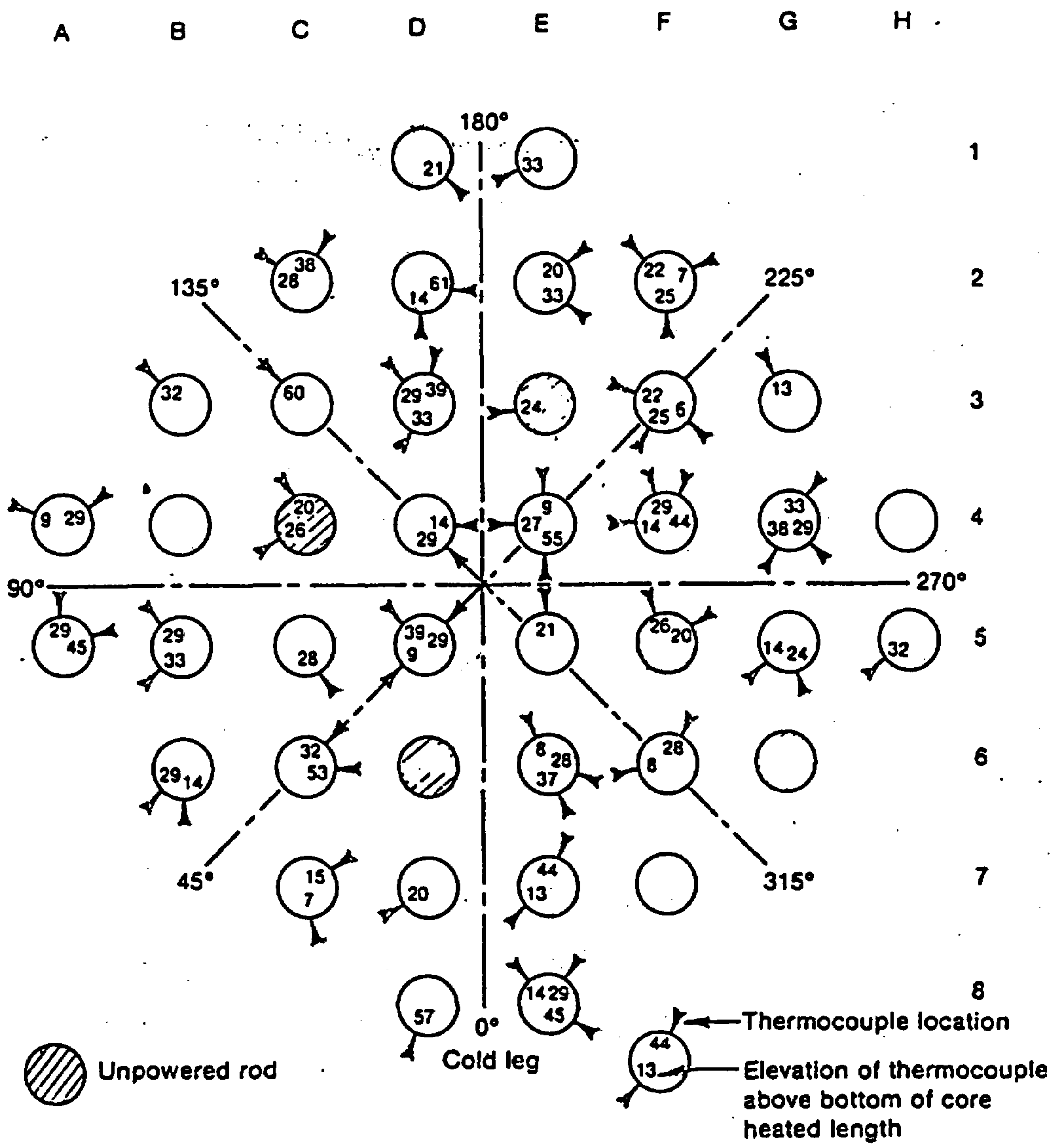

Fig. 2-3. Semiscale Mod-1 Heated Core Plan View

3. MODELING DESCRIPTION

3.1 RELAP5/MOD2 Modeling

RELAP5/MOD2 is an advanced one-dimensional system analysis computer code developed at the INEL for the U.S. Nuclear Regulatory Commission (NRC). The principal feature of the RELAP5 series is the use of a two-fluid, non-equilibriumm non-homogeneous hydrodynamic model for transient and accident simulation of a two-phase system. Instead of only five equations used in the RELAP5/MOD1 version, RELAP5/MOD2 employs a full non-equilibrium, six-equation two-fluid model.

In this report, test data of Semiscale S-06-3 were used to assess version 36.04 of RELAP5/MOD2. In modeling of Semiscale Mod-1 system, a total of 95 hydraulic volumes, 107 junctions and 64 heat strustures were used, as shown in Figure 3-1. In modeling of the reactor core, a total of 22 volumes were used to represent the core hydraulic space, which included both average and hot channels in parallel. Besides, 11 cross-flow junctions were also used to model radial connections between both average and hot channels. In modeling of both average power rods (32) and hot rods (4), a total of 22 heat strustures were used with half set for each, in which the maximum number of axial interval for 2-D reflood calculation was set to 8 in the base model. In modeling of other parts of the pressure vessel, three volumes were used to model each lower and upper plena with attached heat slabs to simulate structure material, and annulus components having 6 volumes were used to model vessel downcomer also with heat slabs attached.

In modeling of the pressurizer attached on the intact loop, 13 volumes were used to model the pressurizer vessel and 3 volumes were used to simulate surge line. In modeling of the steam generator on the intact loop, six volumes were used to repesent the primary side with inlet and outlet plena included, and six volumes were used for the secondary side which included a downcomer and a separator. While in the modeling of the broken loop steam generator, only two volumes were used for the primary side with suitable resistances. In modeling of pumps, due pump component was used for the intact loop coolant pump. As for the broken loop pump modeling only a junction with adequate loss coefficient (K=8.97) was adopted.

In modeling of emergency core cooling system (ECCS), only three sets of time-dependent volumes and junctions were used to simulate each sub-system, which consisted of the high pressure injection system, the low pressure injection system and the accumulator.

In modeling of the double-ended cold leg breaks, two normal junctions with due area and chocking flag on were used to simulate both near pump and near vessel breaks. Two identical time-dependent volumes connected to each break junction were used to represent the pressure suppression tank.

In addition to the system modeling, adequate control variables were generated so that direct comparison with data could be made. Those reproduced parameters included the collapsed water levels, fuel temperatures and so on. All input data are listed in the Appendix.

3.2 Assumptions and Initial Conditions

In simulating the Semiscale S-06-3 test, following assumptions were made so that undesired calculation uncertainties could be avoided:

(1) All ECCS injection flow rates including high pressure injection, low pressure injection and accumulator were provided as boundary,

(2) Recorded pressure history in the pressure suppression tank was provided as boundary,

(3) Measured power variance supplied to heater rods was provided,

(4) Measured intact loop pump speed was also provided, and

(5) Because the measured cladding temperature was actually obtained 0.076 cm below the surface of the cladding, associated heater internal mesh temperature was used to compare instead of heater surface temperature.

Steady state was achieved by using some initialization techniques including pressurizer desired pressure and water level control, desired loop flow control and etc.. The resulting initial condition is listed in Table 3-1. The calculated and measured initial conditions [1] are matched quite well.

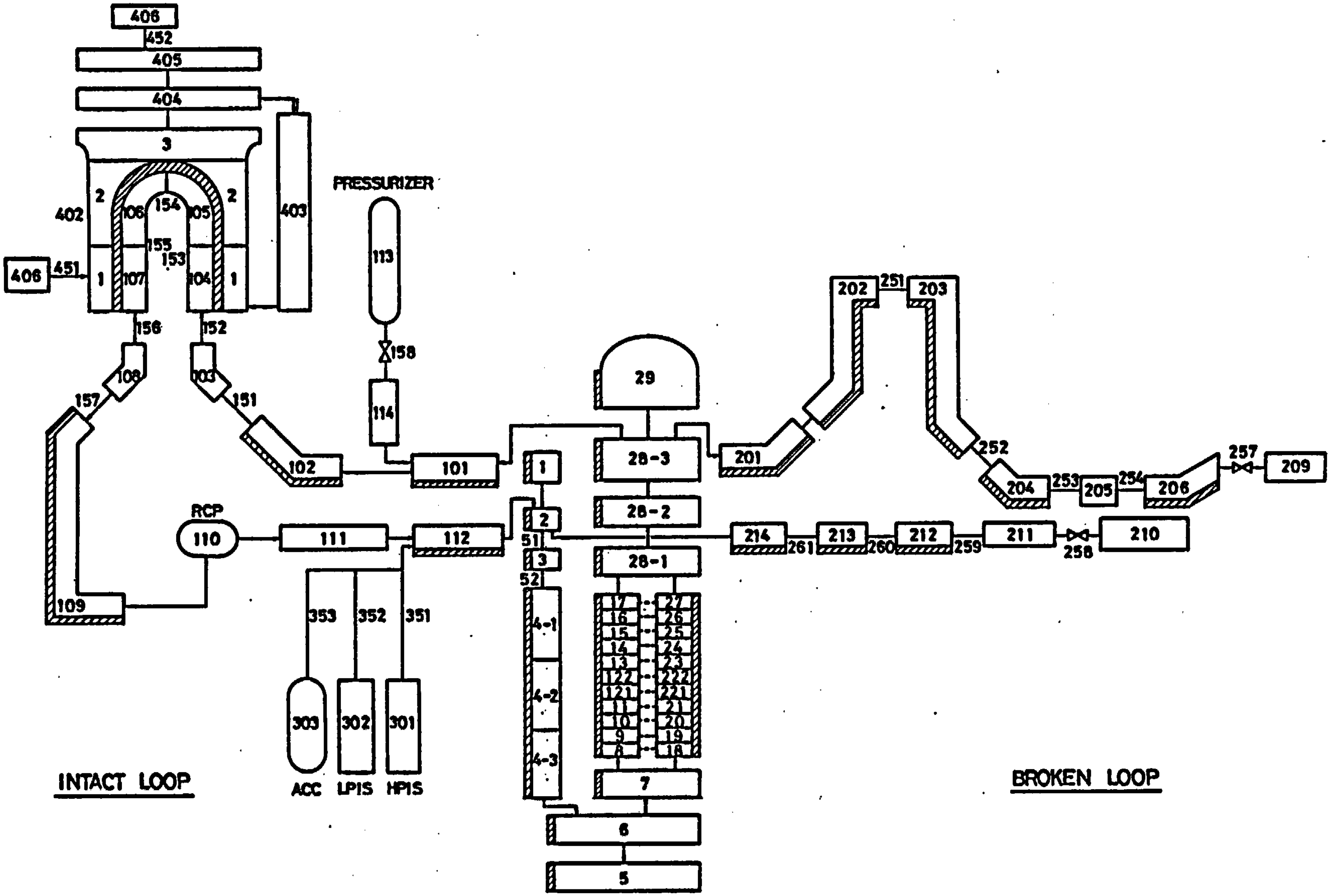

Fig. 3-1. Semiscale Mod-1 System Noding Diagram

Table 3-1 Comparison of Calculated and Measured Initial Conditions

Parameter	Measured	RELAP5
Core power (MW)	1.004	1.004
Intact loop cold leg fluid temperature (K)	563.0	563.0
Intact loop hot leg fluid temperature (K)	598.0	598.0
Broken loop cold leg fluid temperature (K)	562.0	562.0
Broken loop hot leg fluid temperature (K)	591.0	591.0
Intact loop cold leg flow (l/sec)	6.68	6.68
Pressurezer pressure (MPa)	15.769	15.766
Pressurizer liquid mass (kg)	9.09	9.09
S.G. Secondary side pressure (MPa)	6.55	6.53

* Uncertainties of each measurement are discussed in Reference 1

4. RESULTS

In this section, analytical results from the base modeling elaberated above are compared to the test data. Besides, effects of several different modelings are also independently investigated to ensure that results are within reliable domain.

4.1 Comparison with Measurement

Included in this subsection is comprehensive comparisons of the calculated results and measured data. The whole test can be classically divided into three different phases, namely blowdown, refill and reflood. In general, the blowdown phase is characterized by a fast system depressurization and finally the system is in equilibrium with the surroundings. During this phase large part of fuel rods will experience critical heat flux (CHF) due to rapid loss of reactor coolant. In the second refill phase, owing to the activation of injections ECCS, emergency coolant begins to accumulate in the reactor vessel. Once the lower plenum is filled up, this phase is terminated by defination. Because of continuous ECCS injections, vessel water level will keep on ascending up to the active core in the last reflood phase and finally all fuel rods will be rewetted again.

4.1.1 Blowdown Phase (0-35 seconds)

After the artificial rupture took place in the broken loop, the primary system began to blowdown. The resulting break flow rates at two ends from both simulation and measurement are shown in Figures 4-1 and 4-2 respectively. Observing the break flow near the pump side, it can be found that the steam break flow rate seemed to be underpredicted a little. As for the break flow rate near the vessel side, they both matched quite well until the ECCS flow bypassed to the broken loop. When ECCS water bypassed to the broken loop cold leg, break flow rates from calculation and test began to oscillate. Nevertheless, oscillation magnitudes were little different.

The pressureizer pressure responses are compared in Figure 4-3. It can be observed that they also matched quite well except the timing of pressure inflection point. This inflection difference basically was caused by different pressurizer empty time. As well known, the pressurizer empty would cause an inflection of pressurizer pressure. To illustrate this feature, pressurizer outsurge flow rates are also compared, as shown in Figure 4-4. It is clear that the empty time exactly corresponded to each pressure inflection point. The late prediction of the pressurizer empty may come from several reasons. Among them are the modelling of heat transfer between liquid and vapor space, the stored heat of pressurizer vessel and the form loss of pressurizer surge line.

The intact loop cold leg and hot leg flow rates are shown in Figures 4-5 and 4-6 respectively. The calculated intact loop cold leg flow rate matched the data very well. As for the hot leg flow, the calculated one reversed a little late. Also compared are broken loop flow rates, as shown in Figures 4-7 and 4-8 for cold leg and hot leg respectively. Just the same as the intact loop, the calculated cold leg flow rate matched the data very well until the ECCS injection bypass occurred. With reference to the broken loop hot leg flow, they also matched well except in the early 3 seconds. Other than loop flow rates, the core inlet flow rates are also compared, as shown in Figure 4-9. As a result of ruptures, core flow was suddenly stagnated which was clearly elucidated in this figure.

As a result of system blowdown, water levels in the reactor vessel descended drastically. Collapsed water level responses ($\Delta P/\rho_f$) in the downcomer are shown in Figure 4-10. It can be seen that after the rupture began, water level declined steeply and at the end of blowdown there was almost no water existed in the downcomer. From the comparison, it can be found that the RELAP5 calculation agreed with what was measured. Concerning the water level in the lower plenum, since it is the lowest part of the system, water level in it varied less violently and at the end of blowdown it still detained about one-third of coolant in it, as shown in Figure 4-11. Again, reasonable agreement between calculation and measurement was also observed. Resulting core collapsed water level responses are shown in Figure 4-12. It can be seen that the calculated water level dropped below the active fuel within 5 seconds after ruptures began, which was about 10 seconds ahead of what was measured.

Peak cladding temperature responses of both high and low power rods are also compared. After ruptures began, system pressure would reduce sharply and core flow would quickly drop to zero due to stagnation as depicted above. As a result, fuel rods in the core experienced CHF quickly and consequently fuel cladding temperatures jumped to certain elevated values, as shown in Figures 4-13 and 4-14 for high and low power rods respectively. From the comparison, it can be found that calculated responses had a good agreement with what was measured, especially true for time to CHF.

As for the coolant temperature calculation, superheated steam was observed in the reactor vessel. Calculated coolant temperatures in both lower and upper plena are compared to associated measured temperatures, as shown in Figures 4-15 and 4-16 respectively. From comparisons, it can be found that superheated steam was calculated and reasonable agreement was achieved. In addition, owing to the reversed steam flow through the core the degree of steam superheating in the lower plenum ascended sharply and the resulting steam temperature was even higher than the initial heat slab temperature in this region. Basically, the reversed steam flow through the core was caused by the effect of condensation induced by the accumulator injection [5].

4.1.2 Refill Phase (35-75 seconds)

Before the end of blowdown, emergency cooling water provided

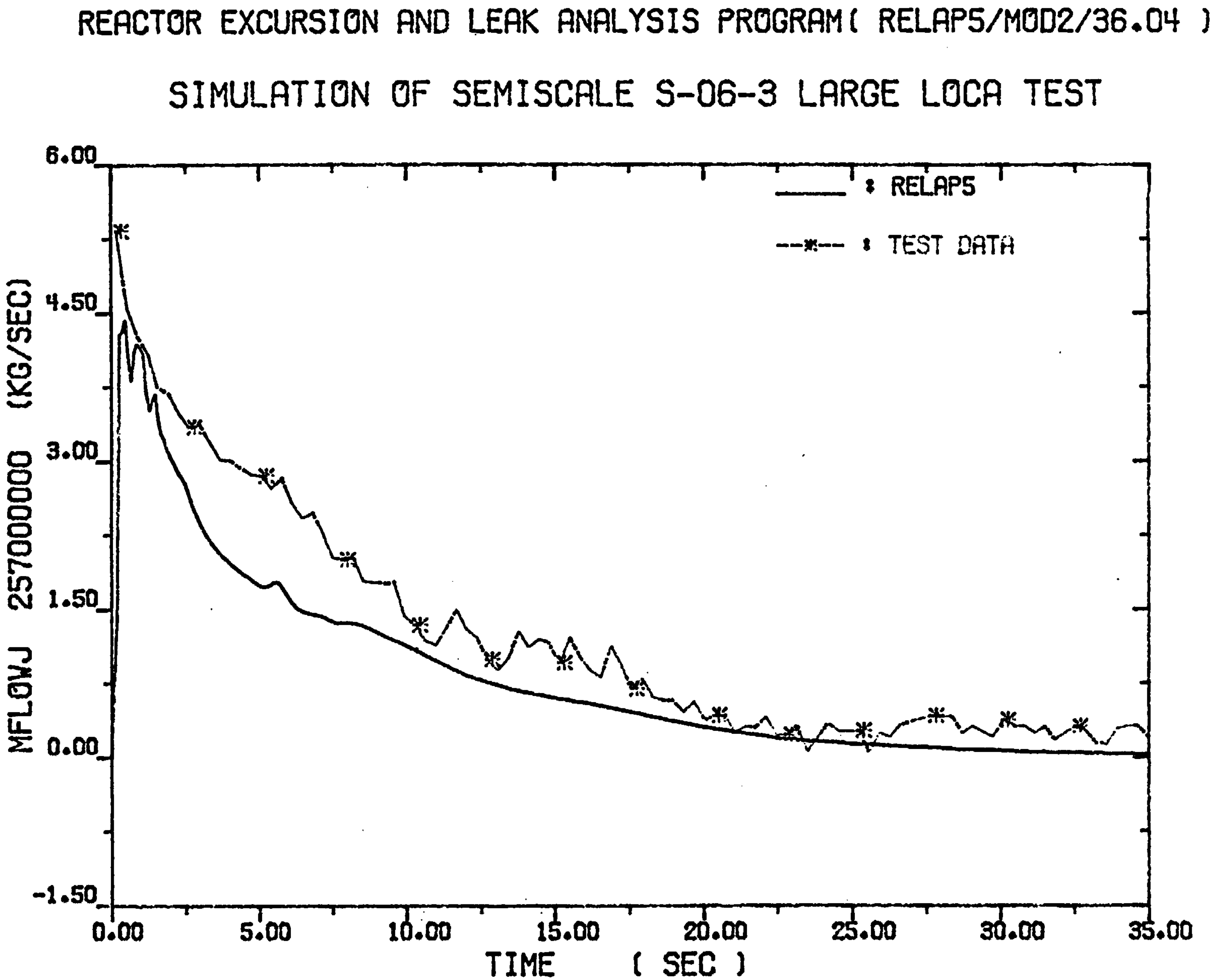

Fig. 4-1. Break Flow Rates near Pump Side

REACTOR EXCURSION AND LEAK ANALYSIS PROGRAM(RELAP5/MOD2/36.04)

SIMULATION OF SEMISCALE S-06-3 LARGE LOCA TEST

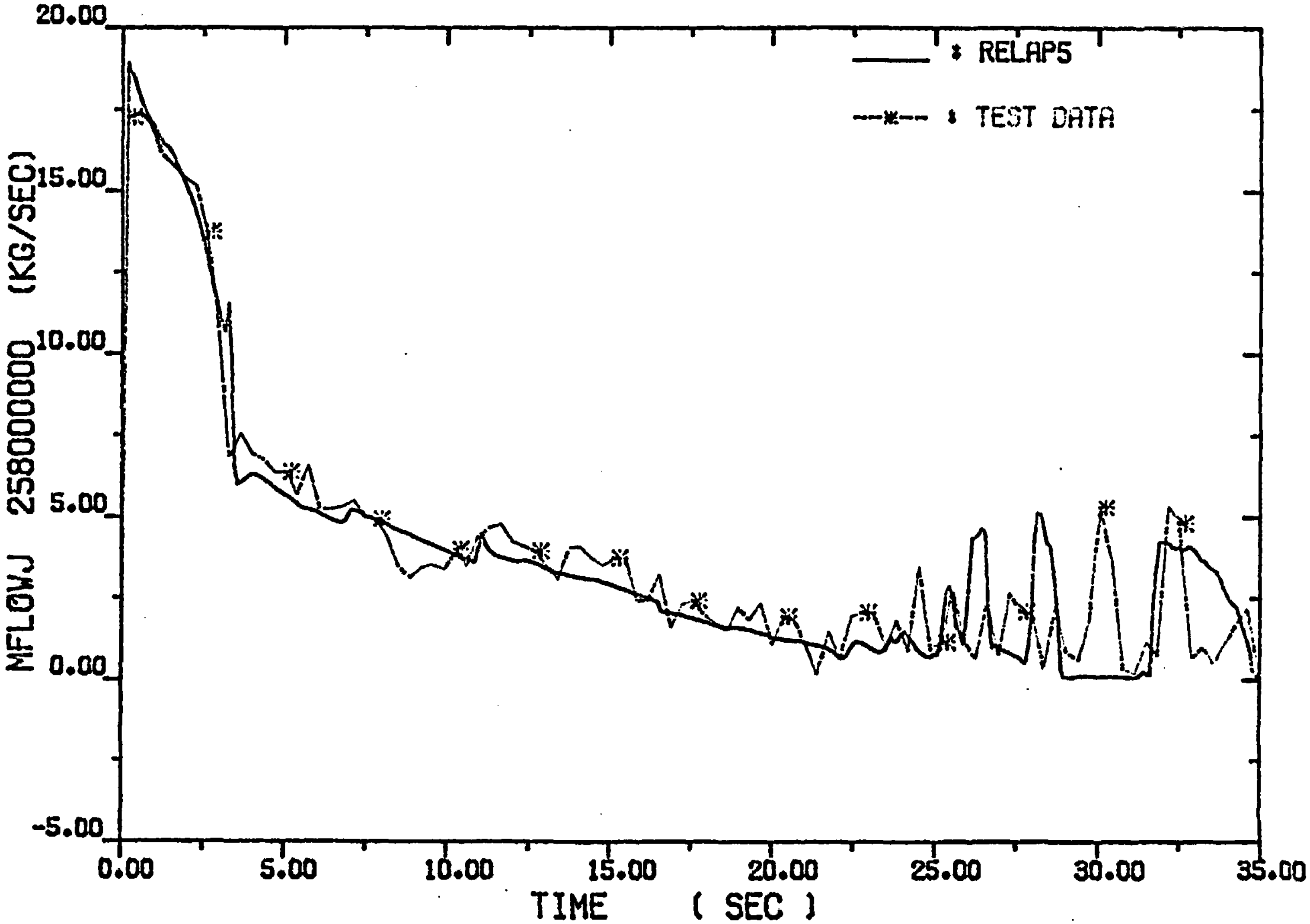

Fig. 4-2. Break Flow Rates near Vessel Side

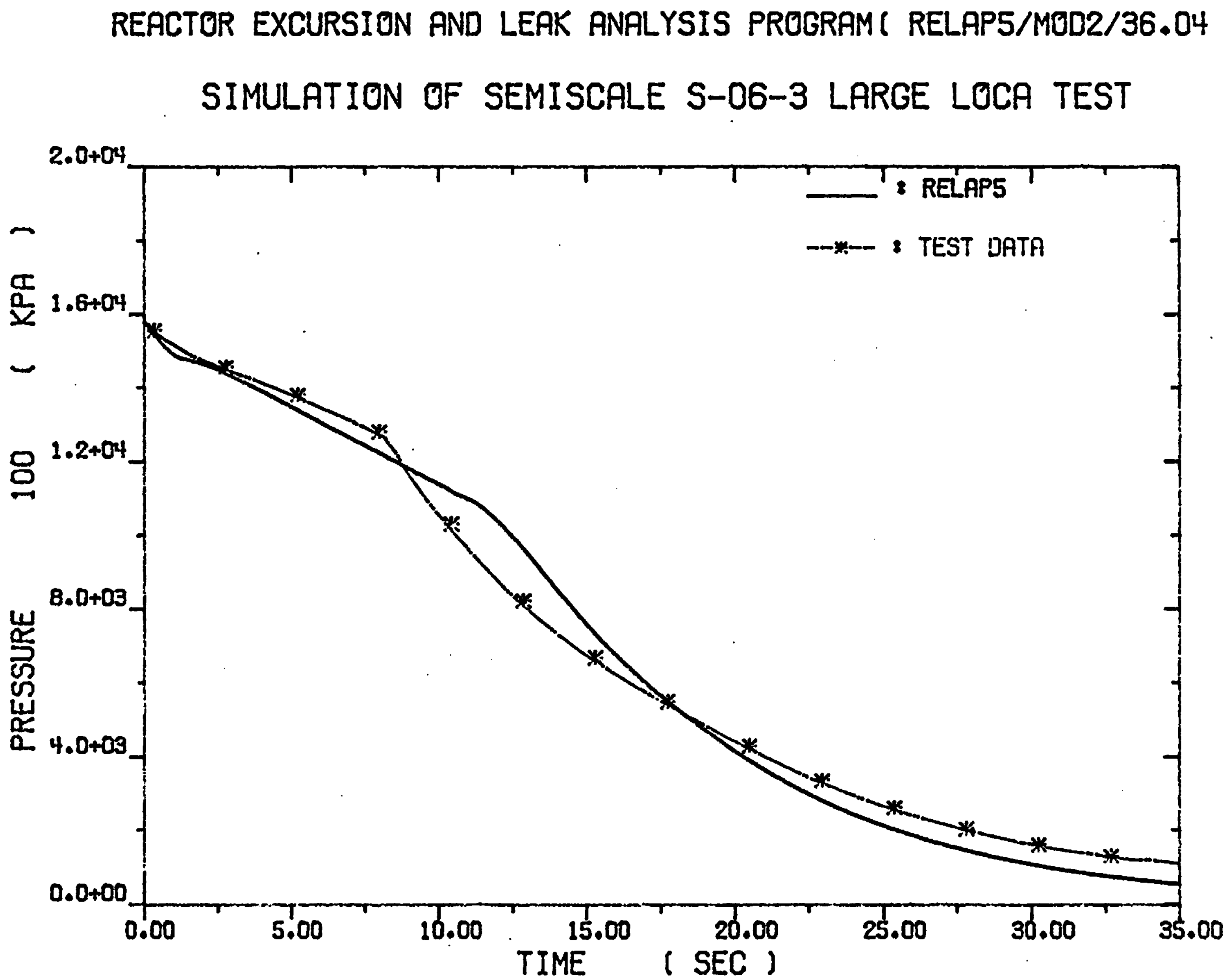

Fig. 4-3. Pressurizer Pressures

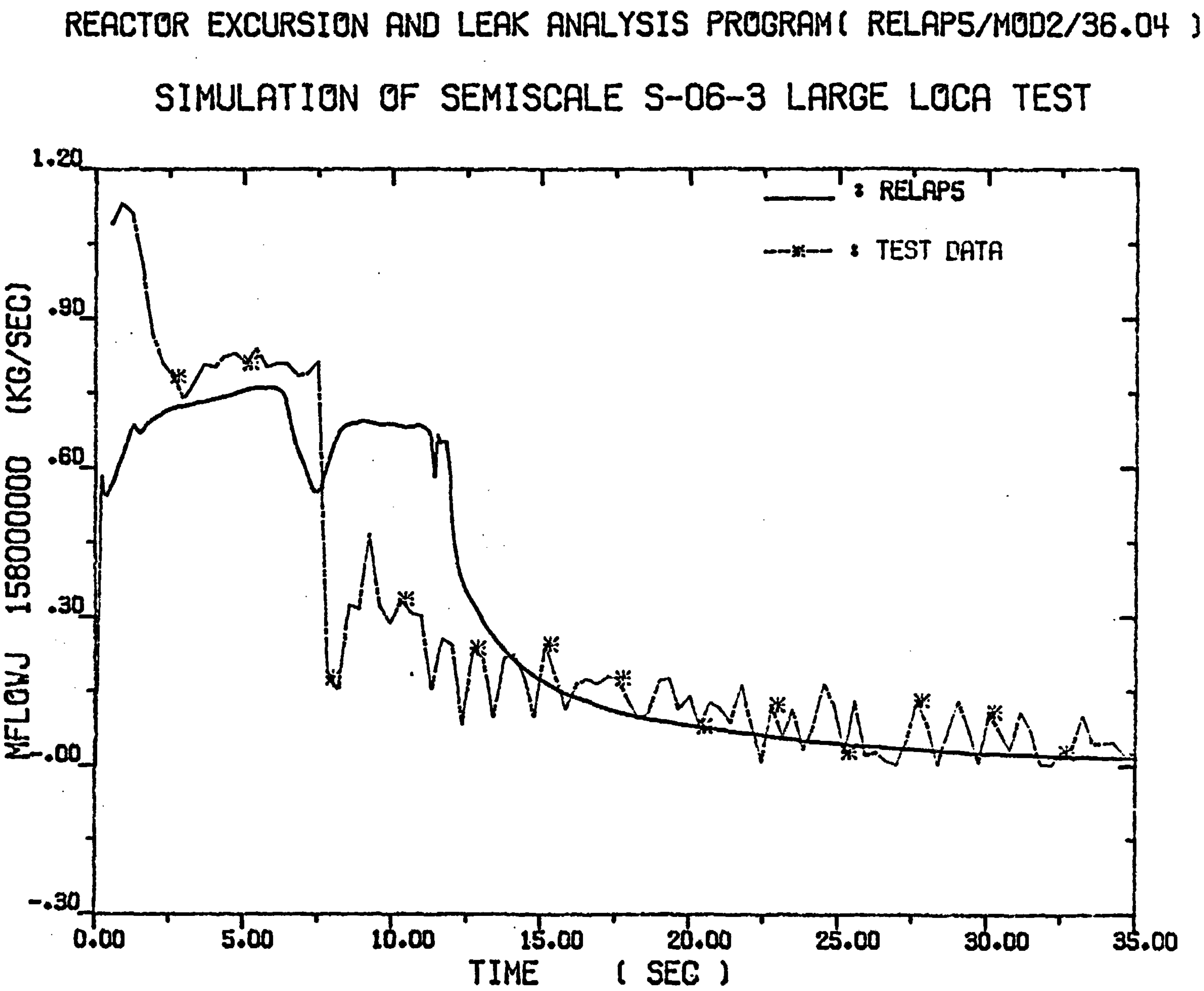

Fig. 4-4. Pressurizer Outsurge Flow Rates

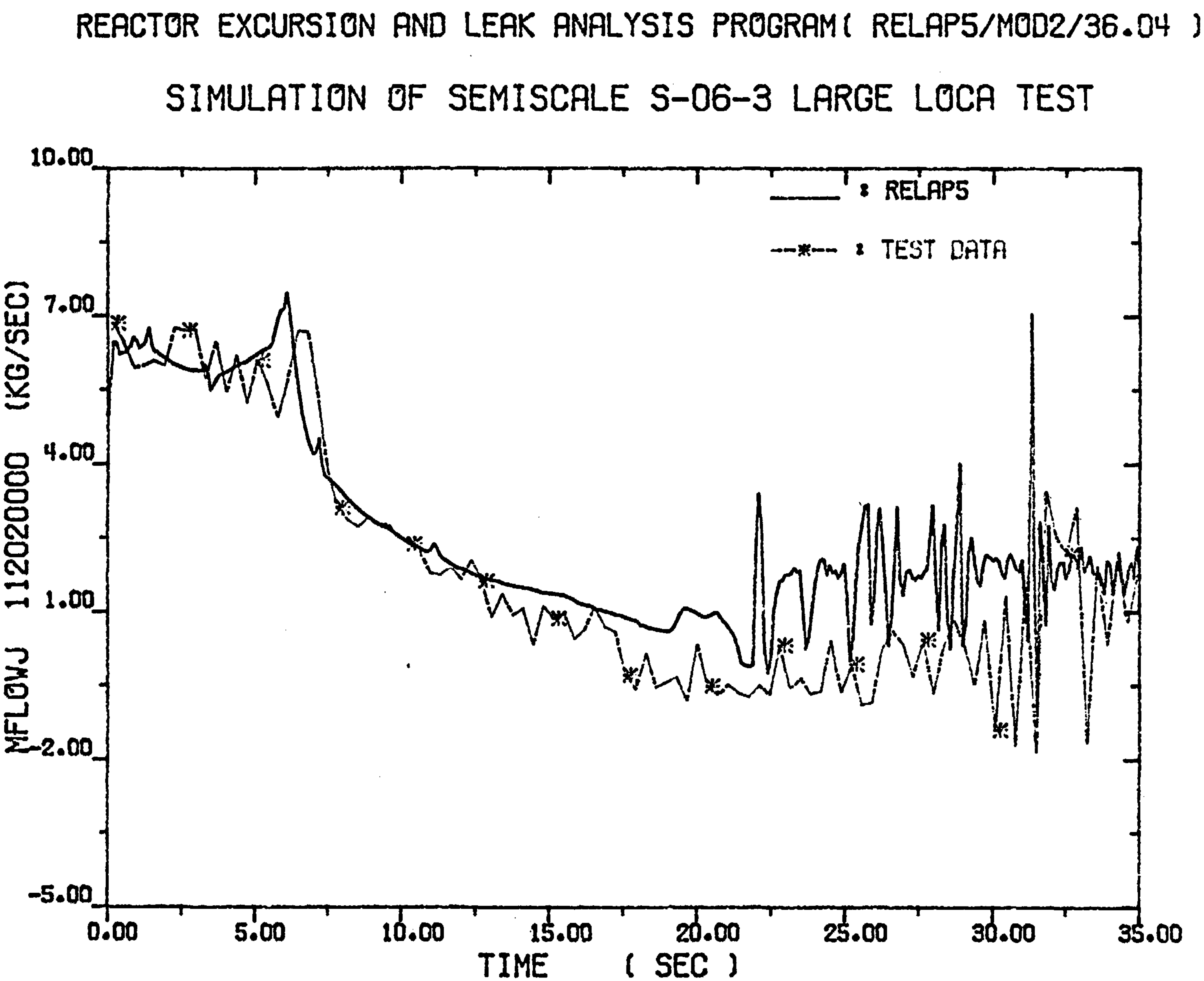

Fig. 4-5. Intact Loop Cold Leg Flow Rates

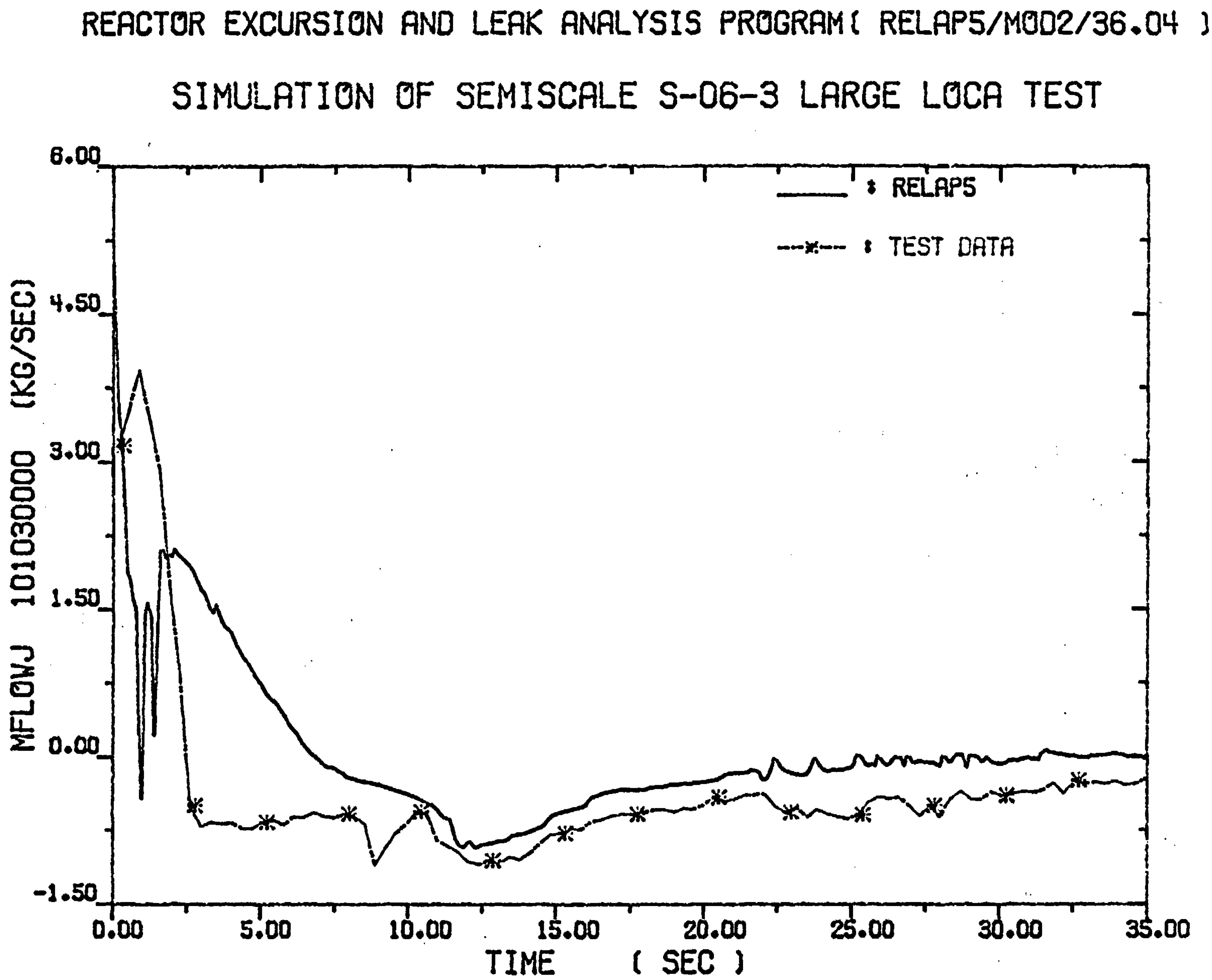

Fig. 4-6. Intact Loop Hot Leg Flow Rates

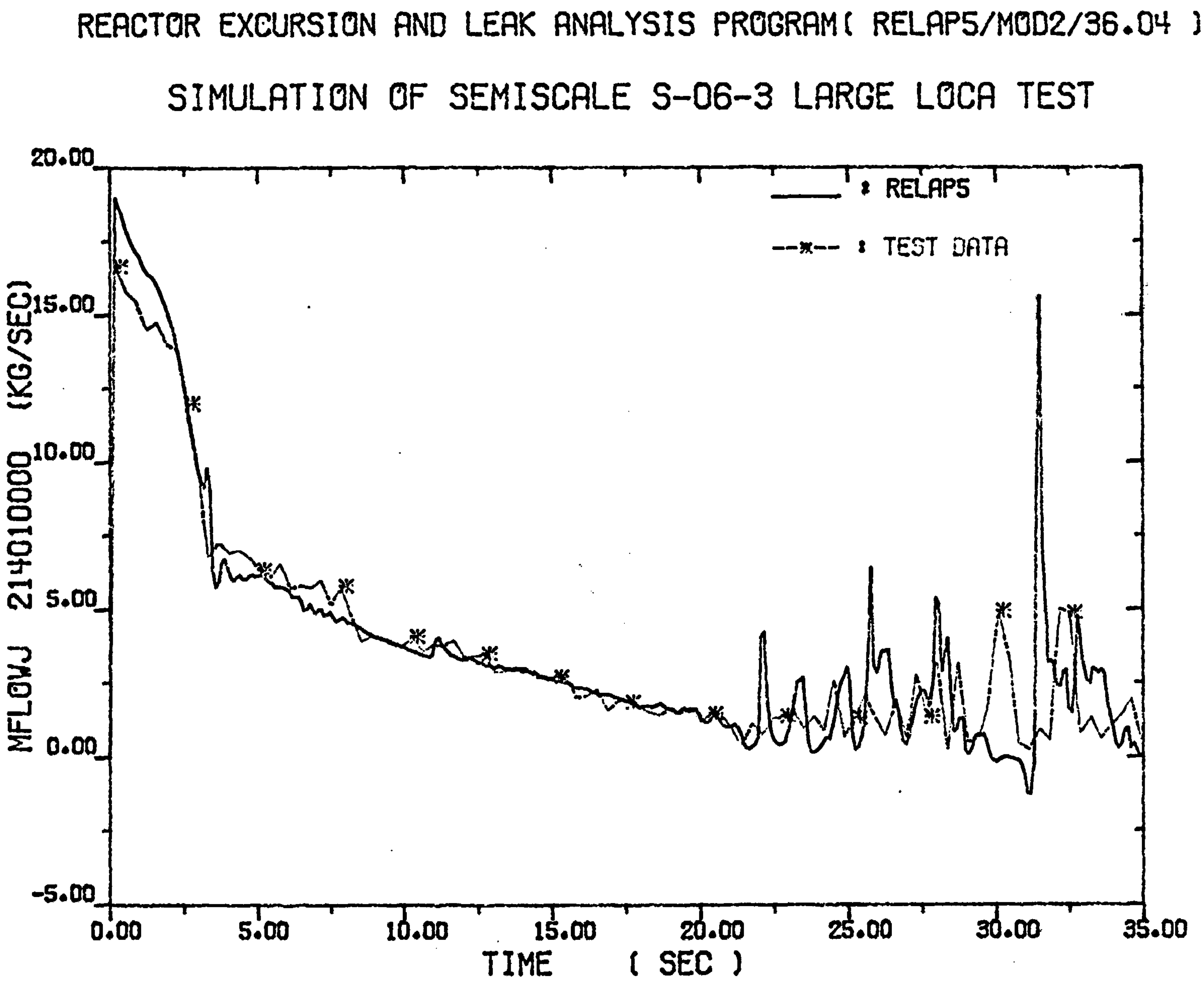

Fig. 4-7. Broken Loop Cold Leg Flow Rates

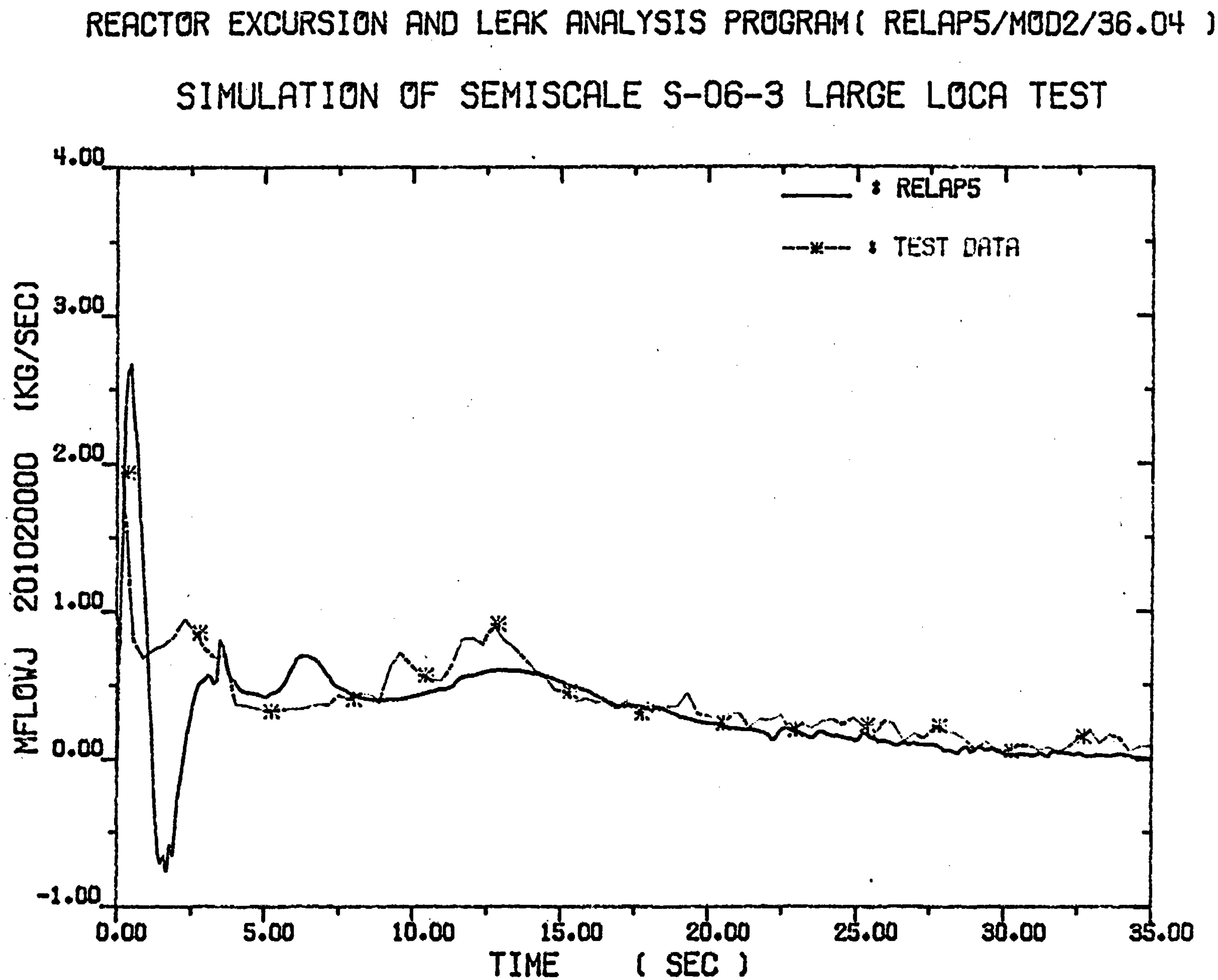

Fig. 4-8. Broken Loop Hot Leg Flow Rates

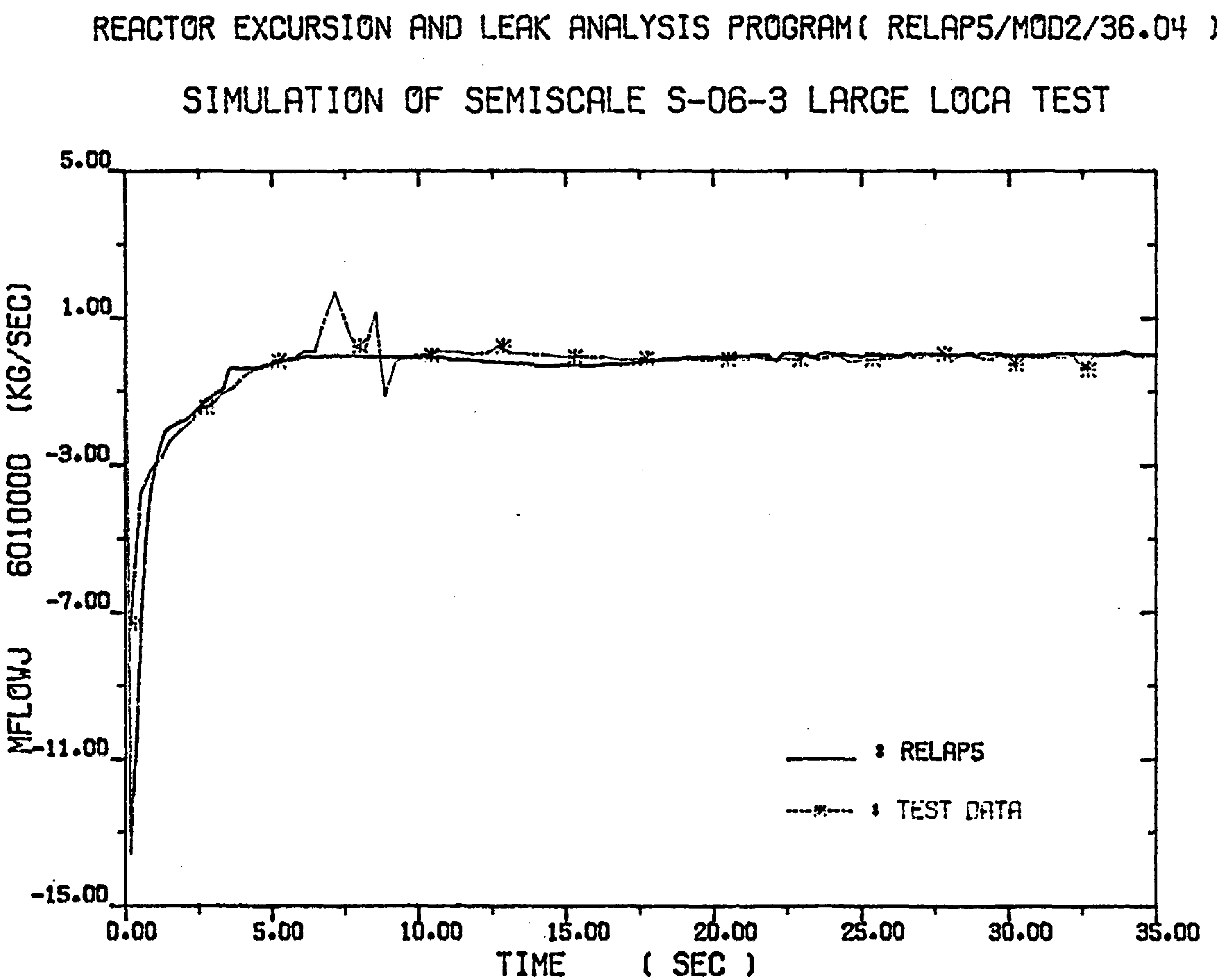

Fig. 4-9. Core Inlet Flow Rates

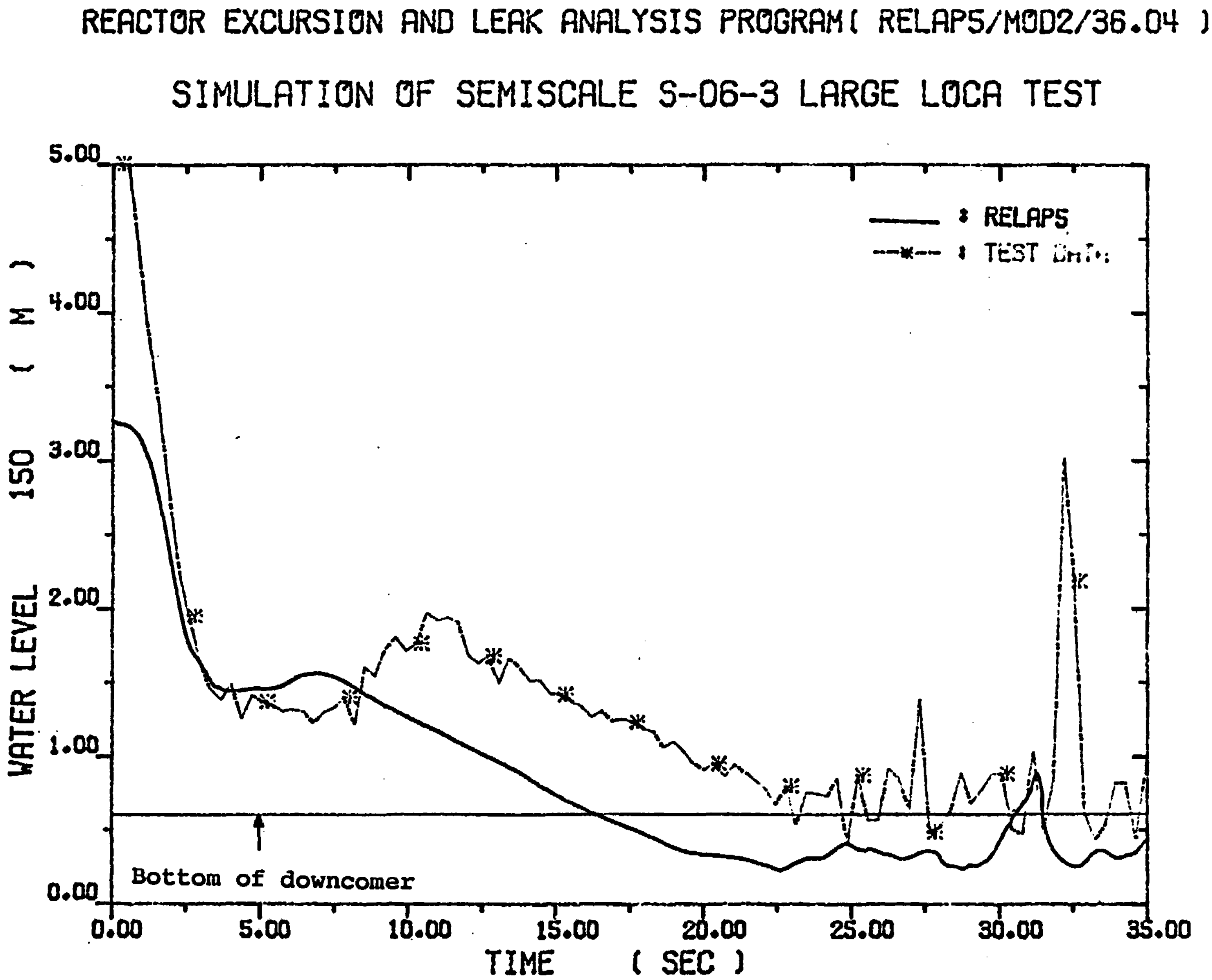

Fig. 4-10. Collapsed Water Levels across The Downcomer

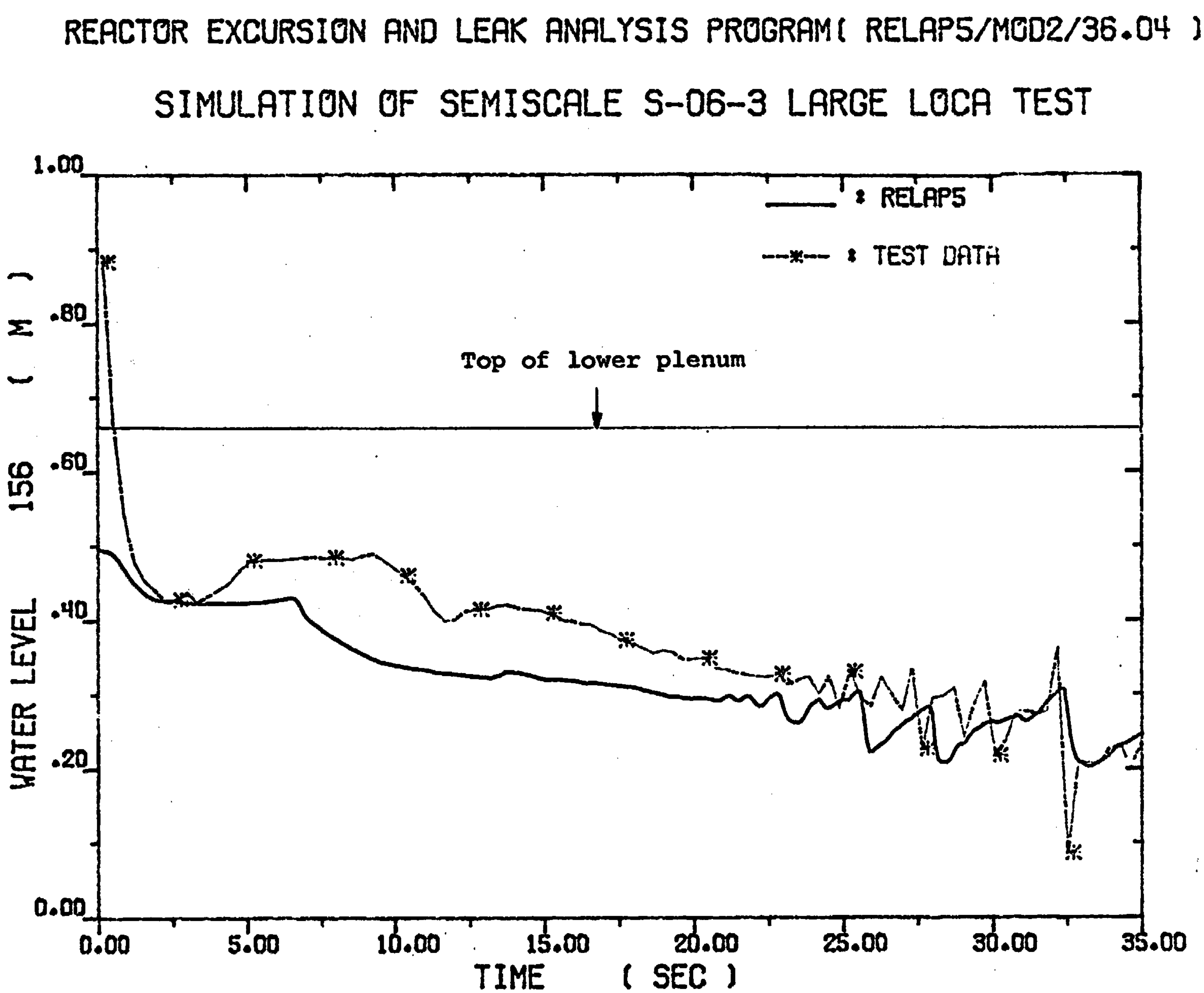

Fig. 4-11. Collapsed Water Levels across The Lower Plenum

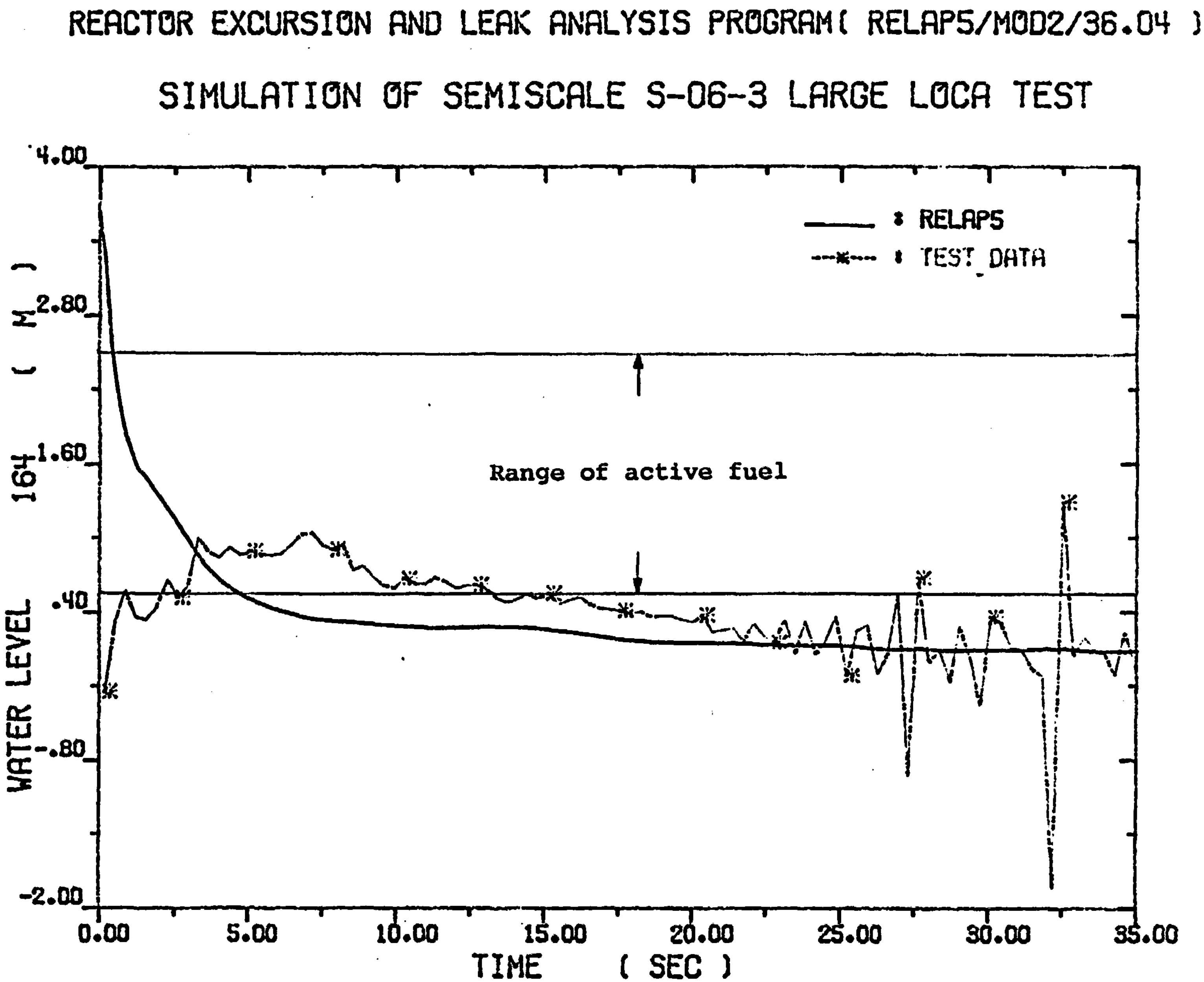

Fig. 4-12. Collapsed Water Levels across The Core

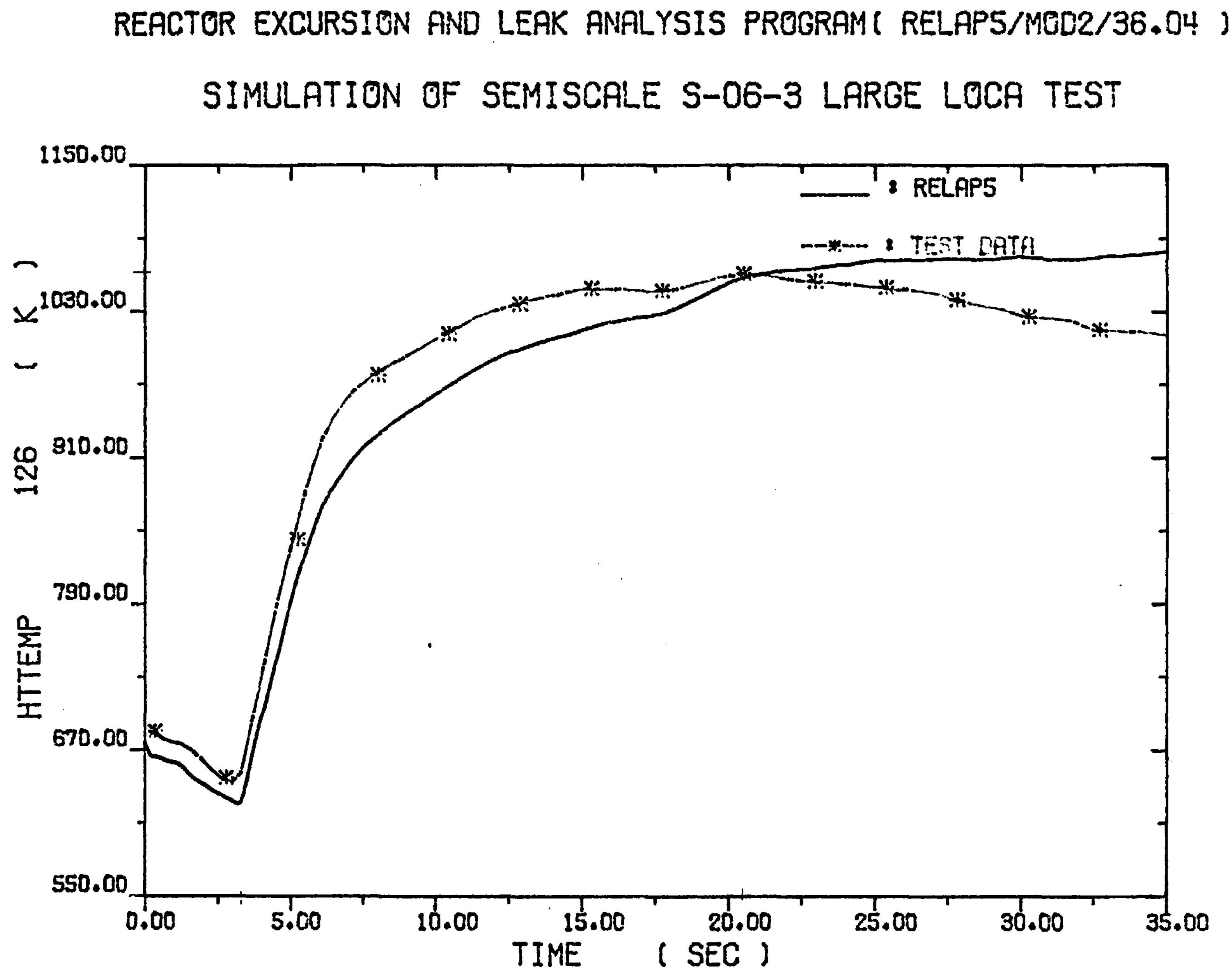

Fig. 4-13. High Power Rod Hot Spot Cladding Temperatures

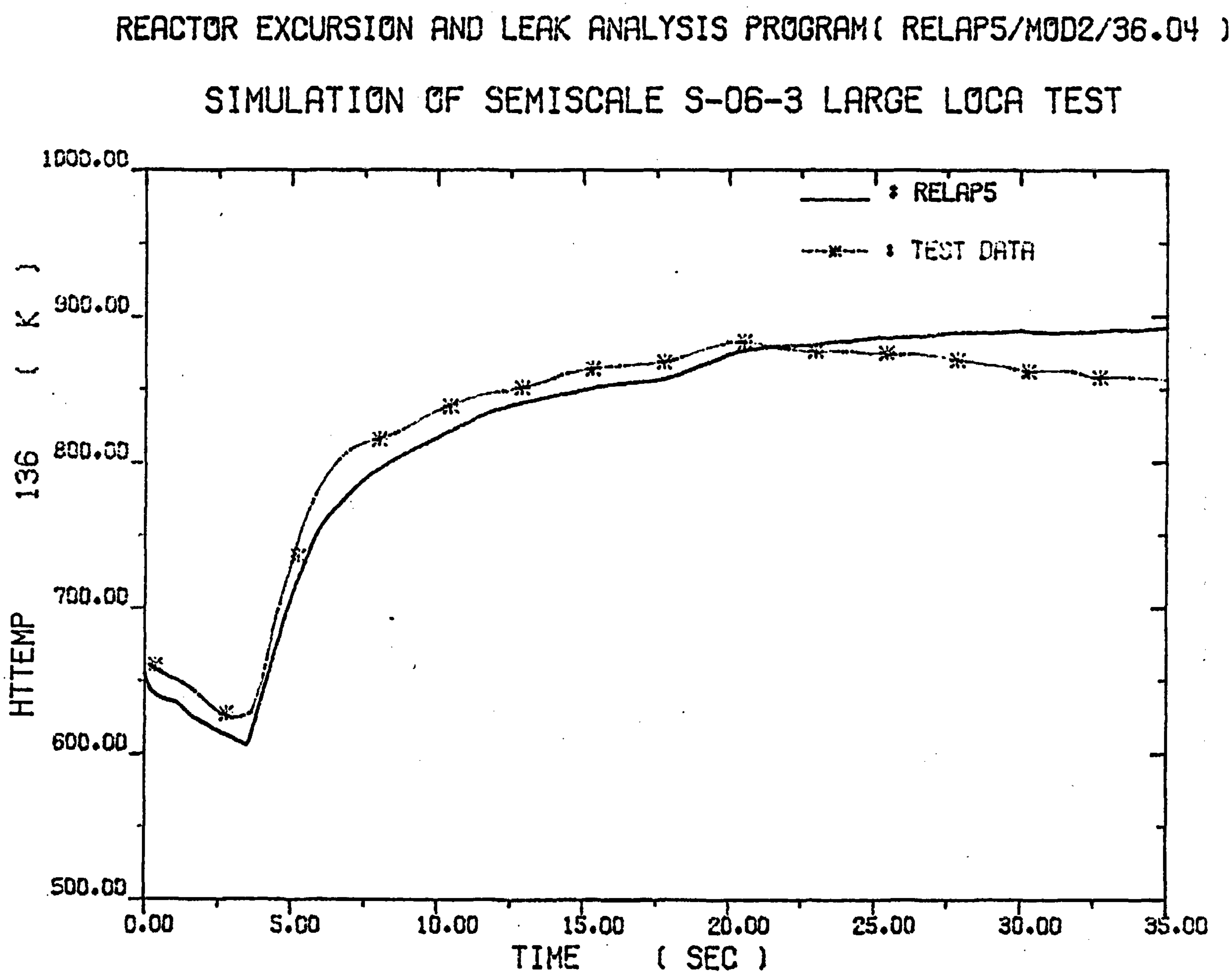

Fig. 4-14. Low Power Rod Hot Spot Cladding Temperatures

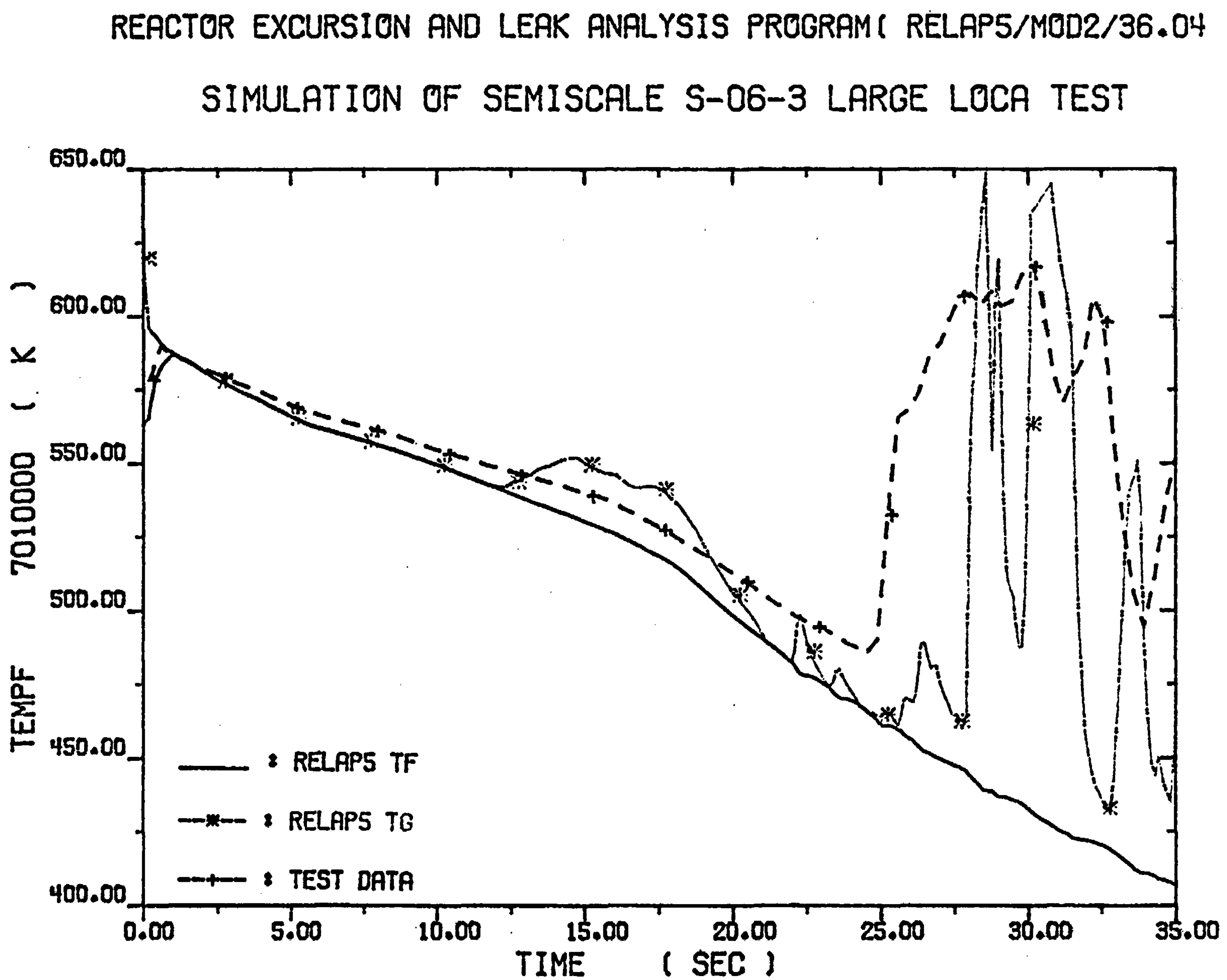

Fig. 4-15. Lower Plenum Coolant Temperatures

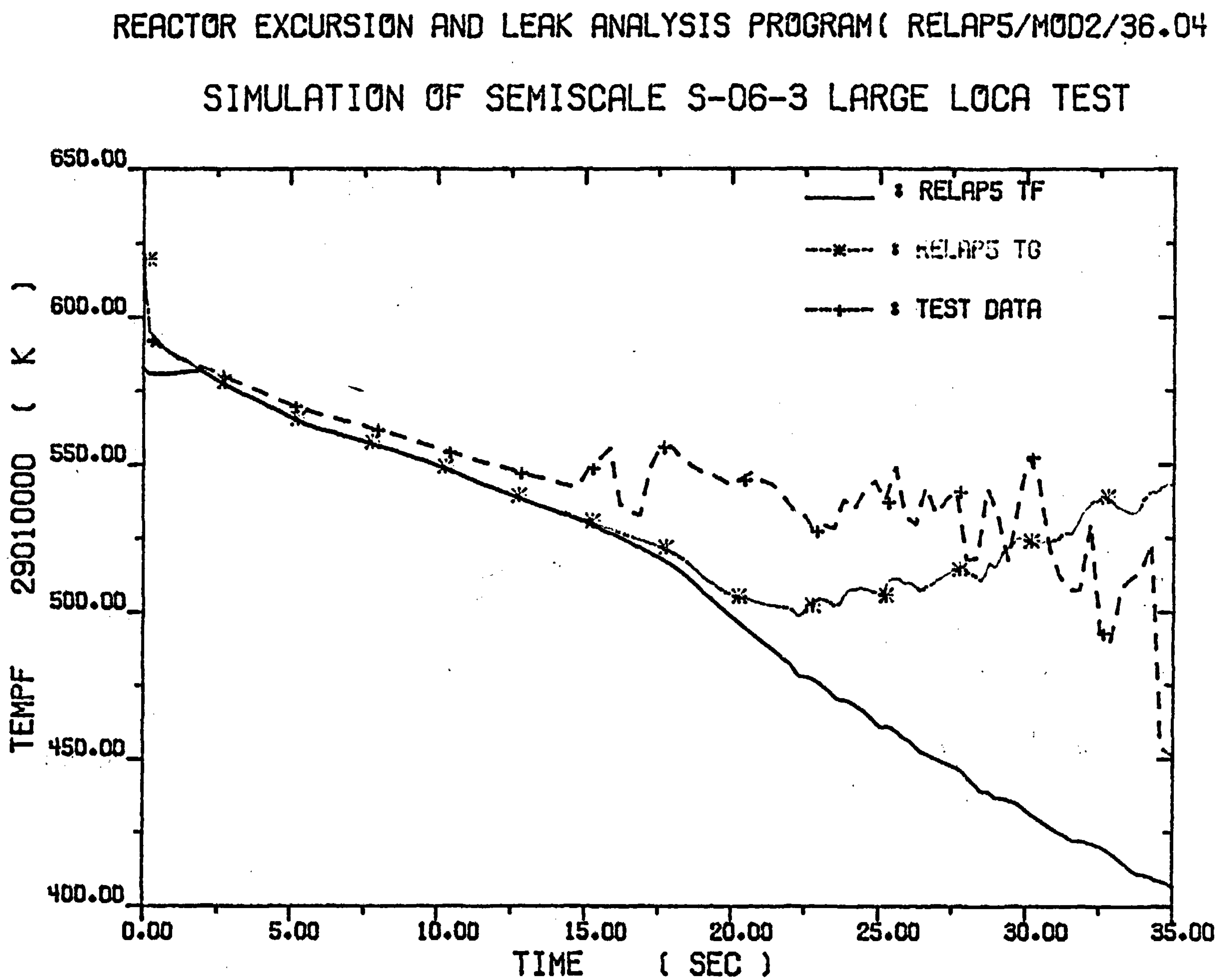

Fig. 4-16. Upper Plenum Coolant Temperatures

by the ECCS would enter the system when system pressure was low enough. In our calculation ECCS injections were provided as a given boundary condition to exclude unnecessary uncertainties.

When accumulator injection began at about 20 seconds, apparent ECC bypass was observed in the test. While in the calculation, due to lack of counter-current flow limit (CCFL) model this phenomenon could not be caught well. In the test, two ECC bypass delay periods were identified [6]; a blowdown-force ECC bypass period supported by counter-current flow-flooding phenomenon in the downcomer annulus; a "hot wall" delay period due to steam generation as cold ECC water comes in contact with the vessel hot walls. As an evidence of this phenomena, broken loop cold leg densities and break flow near vessel side from both experiment and calculation are compared and shown in Figures 4-17 and 4-18 correspondingly. From the comparison, it can be seen that the cold leg density in the test obviously increased after accumulator injection began, while in the calculation the density change was very small only after the downcomer was filled up with water, which will be described later. As for the break flows near the vessel side, it can be also observed that after accumulator injection began, measured break flow rate was obviously higher than what was calculated until about 60 seconds. After 60 seconds, the downcomer was filled up with water in the calculation and therefore following ECC water directly flowed to the broken loop cold leg, which caused the break flow near the vessel side rose again just as appeared in the associated figure. Serving as another evidence was the core barrel temperature response. Comparison of core barrel temperatures is shown in Figure 4-19. It can be seen that after accumulation injection, core barrel temperature in the calculation began to decrease with another slope, while in the test this temperature behaved just on the contrary until ECC water penetrated the downcomer at the time of 42 seconds.

As a result of inability to properly simulate ECC bypass, the calculated water level in the downcomer rose much earlier than what was measured, as shown in Figure 4-20. Same as in the downcomer, the lower plenum was also filled up earlier in the calculation, as shown in Figure 4-21. As a result, the low plenum was filled up with water at 52 seconds in the calculation, while it was 71 seconds in the test.

During the refill period, there is no water entering the active core except a little droplets entrained by the up-going vapor [7]. As a result, the fuel cladding temperature would remain elevated, as shown in Figure 4-22 and 4-23 for low and high power rods respectively. Owing to the entering of ECC water during this period, superheated steam existed in the lower plenum began to be suppressed, as shown in Figure 4-24. Since the ECC water entered earlier in the simulation, calculated superheated steam in this region was suppressed sooner as expected. As for the coolant temperature response in the upper plenum shown in Figure 4-25, due to the overpredicted interfacial drag when flow was vertically stratified [8], once ECC water entered the lower plenum droplets would entrain into the active core, and some of them even could penetrate the core then entering the upper plenum. As a result, the calculated superheated steam in this region was suppressed sooner in this phase.

4.1.3 Reflood Phase (after 75 seconds)

During this phase, water began to flow into the active core and consequently fuel rods were rewetted again. Water levels across the core (from lower to uppper plenum) are shown in Figure 4-26. Same as in the lower plenum, the calculated core water level ascended earlier than what was measured. From the comparison, it also can be observed that the calculated water level oscillated with larger magnitudes, especially after the termination of accumulator injection. The accumulator injection flow rates were shown in Figure 4-27. It can be seen that the injection was terminated at about 90 seconds which exactly corresponded to the oscillations of the core water level. As direct results of the injection termination, the calculated broken loop cold leg density and flow began to oscillate, as shown in Figure 4-28 and 4-29 respectively, which in turn would cause core water level to oscillate. As for the reason why the calculated cold leg density and flow began to oscillate right after the termination of accumulator injection, the different status of the broken loop cold leg may be the explanation. From

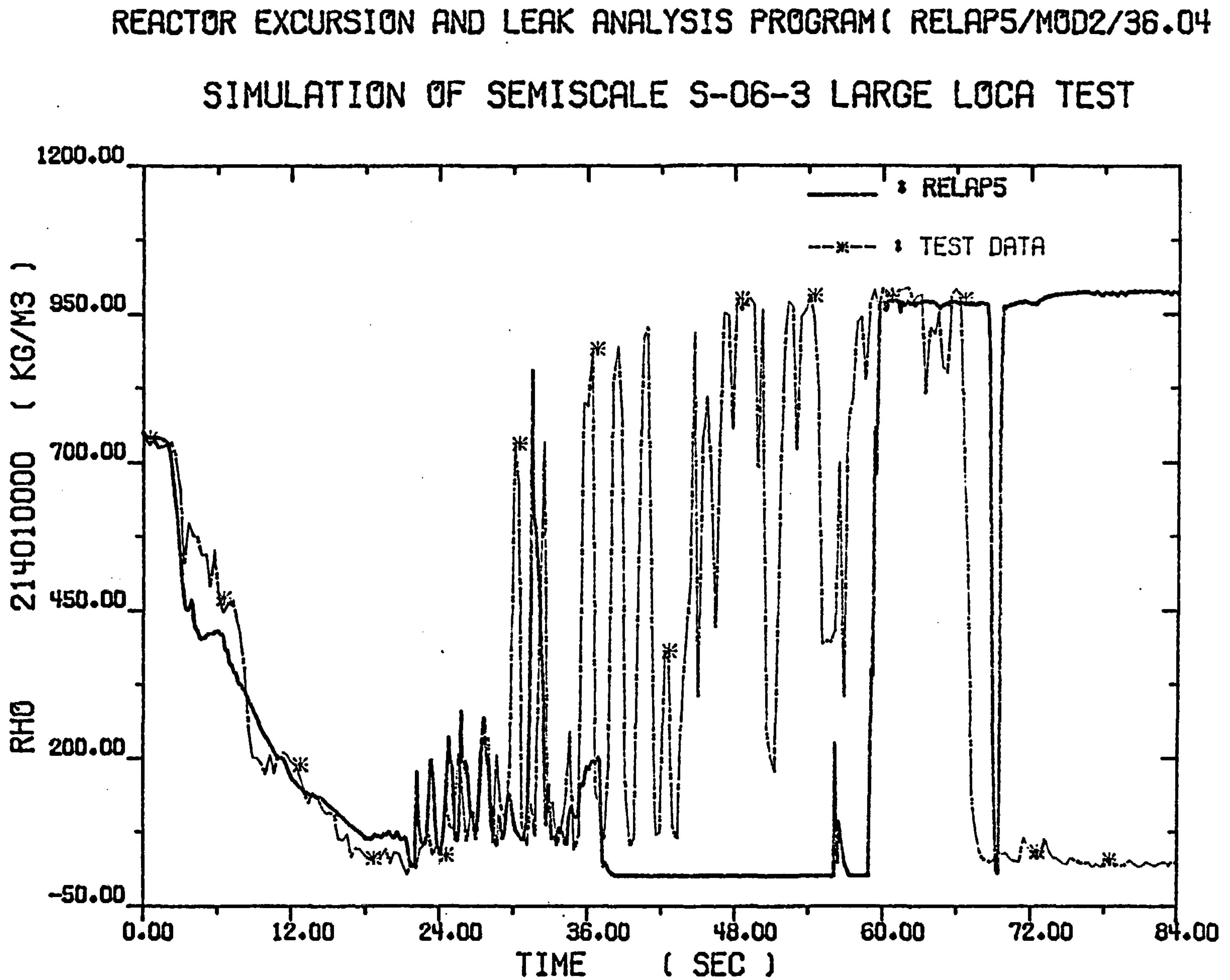

Fig. 4-17. Broken Loop Cold Leg Coolant Densities

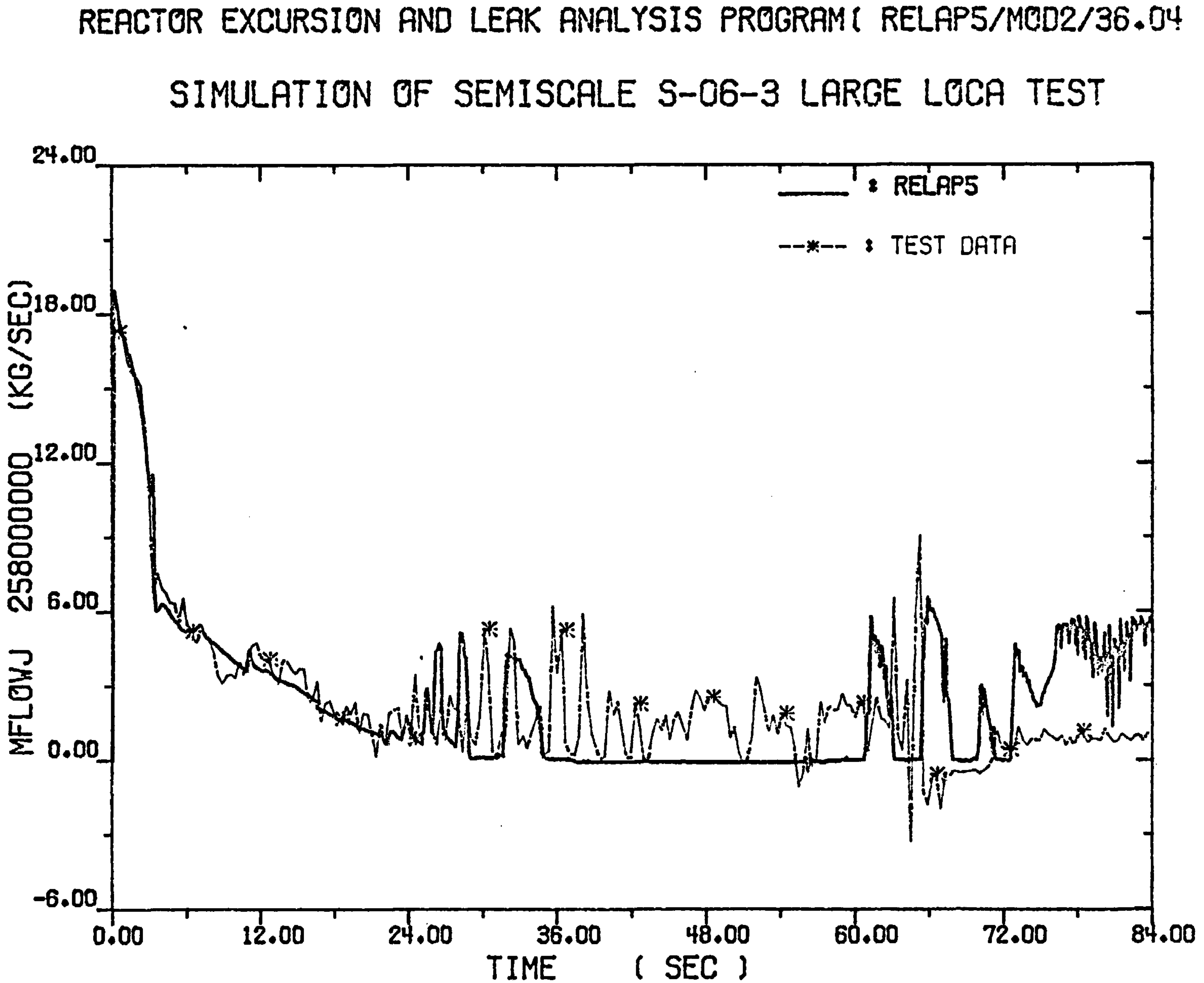

Fig. 4-18. Break Flow Rates near Vessel Side

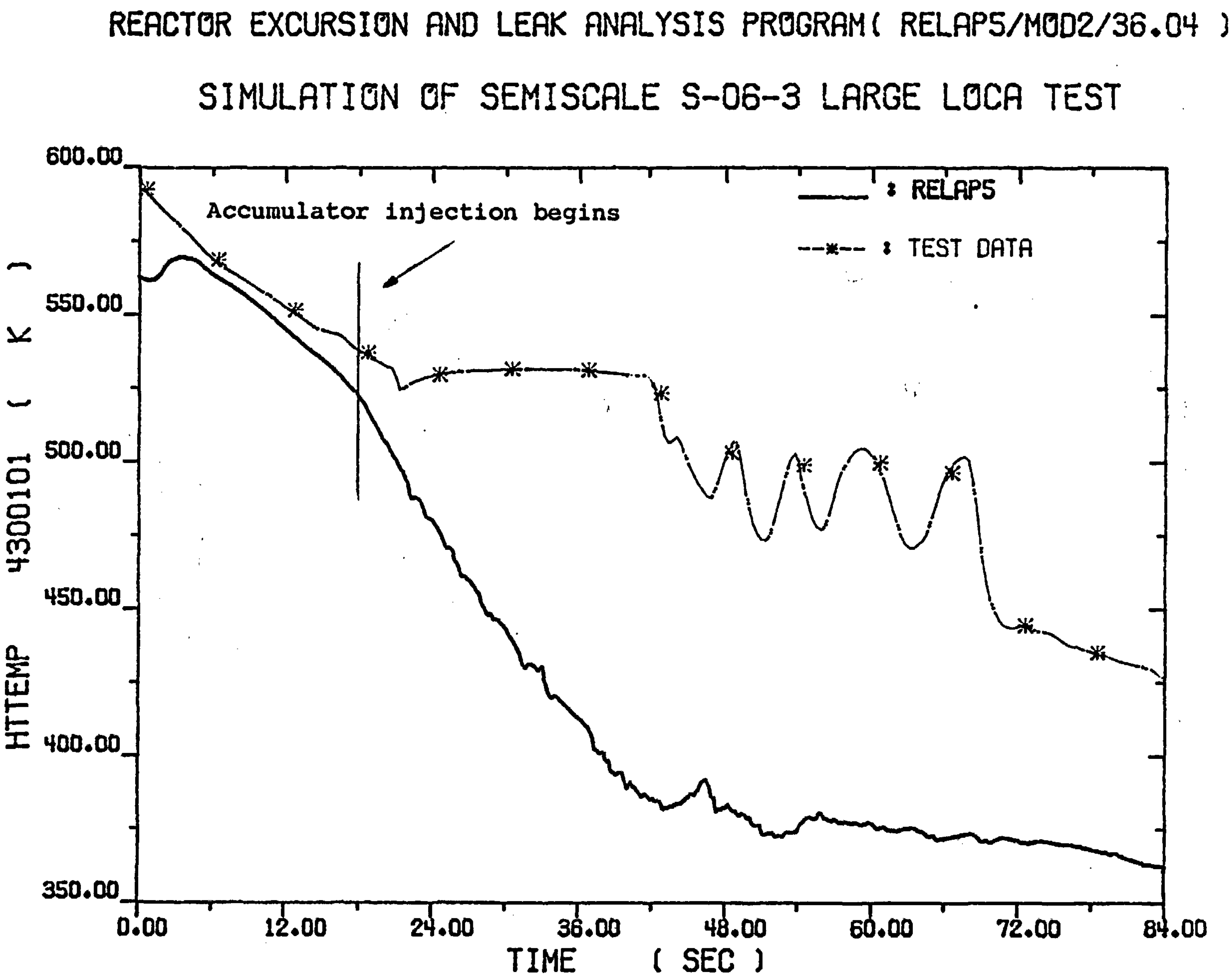

Fig. 4-19. Core Barrel Wall Temperatures

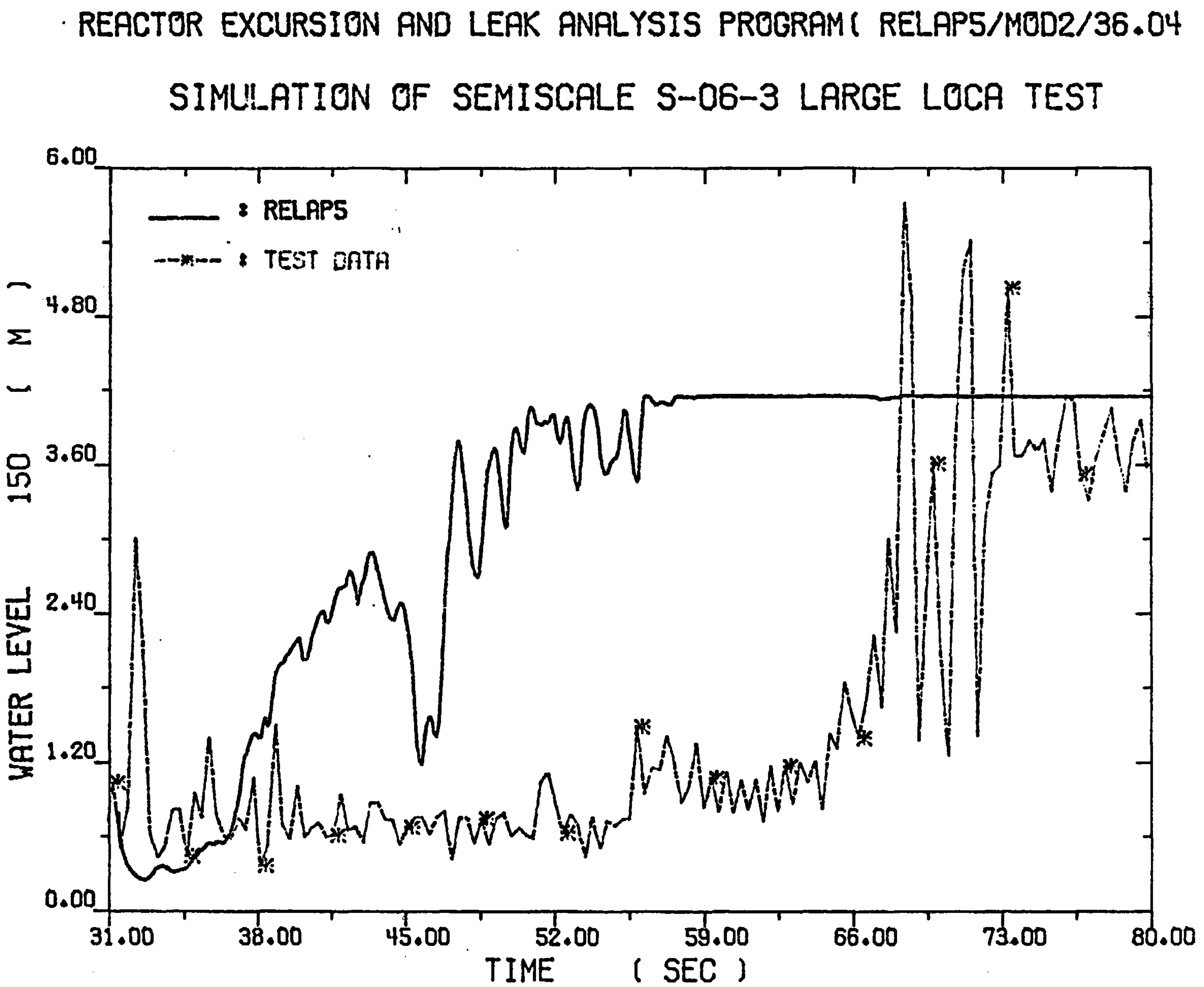

Fig. 4-20. Collapsed Water Levels across The Downcomer

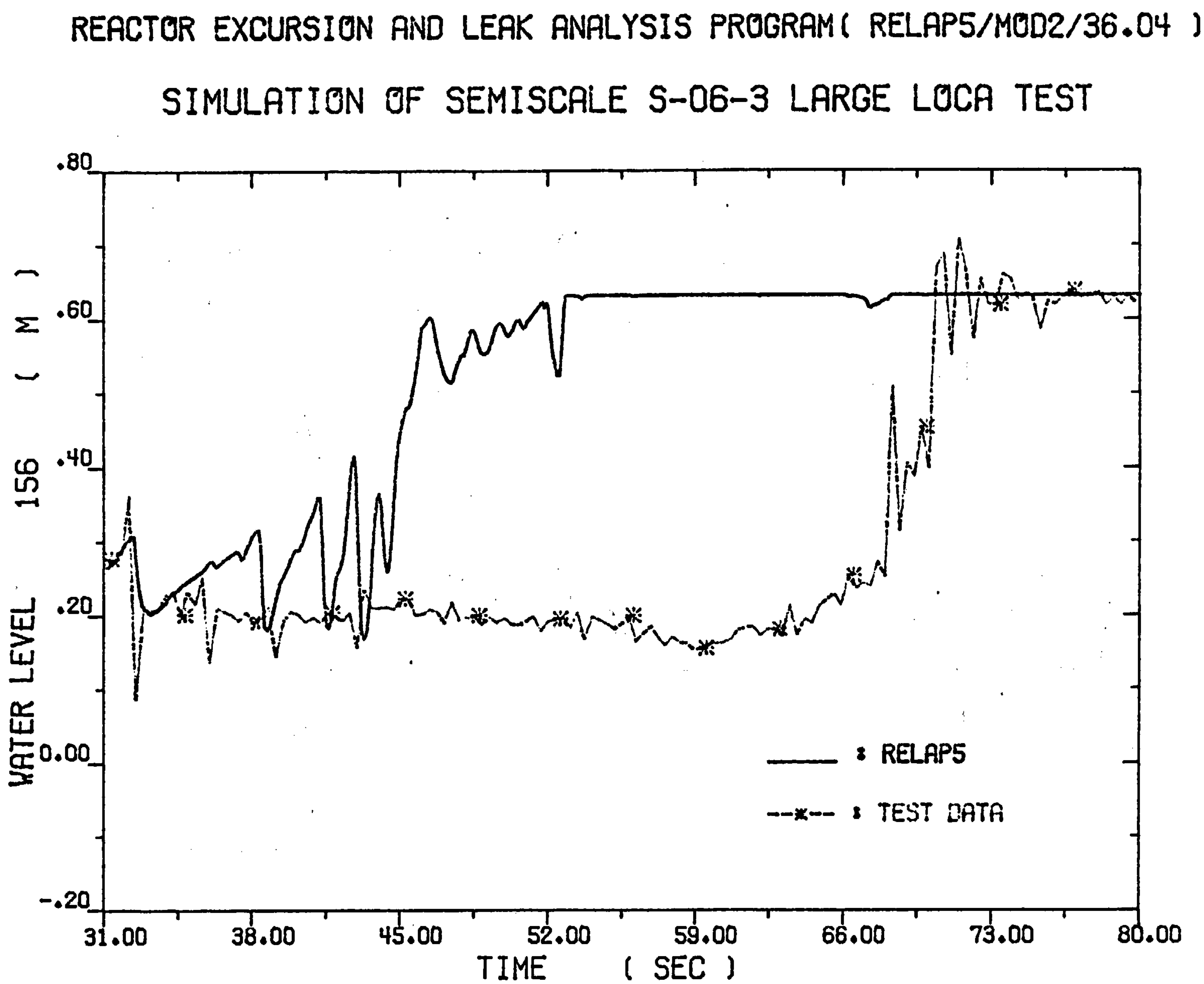

Fig. 4-21. Collapsed Water Levels across The Lower Plenum

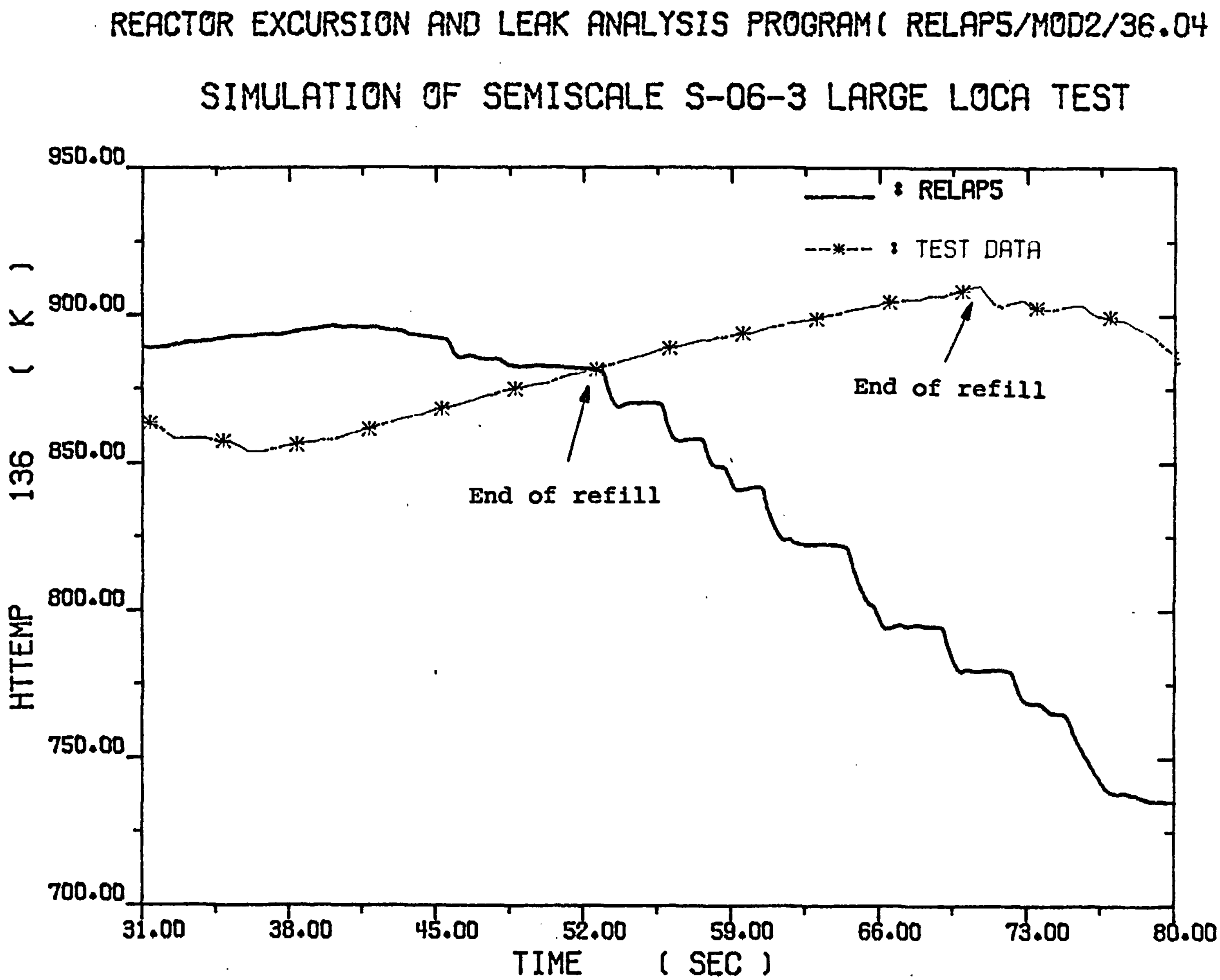

Fig. 4-22. Low Power Rod Hot Spot Cladding Temperatures

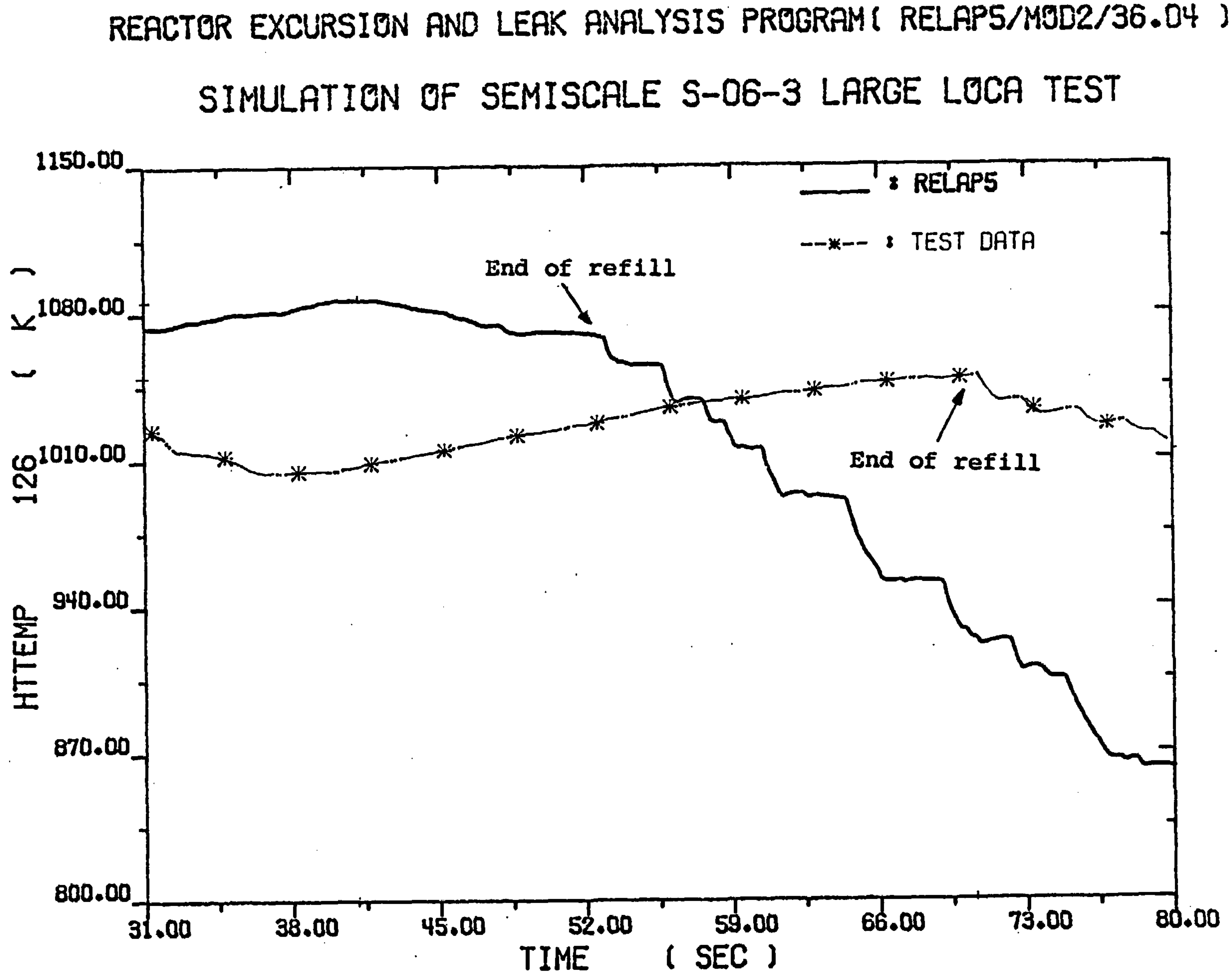

Fig. 4-23. High Power Rod Hot Spot Cladding Temperatures

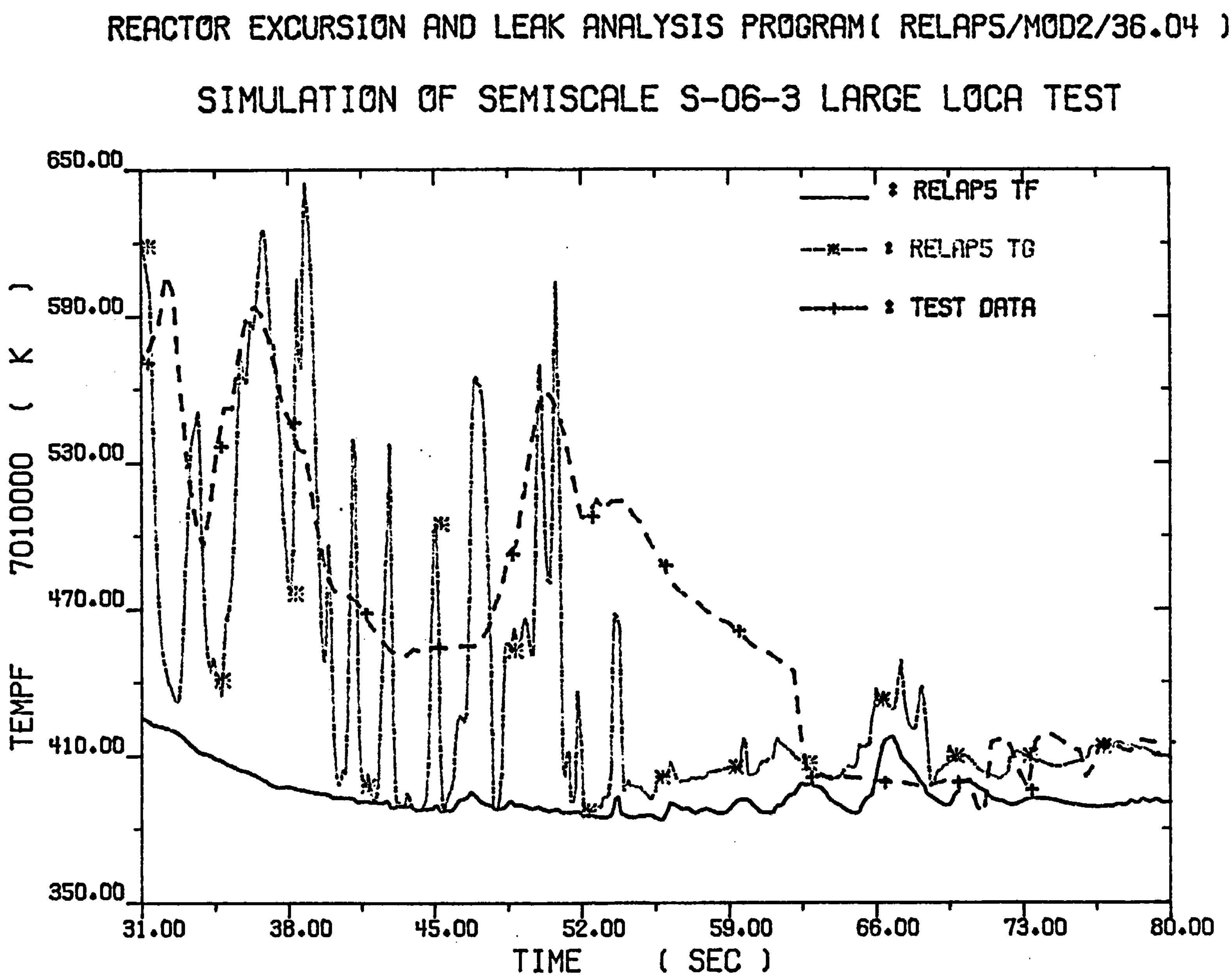

Fig. 4-24. Lower Plenum Coolant Temperatures

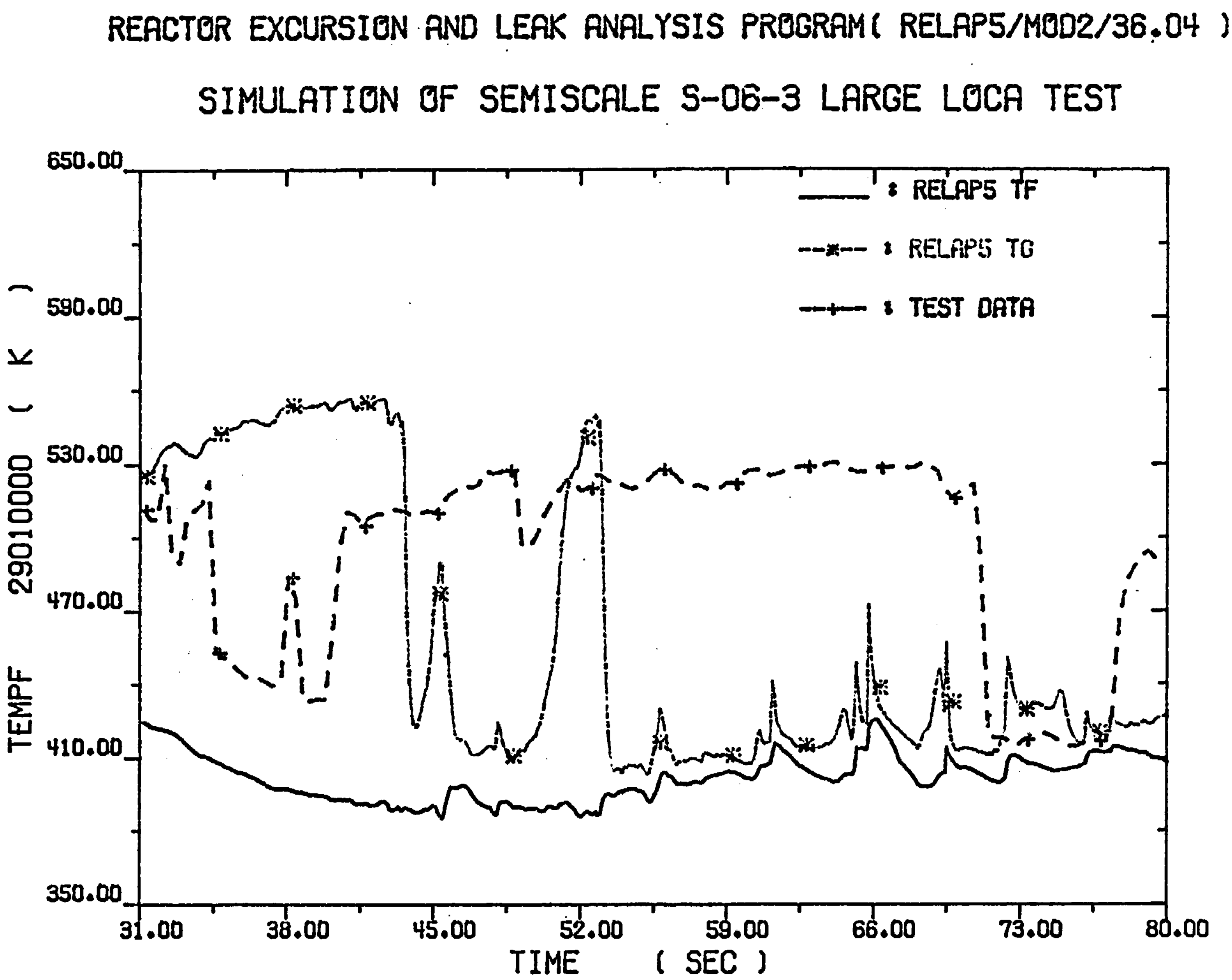

Fig. 4-25. Upper Plenum Coolant Temperatures

the comparison of cold leg density (Figure 4-28), it can be observed that prior to the injection termination, the calculated broken loop cold leg was filled with liquid provided by the accumulator bypass. In the calculation, the accumulator bypass revealed in Figure 4-29 began right after the occupation of downcomer at about 60 seconds shown in Figure 4-20. After the termination of accumulator injection, part of water remained in the broken loop cold leg flowed back to the vessel, which also can be seen in Figure 4-29.

Comparisons of peak cladding temperature responses are shown in Figures 4-30 and 4-31 for low and high power rods respectively. From the comparisons, it can be observed that prior to the rewetting of the hot spots, substantial heat transfer took place. This cooling was attributed to the interaction between entrained water and rods above the quench front and was named precursor cooling [7]. As illustrated, the calculated precursor cooling seemed to be more effective. This difference probably was resulted from the overprediction of liquid entrainment under low flow reflood condition at low pressure [8] and the use of Dougall-Rohsenow correlation for film boiling heat transfer [9]. Other than this, it also can be easily found that the calculated rewetting occurred much earlier than in the test. This discrepancy basically was caused by the earlier refill in the calculation. Furthermore, it also can be found that the calculated rewet temperature was a little lower. The highest cladding temperatures along fuel rods were also compared. In the test, there were 4 high power rods and 32 low power rods, among which about 70 fuel temperature sensors were distributed. While in our simulations, all fuel rods were modelled only with two heat structures, one representing low power rods and the other representating high power rods. To make comparisons more representative, two curves were used to fit those distributed measuements of cladding temperatures, one for lower power rod as shown in Figure 4-32 and the other for high power rods as shown in Figure 4-33; the method used for curve fitting is Least Squares [10]. In the following discussions, one should bear in mind that the representative curves represent a generalized concept of the maximum cladding temperature response and the real data are always scattered around these curves. Comparisons of representative curves with calculated results are shown in Figures 4-34 and 4-35 for low and high power rods respectively. It can be found from the comparison that the calculated highest cladding temperatures along low power rods matched the data very well, while for the high power rods there was a little shifting of the calculated one. As a result, the calculated position of the highest cladding temperature of the high power rods was 17 cm higher than measured. Besides, the calculated peak value was lower about 30K. Concerning the quench time, same as the fitting of peak cladding temperatures two curves were used to fit the quench time distribution, as shown in Figures 4-36 and 4-

37 for low and high power rods correspondingly. Comparisons of fitting curves to calculated quench time are shown in Figures 4-38 and 4-39 for low and high power rods respectively. As observed, recorded top quenching phenomena was caught in calculation for both low and high power rods. As is well known, this phenomena occurs from cooling provided by the two-phase flow moving upward through the core and the fallback of water which is deentrained at the top of the core or in the upper plenum. The net effect of this is to quench the uppermost part of the fuel rods sooner than would occur from the propagation of the bottom quench front. Top-down cooling generally does not extend to the hot spot [7], which also can be easily observed in these figures. However, all rods in calculation were obviously rewetted earlier, especially for the high power sections. Besides, the latest quenching positions in the calculation for both low and high power rods seemed to be a little lower than what was observed in the test. Basically the calculated earlier rewet can be attributed to the earlier refill and more liquid entrained upward by the up-going vapor during reflood period.

As a summary, important sequence of events is listed in Table 4-1 and compared to what were recorded in the test.

4.2 Sensitivity Study

To ensure that analytical results are within reliable domains and to investigate effects of several different modelings and options, the following sensitivity studies are

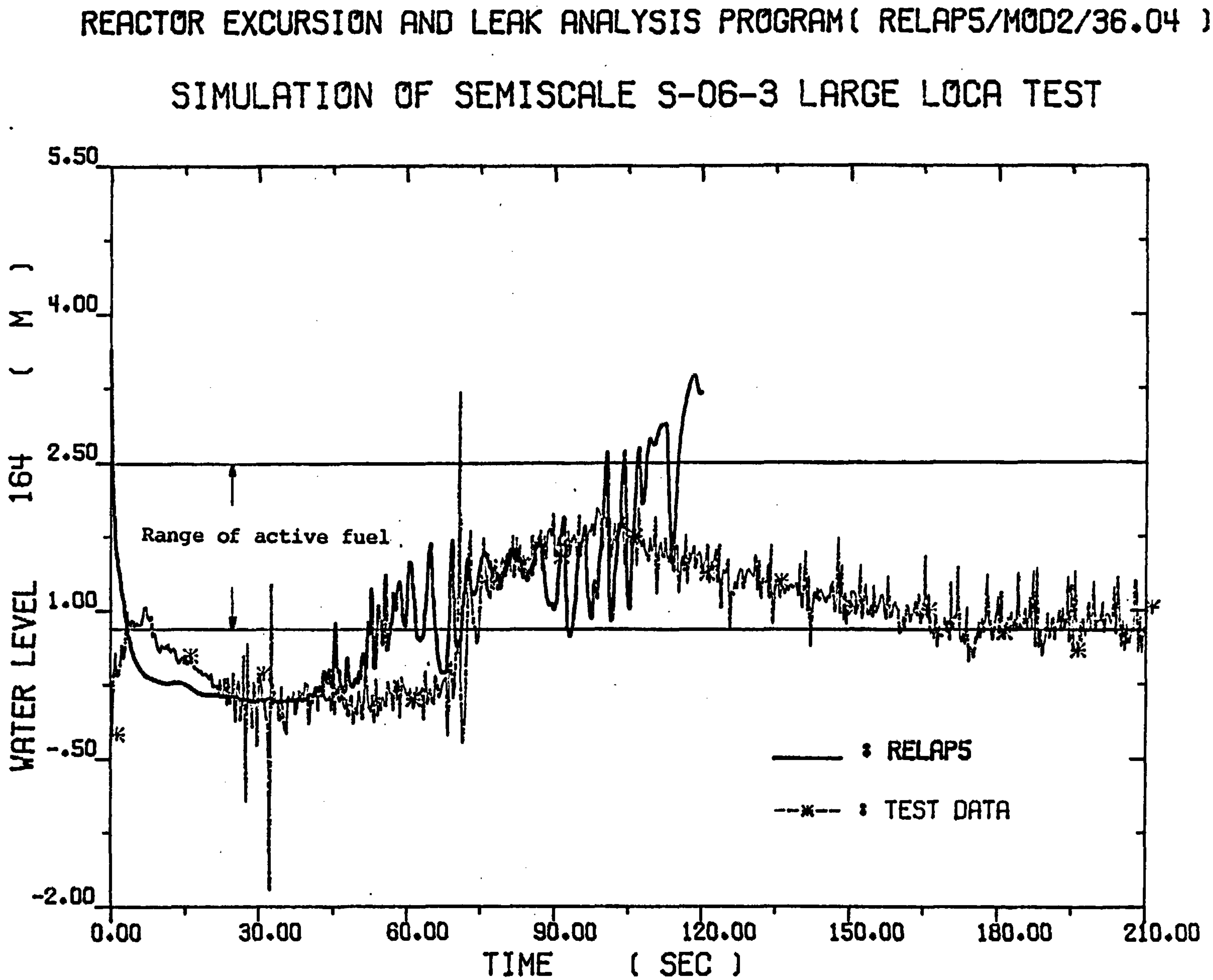

Fig. 4-26. Collapsed Water Levels across The Core

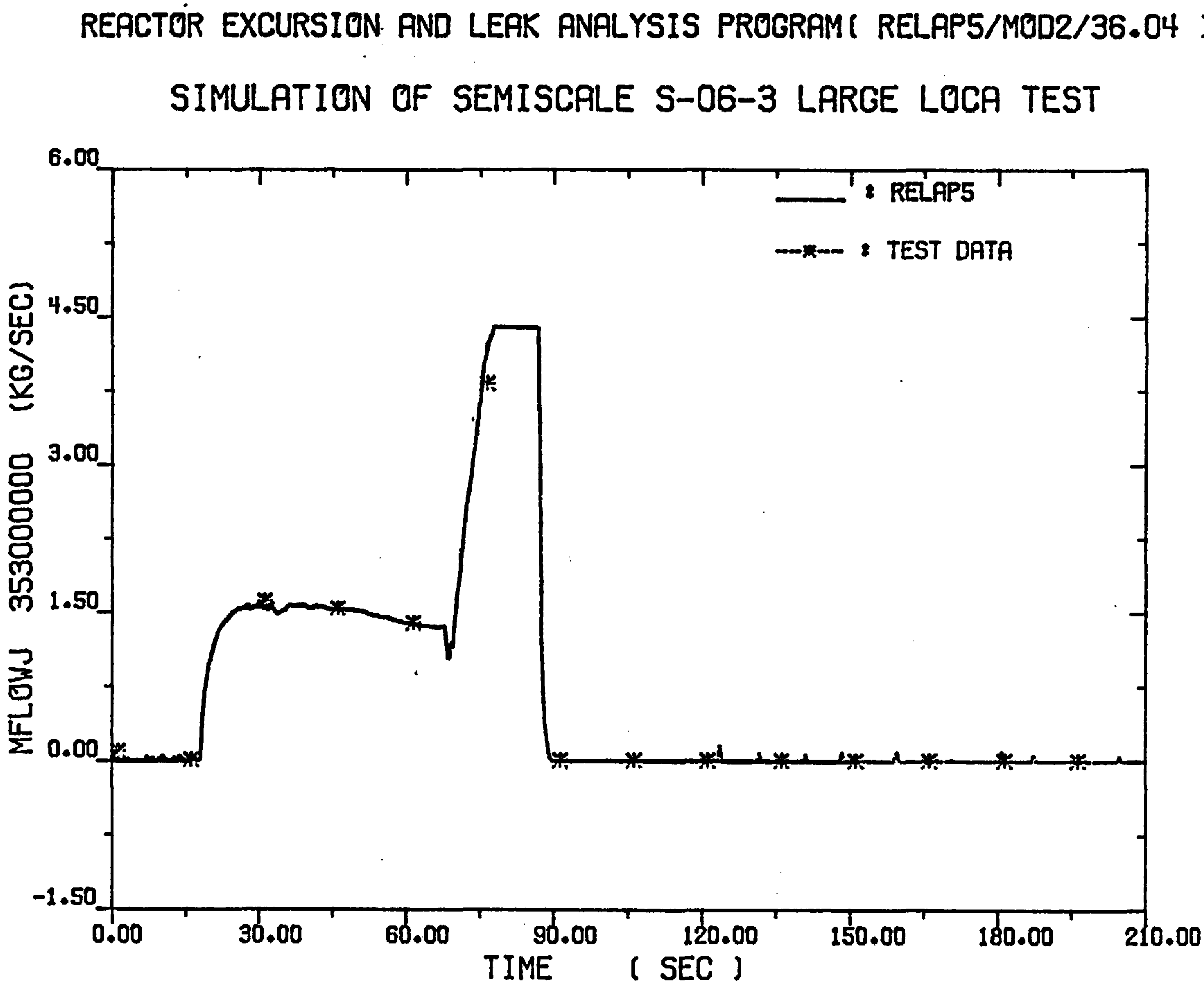

Fig. 4-27. Accumulator Flow Rates

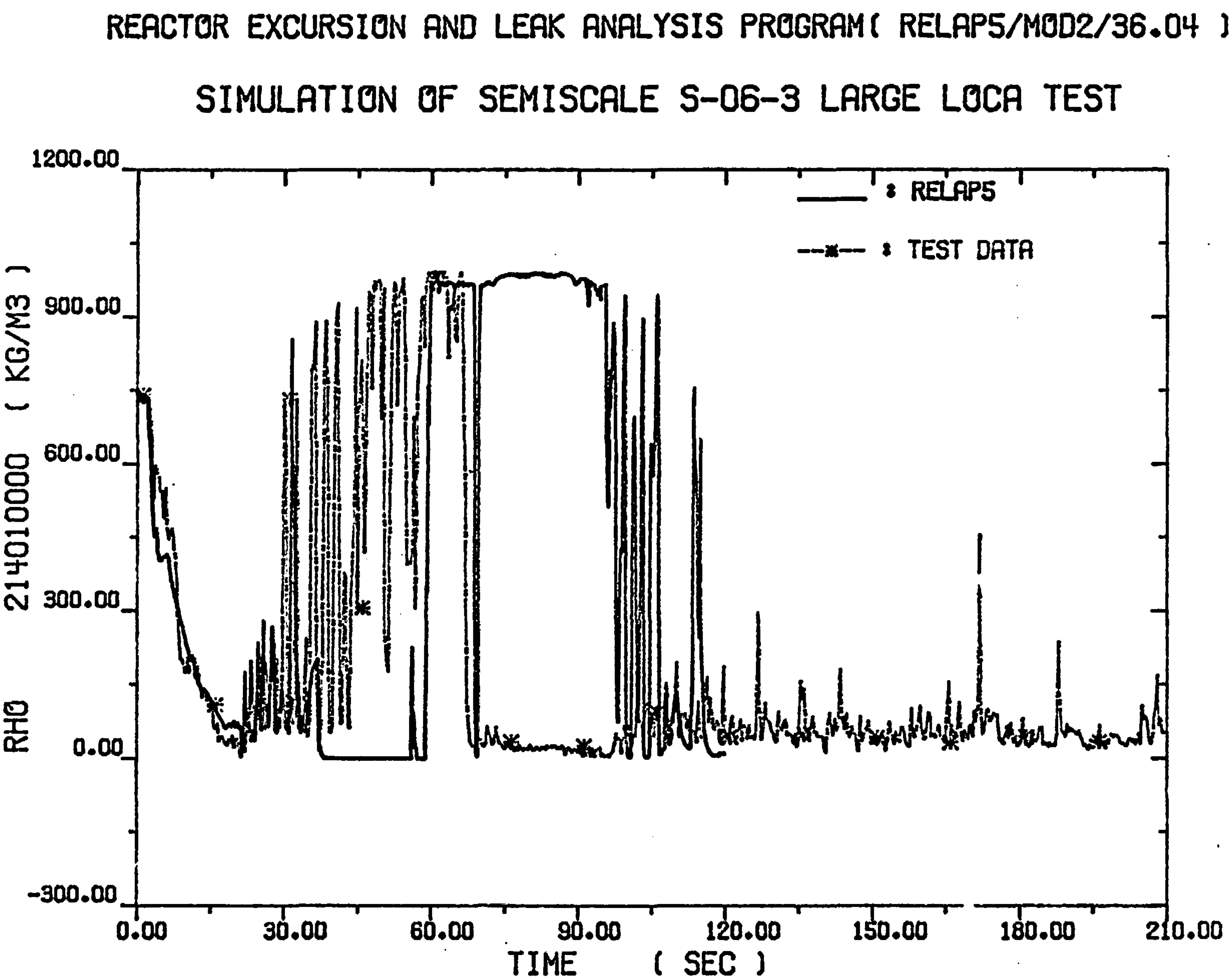

Fig. 4-28. Broken Loop Cold Leg Coolant Densities

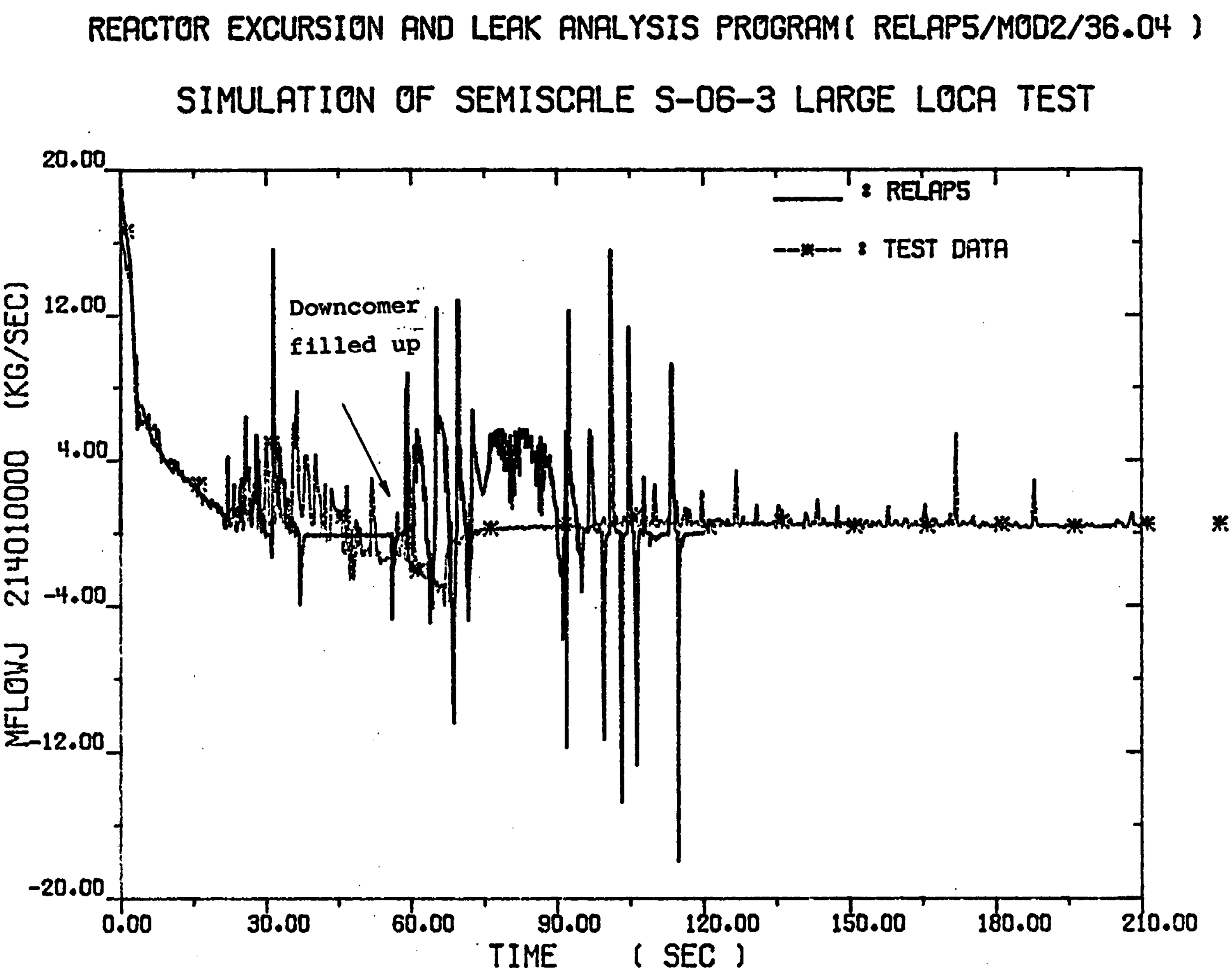

Fig. 4-29. Broken Loop Cold Leg Flow Rates

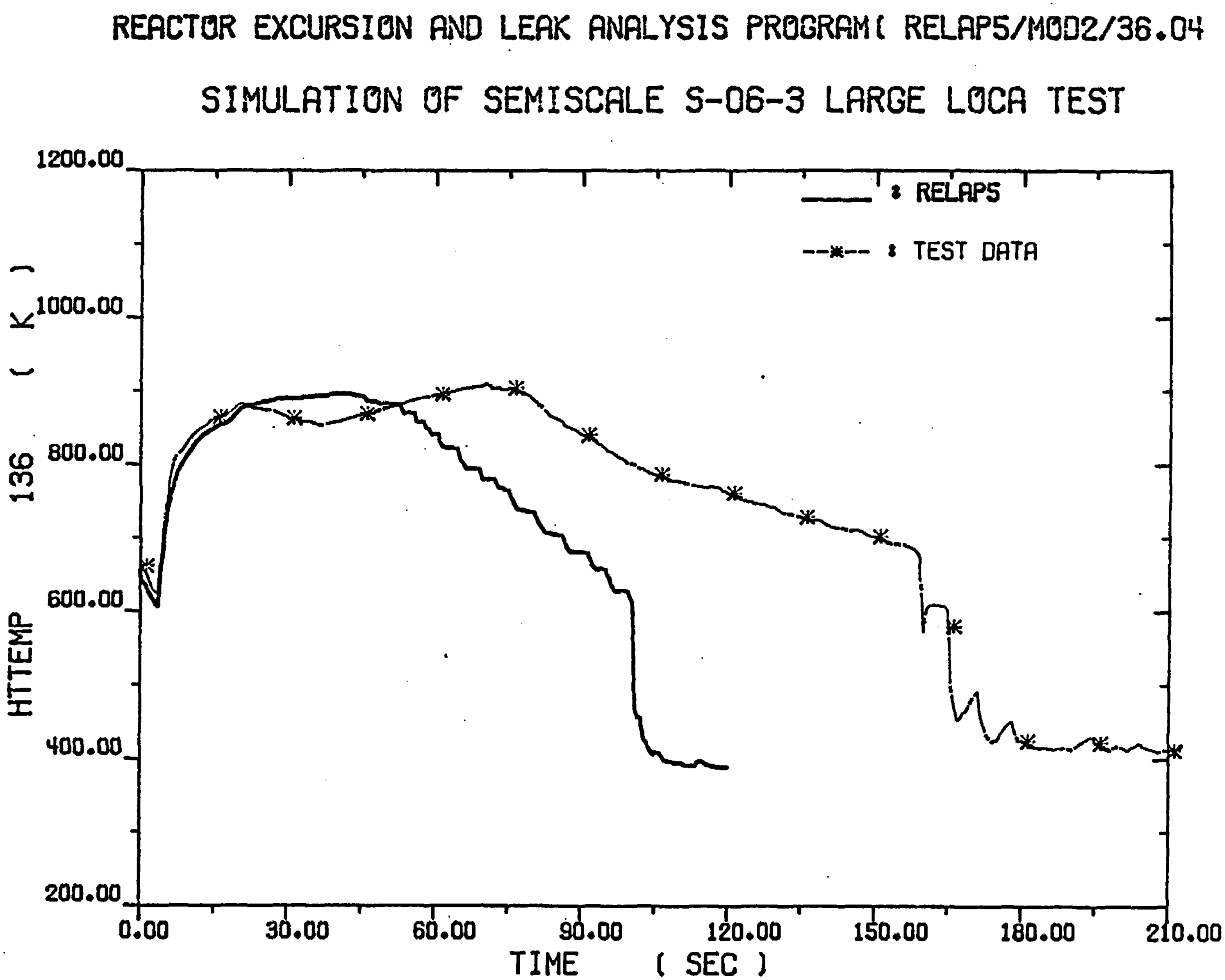

Fig. 4-30. Low Power Rod Hot Spot Cladding Temperatures

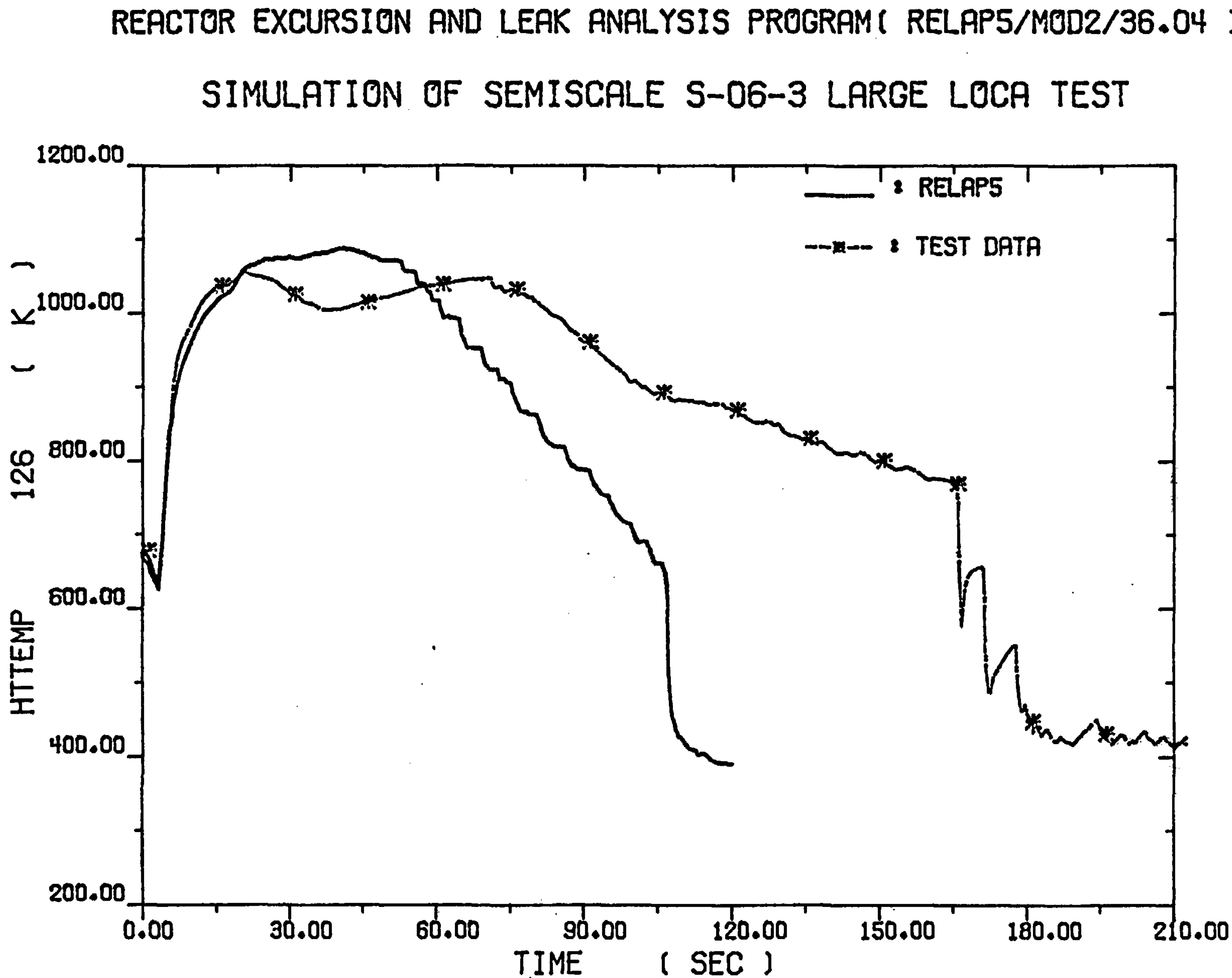

Fig. 4-31. High Power Rod Hot Spot Cladding Temperatures

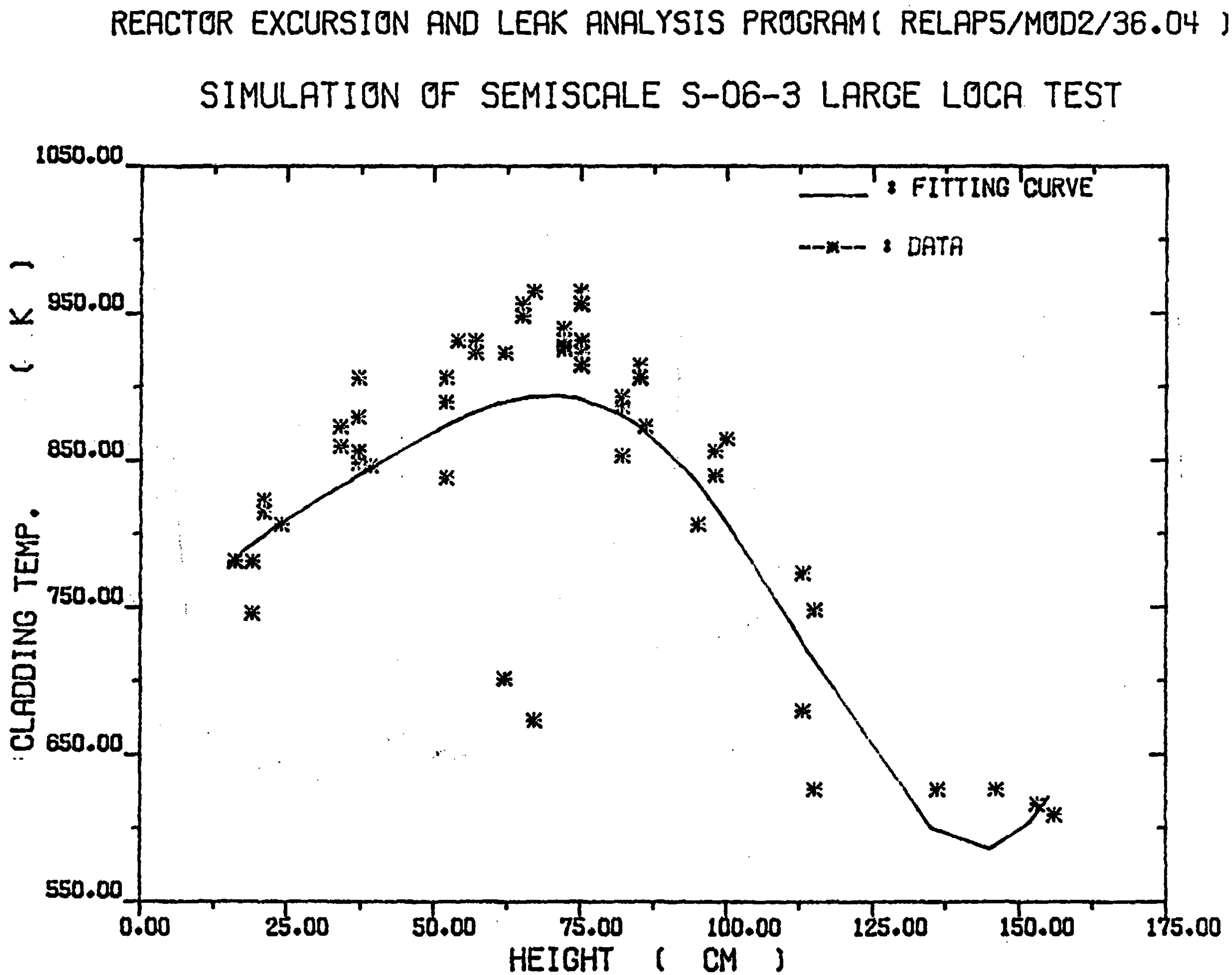

Fig. 4-32. Curve Fitting of The Low Power Rod Peak Cladding Temperature versus Elevation

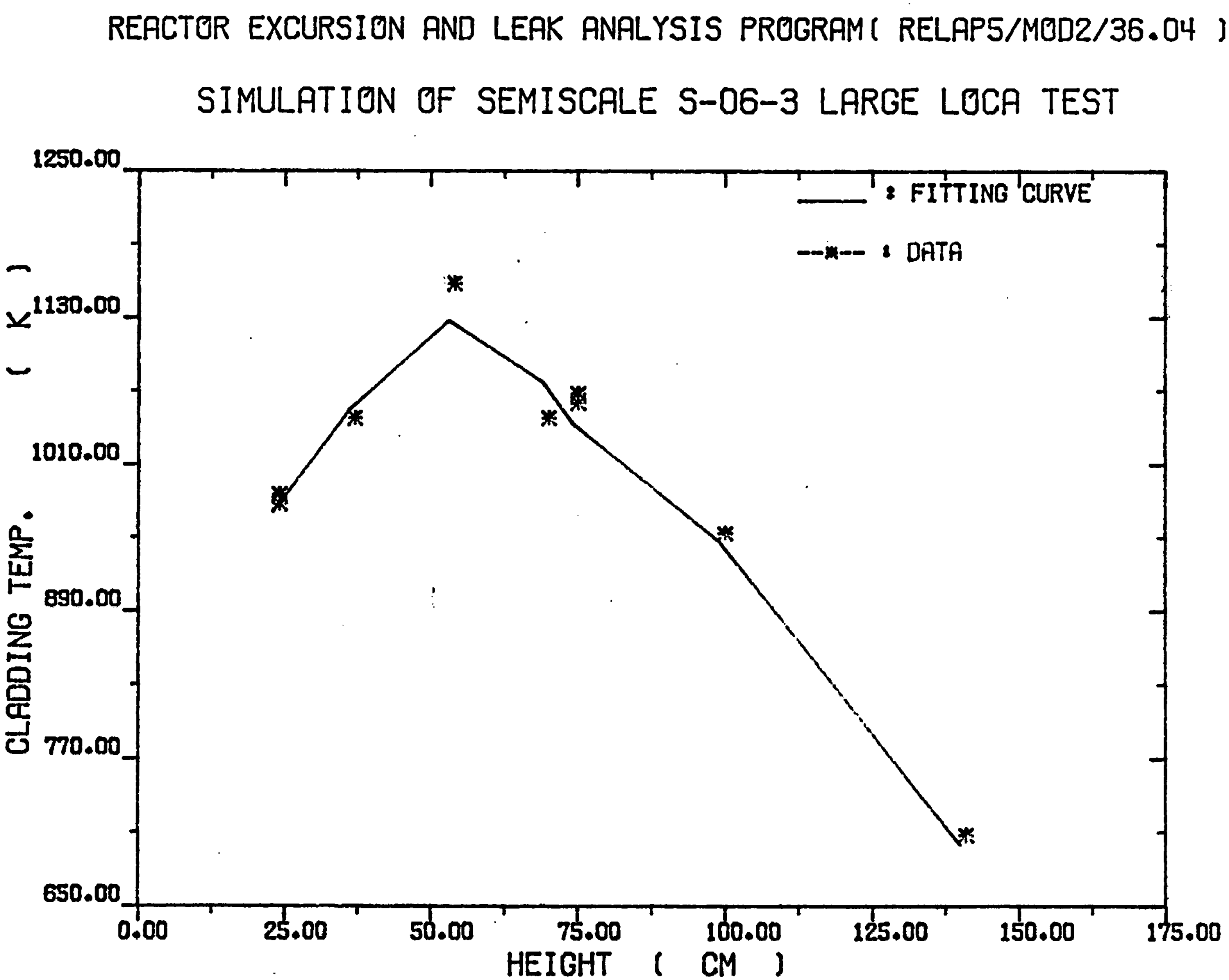

Fig. 4-33. Curve Fitting of The High Power Rod Peak Cladding Temperature versus Elevation

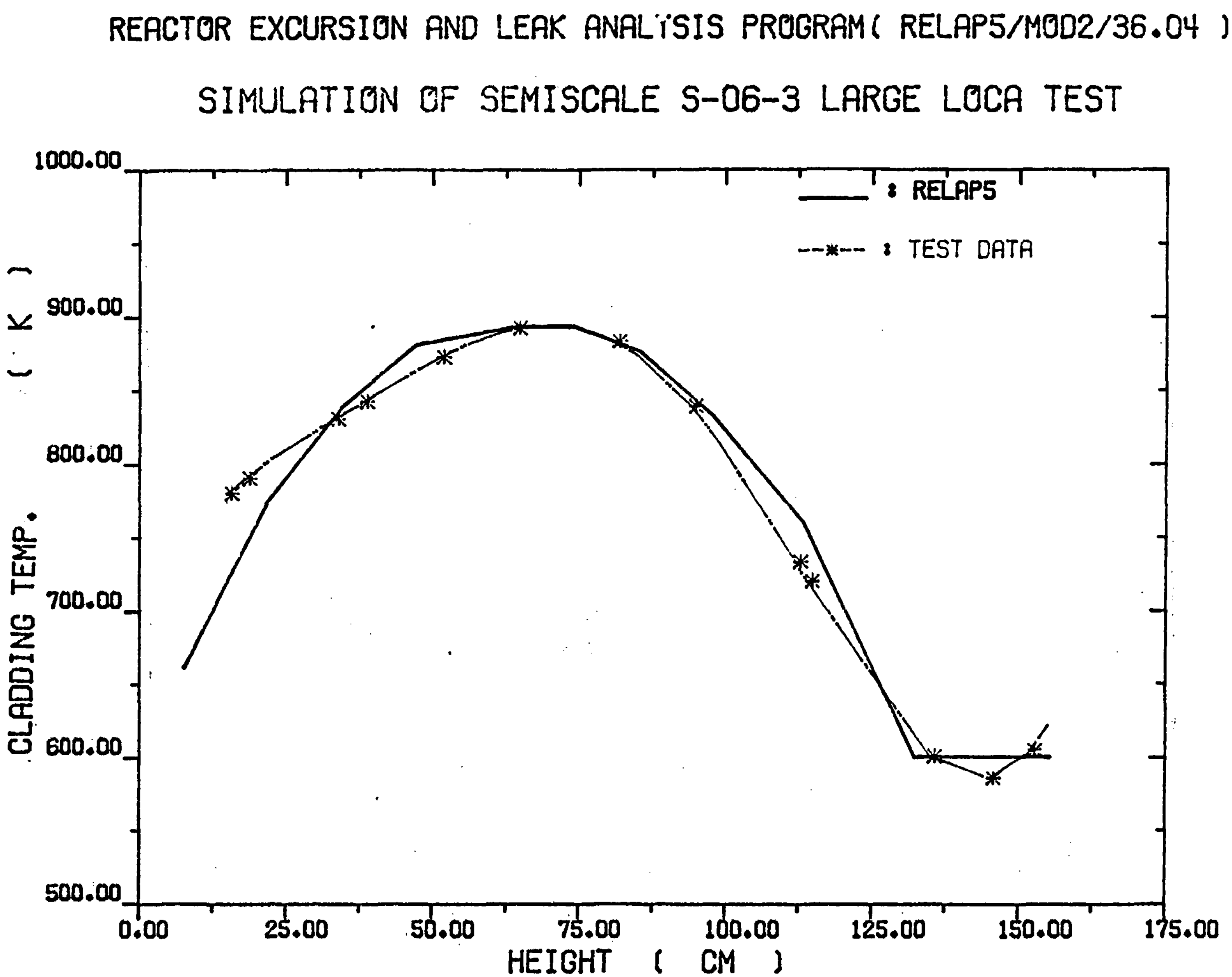

Fig. 4-34. Low Power Rod Peak Cladding Temperatures Versus Elevation

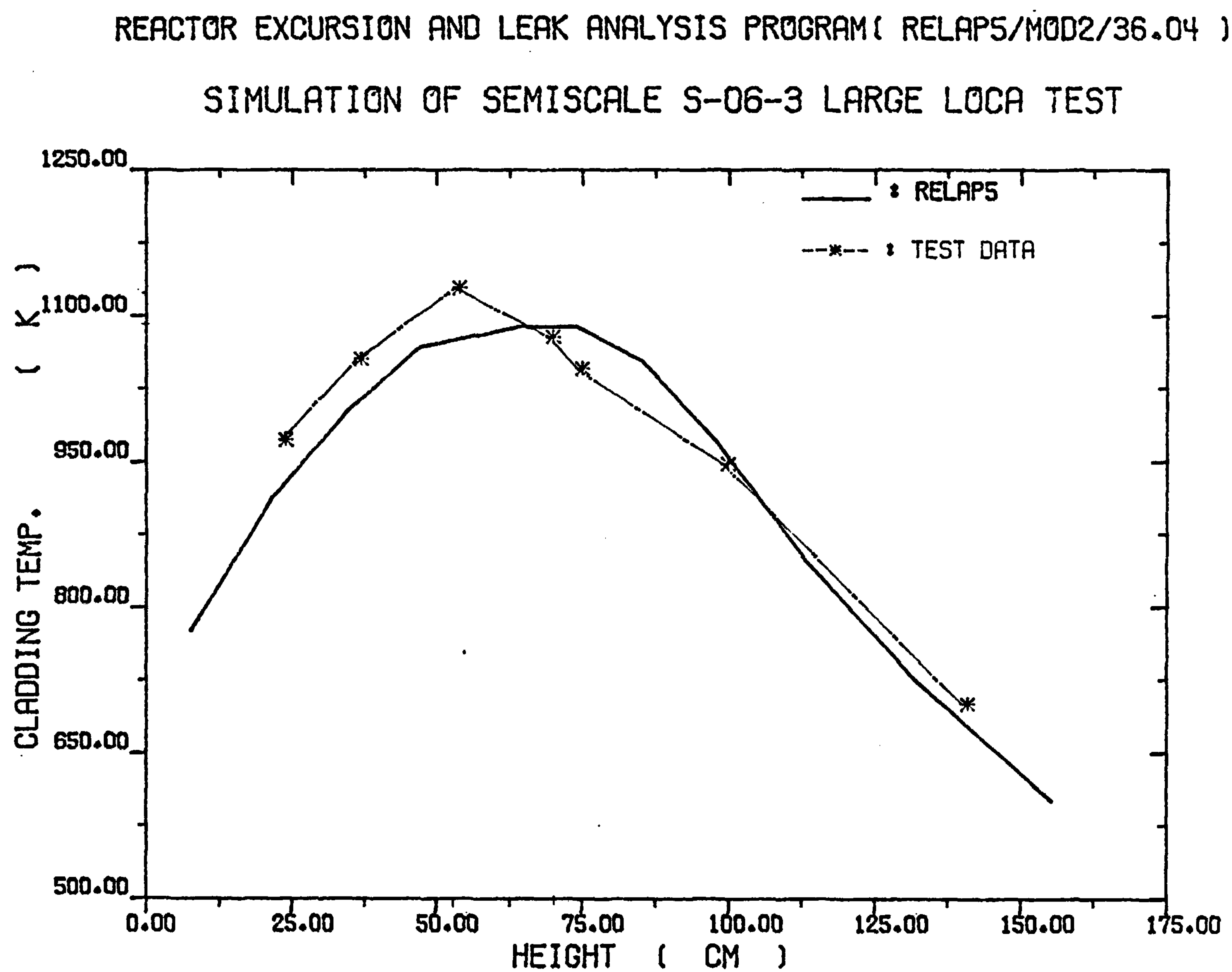

Fig. 4-35. High Power Rod Peak Cladding Temperatures Versus Elevation

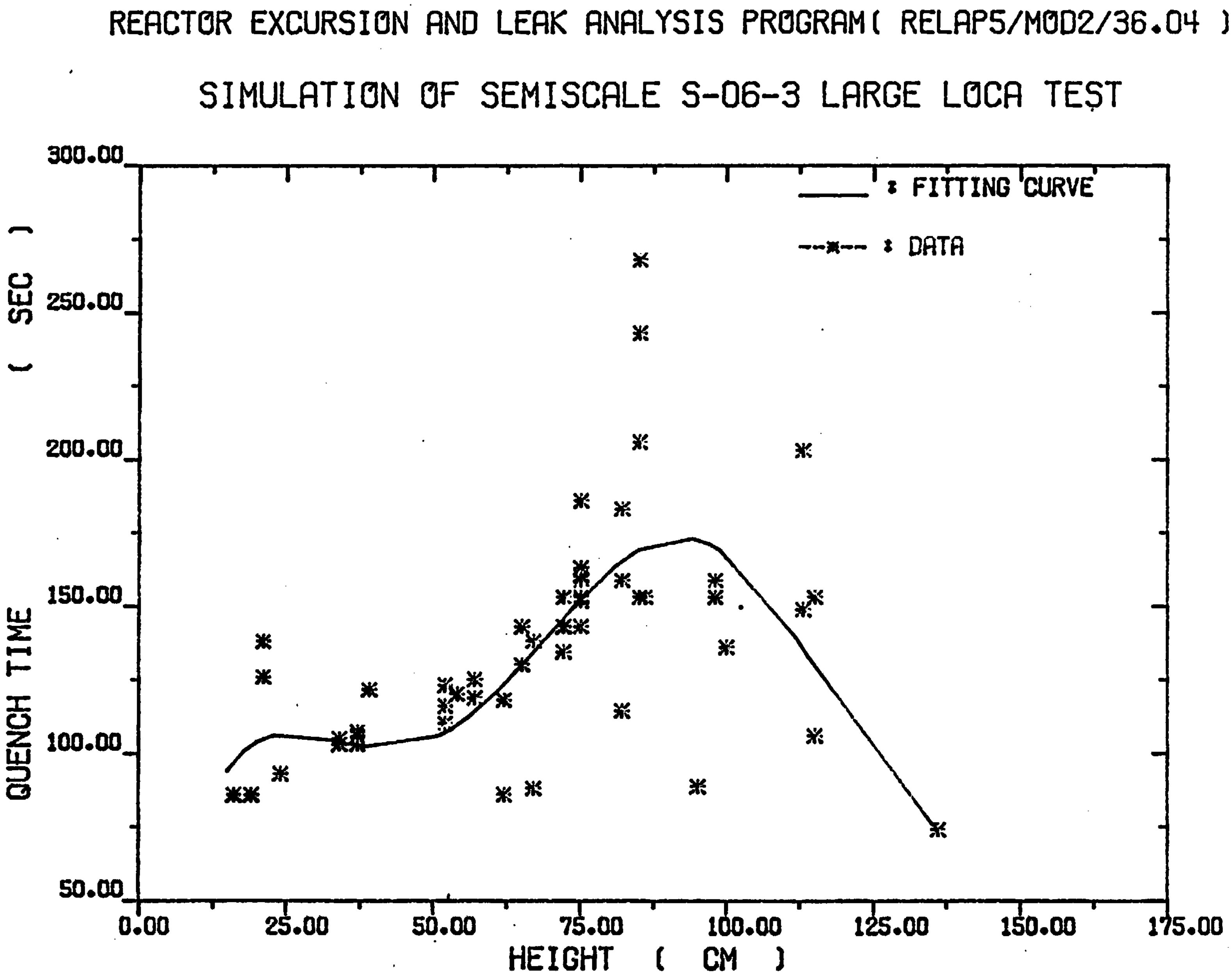

Fig. 4-36. Curve Fitting of The Low Power Rod Quench Time versus Elevation

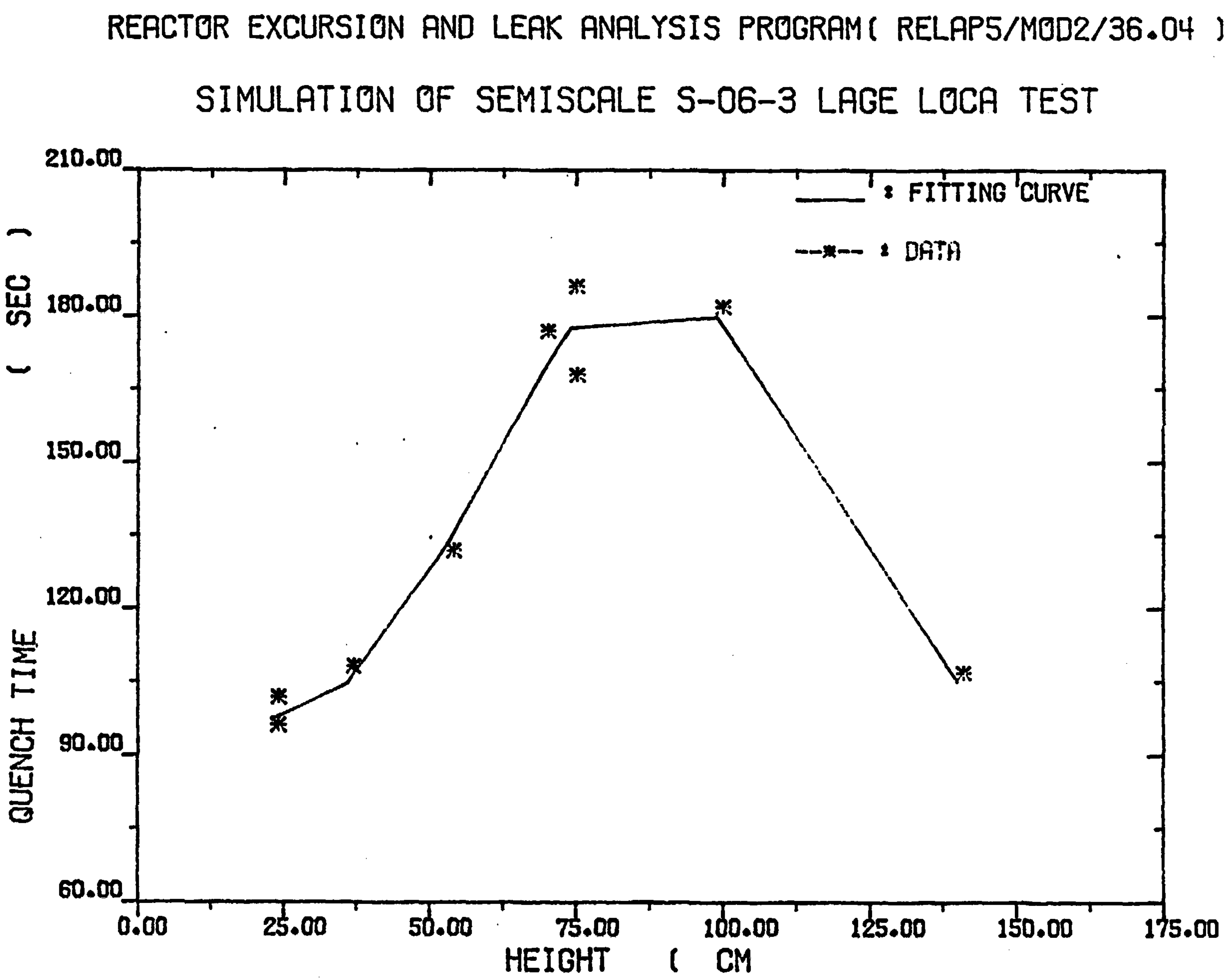

Fig. 4-37. Curve Fitting of The High Power Rod Quench Time versus Elevation

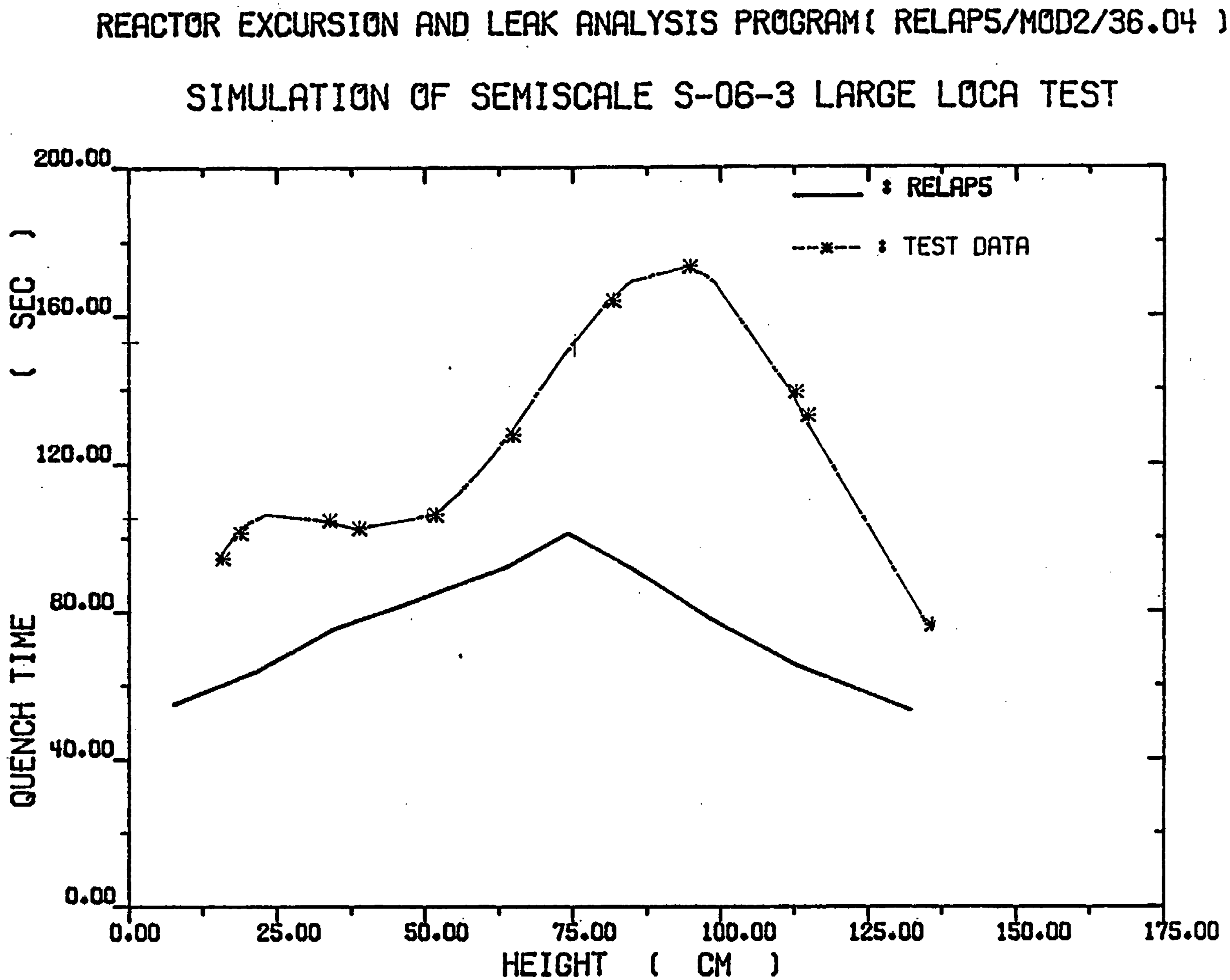

Fig. 4-38. Low Power Rod Quench Time versus Elevation

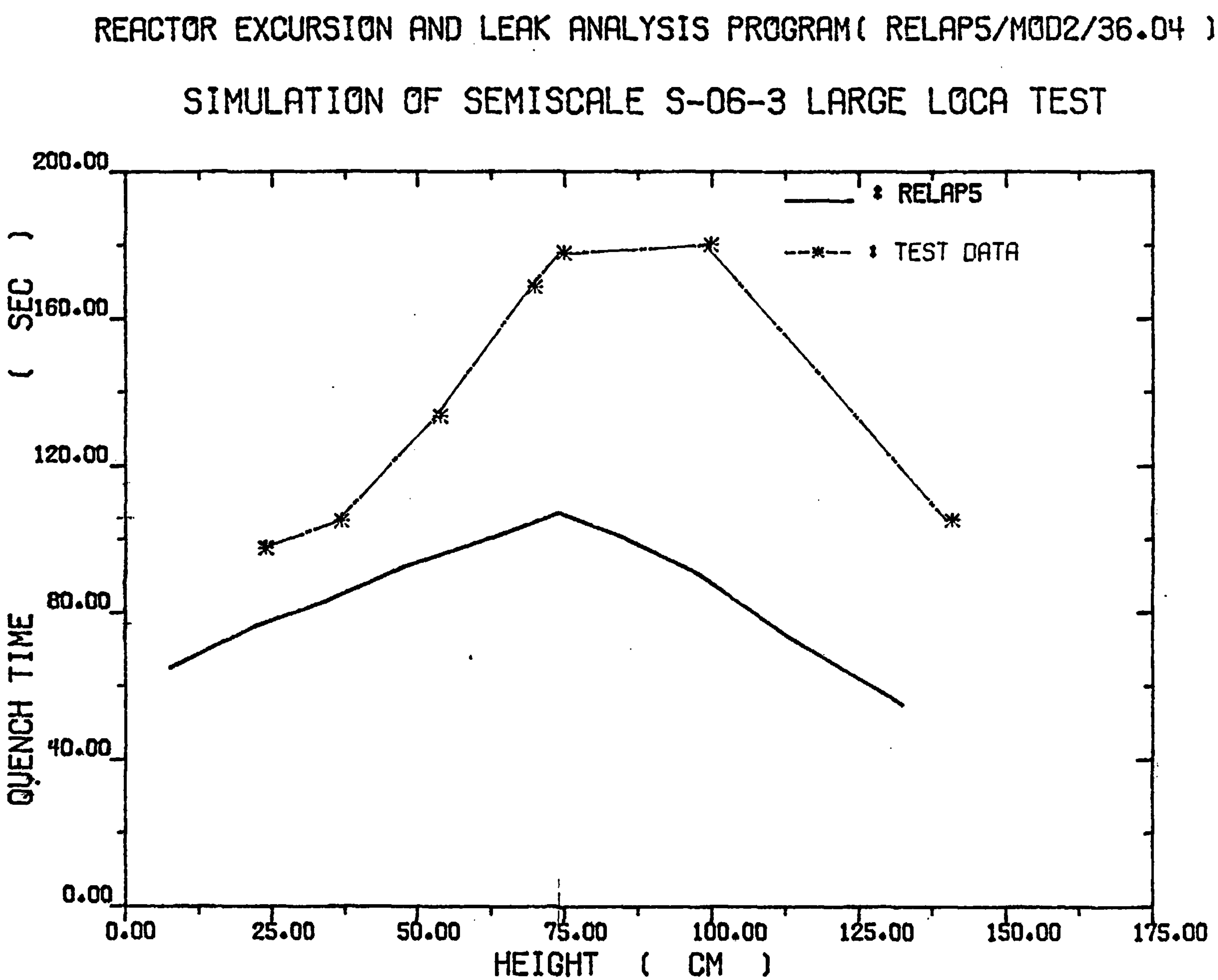

Fig. 4-39. High Power Rod Quench Time versus Elevation

Table 4-1 Sequence of Events

Event	Time (s) Measured	RELAP5
Blowdown initiated	0.0	0.0
High pressure injection started	0.0	0.0
Core power decay transient started	1.27	1.27
Fuel hot spot temperature excursion began	2.94	3.33
Pressurizer emptied	7.5	12.5
Accumulator injection started	18.5	18.5
PCT reached	20.5	41.0
Downcomer penetration	42.0	*
Lower plenum water level began to increase	60.0	32.5
Lower plenum filled up	71.0	52.0
Downcomer filled up	73.0	58.0
Accumulator injection stopped	90.0	90.0
Fuel hot spot rewetted	165.0	105.0

* Fail to simulate

performed. Each different modeling or option is isolated and results are compared to what were obtained from the base modeling described in the previous section.

4.2.1 Pressurizer Modeling

In the base model pressurizer was represented by 13 volumes, while in this study noding was reduced to 5. Pressurizer surge flow and pressure responses during blowdown period from both models are compared and shown in Figures 4-40 and 4-41. It can be seen that the slope change of surge flow corresponding to the pressurizer empty was better simulated in the base model, and two-slope pressure response resulted from pressurizer empty was also more obvious in the base calculation.

4.2.2 Radial Connections Between Core Average and Hot Channels

As depicted in the previous section, radial connections between core average and hot channels were modelled in the base case using cross-flow junctions. In this study, such radial links are disconnected. The resulting peak cladding temperatures of both low and high power rods along the fuel elevations are shown in Figures 4-42 and 4-43 respectively. For the low power rods, the peak temperatures along the fuel were almost identical in both cases. However, for the high power rods the peak temperatures located on the bottom and top sections of the fuel were a little different. Such discrepancies actually were caused by different cladding temperature responses on both sections.

The cladding temperature responses on both end sections are shown in Figures 4-44 and 4-45 correspondingly. As revealed from the comparisions, it can be found that in both sections, the cladding would not experience dryout in the calculation without radial connections, while in the base calculation the fuel rods do experience dryout and temperature excursions resulted consequently.

The resulting fuel quench time along the fuel of both high and low power rods from both calculations are shown in Figures 4-46 and 4-47. For the high power rods, other than the difference in the bottom section which did not experience dryout in sensitivity calculation, the quench time of lower part of fuel in the calculation without radial connection was all postponed by about 6-10 seconds. While for the low power rods, except the central section, the quench time was postponed a little in the calculation without radial connections.

The core inlet flow rates and collapsed water levels from both calculations are also compared, as shown in Figures 4-48 and 4-49 respectively. It can be observed that there were no noticeable differences for these two parameters. In addition, the CPU time used in the two calculations was also compared as shown in Figure 4-50. The costs of the two calculations were quite close.

4.2.3 The Maximum Number of Heat Slab Axial Interval for 2-D Reflood Calculation

In the base modeling the heat slab axial maximum interval was set to 8. To investigate the effect of this number, it was timed and divided by a factor of 4. The resulting peak cladding temperatures along the fuel rod elevations for both high and low power rods are shown in Figures 4-51 and 4-52 respectively. It can be observed that there is no noticeable difference for both high and low power rods. The resulting quench time on each different elevation of both high and low power rods is also shown in Figures 4-53 and 4-54. It can be seen that the effect of the maximum axial number on the reflood calculation was not obvious. Even though, there is an interesting tendency revealed from the results implying that the larger the maximum number, the later the rewetting that may occur. The difference probably was resulted from the rewetting rate featured in Semiscale test facility. As revealed from the test results, the rewetting rate was about 1.8 cm/sec. In addition, the resulting cladding temperature histories of the highest power sections of both high and lower power rods are also put together for comparison and shown in Figures 4-55 and 4-56. Both trends and magnitudes from those different modelings were quite matched. Again, it can be said that the effect of the maximum number on the integral cladding temperature response was obscure. Finally, the CPU time used in three cases is compared in Figure 4-57. It can be seen that once the reflood calculation began, the difference appeared. However, the difference was not noticeable.

4.2.4 Number of Axial Hydraulic Volumes Representing the Core

In this study, the axial number of hydraulic volumes representing the core was changed from the base model numbered 11 to 5 and 22. Several important parameters associated with the hot channel were compared. The resulting peak cladding temperatures versus the hot fuel elevations are shown in Figure 4-58. It can be found that results from three modelings were quite matched except a dip in the calculation with 22 axial volumes representing the core. To illustrate such difference, the cladding temperature responses at this location are compared in Figure 4-59. It can be seen that although in all cases the fuel has experienced dryout at this location, dryout time from the modeling having 22 volumes was a little postponed and the resulted magnitude of temperature excursion was smaller.

The quench time versus fuel elevations is also compared in Figure 4-60. It can be seen that other than at ends of fuel rods, there existed a tendency showing that fine noding of the core may result in a later quench. The temperature responses of the highest power section from three modeling are compared too, as shown in Figure 4-61. The noding difference seemed to have no effect on the intergral cladding temperature response on the hot spot.

Comparison of core collapsed water levels from three modelings are shown in Figure 4-62. Also, no noticeable difference was noted. Nevertheless, the CPU time cost in the calculation of 22 axial nodes was much more than the other two did, as shown in Figure 4-63.

4.2.5 Cross-Flow Junctions on Reactor Vessel Entrances

In the base calculation the entrances of four legs entering the reactor vessel were modelled with normal junctions. In this study, those normal junctions were replaced by four cross-flow junctions to investigate the effect of momentum flux in loops. Resulting break flow rates are shown in Figures 4-64 and 4-65 and compared to what was obtained from the base calculations. It can be seen that it had almost no effect on break flow rates especially for the break flow near the pump side. As for downcomer and lower plenum collapsed water levels, shown in Figures 4-66 and 4-67, it can be seen that trends were quite matched. However, the associated filled-up time was a little delayed in the calculation with cross-flow junctions. As a result, the core water level ascending in the sensitivity calculation was a little postponed too, as shown in Figure 4-68. The quench time of high power rods versus fuel elevations is also compared and shown in Figure 4-69. It can be seen that other than on the ends of the fuel, the fuel quench time was a little put off in the calculation with cross-flow junctions. This postponement basically was caused by the associated delayed ascending of core water level depicted above. Other than the quench time, the highest cladding temperature along the fuel elevation is also compared and results are shown in Figure 4-70.

It can be found that both curves were almost identical. To investigate the effect on the integral cladding temperature responses, the cladding temperatures of the highest power section versus time are shown in Figure 4-71. As revealed, both trend and maguitude were quite matched except a little delay of the quench in the sensitivity calculation which already has been described. Finally, the costs of CPU time for both calculations are also compared and shown in Figure 4-72. It can be observed that the calculation with cross-flow junction modeling used more CPU time than base calculation by a factor about 1.15.

4.2.6 Reflood Calculation

In the base modeling, reflood calculation is actuated when the core is nearly empty. As addressed in Reference 2, a two-dimensional conduction scheme and different heat transfer correlations known to apply for the reflood process are employed. In this study, normal reflood calculation is intentionally defeated to investigate associated effects. Resulting high power rod hot spot cladding temperature is shown in Figure 4-73 and compared with result from base calculation. It can be observed that after the actuation of reflood calculation in the base case, difference between both calculations appeared and it was enlarged after the fill of the lower plenum. Such difference basically was caused by the effect of axial conduction along the fuel and different heat transfer package used. To further identify which one plays the key role in making this difference, a reflood unit consisting of 11 sections in the base modeling to represent fuel rods was changed to 11 reflood unit in series consisting of 1 section in each. The result is such that the two-dimensional conduction effect can almost be suppressed in this alter modeling while still using the same reflood heat transfer package. Resulting temperature is shown in Figure 4-74 and compared to the result from base modeling. From comparison, it can be deduced that the effect of two-dimensional conduction was rather small and the difference shown in Figure 4-73 was mainly caused by the usage of different heat transfer package when defeating of normal reflood calculation. The comparison of CPU time used is shown in Figure 4-75. It is clear that the cost of CPU time is very close even without reflood calculation.

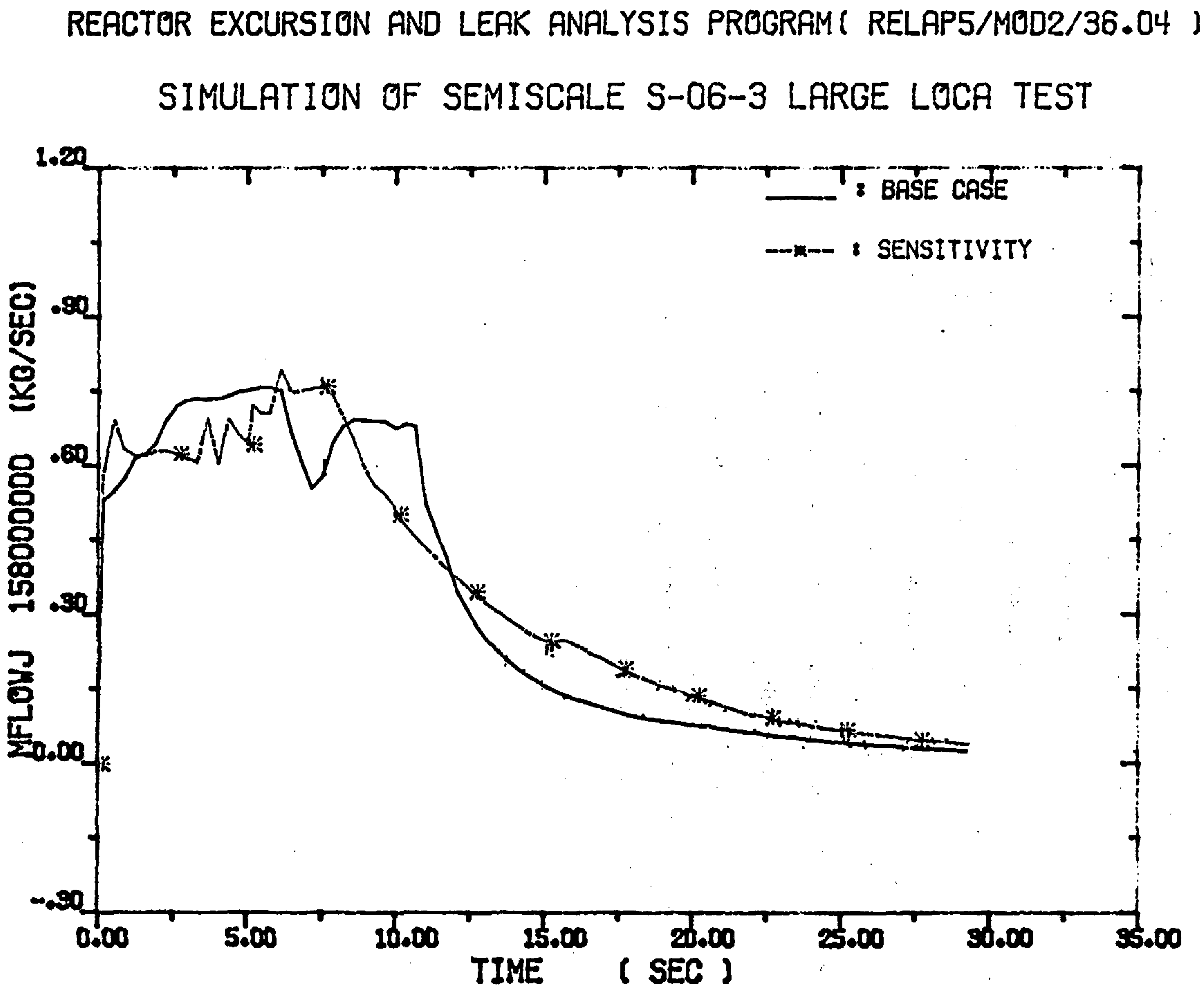

Fig. 4-40. Pressurizer Outsurge Flow Rates

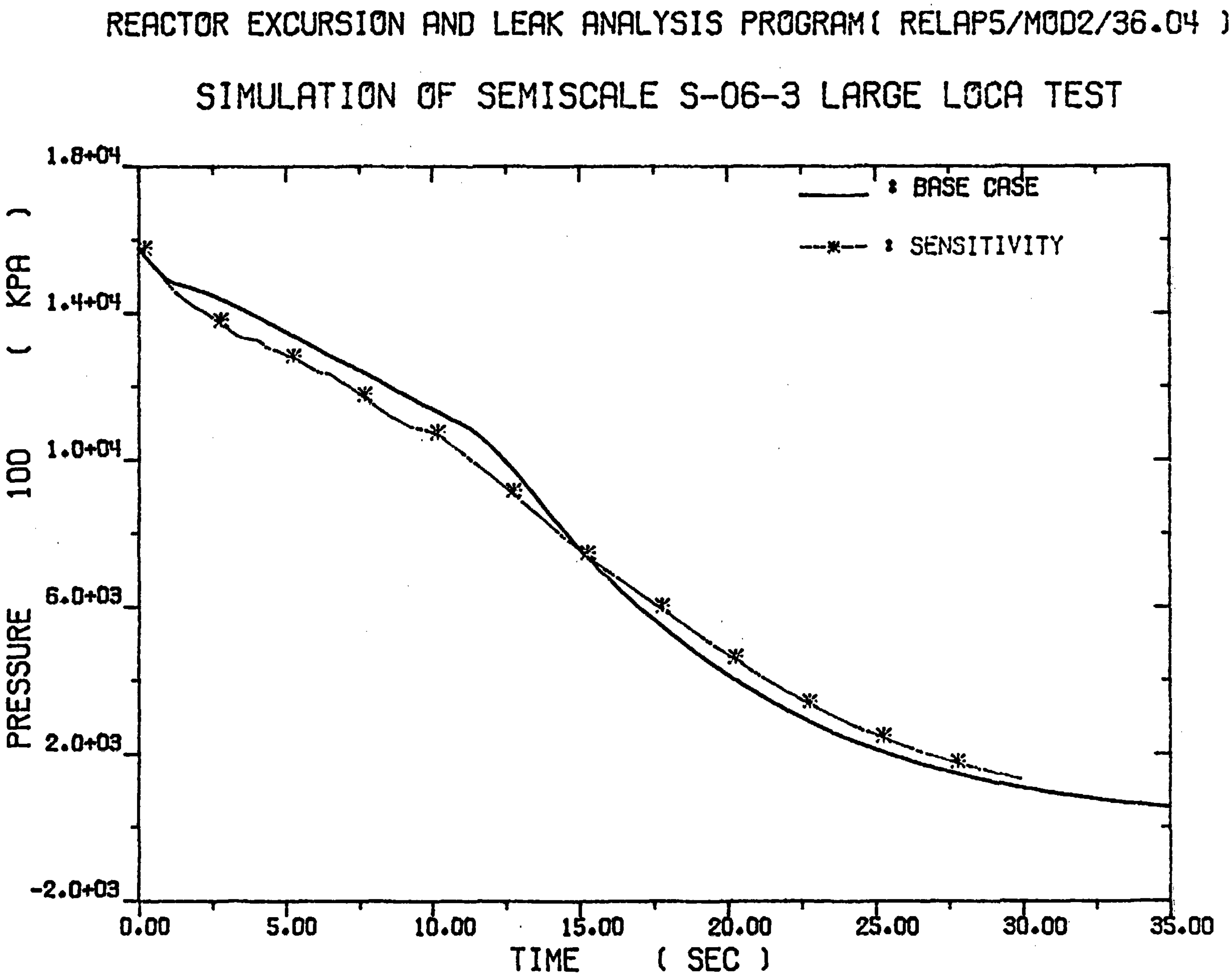

Fig. 4-41. Pressurizer Pressures

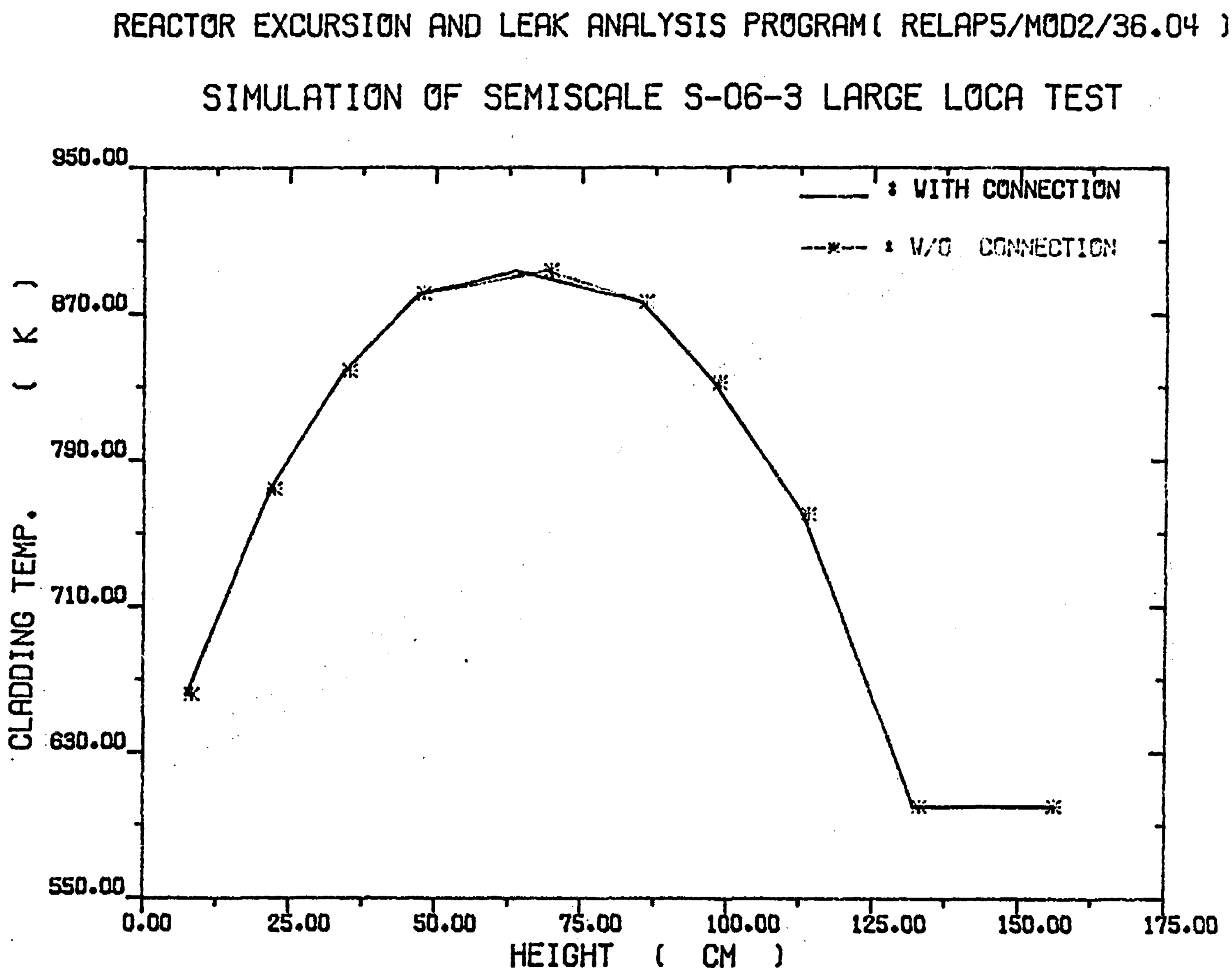

Fig. 4-42. Low Power Rod Peak Cladding Temperatures versus Elevation

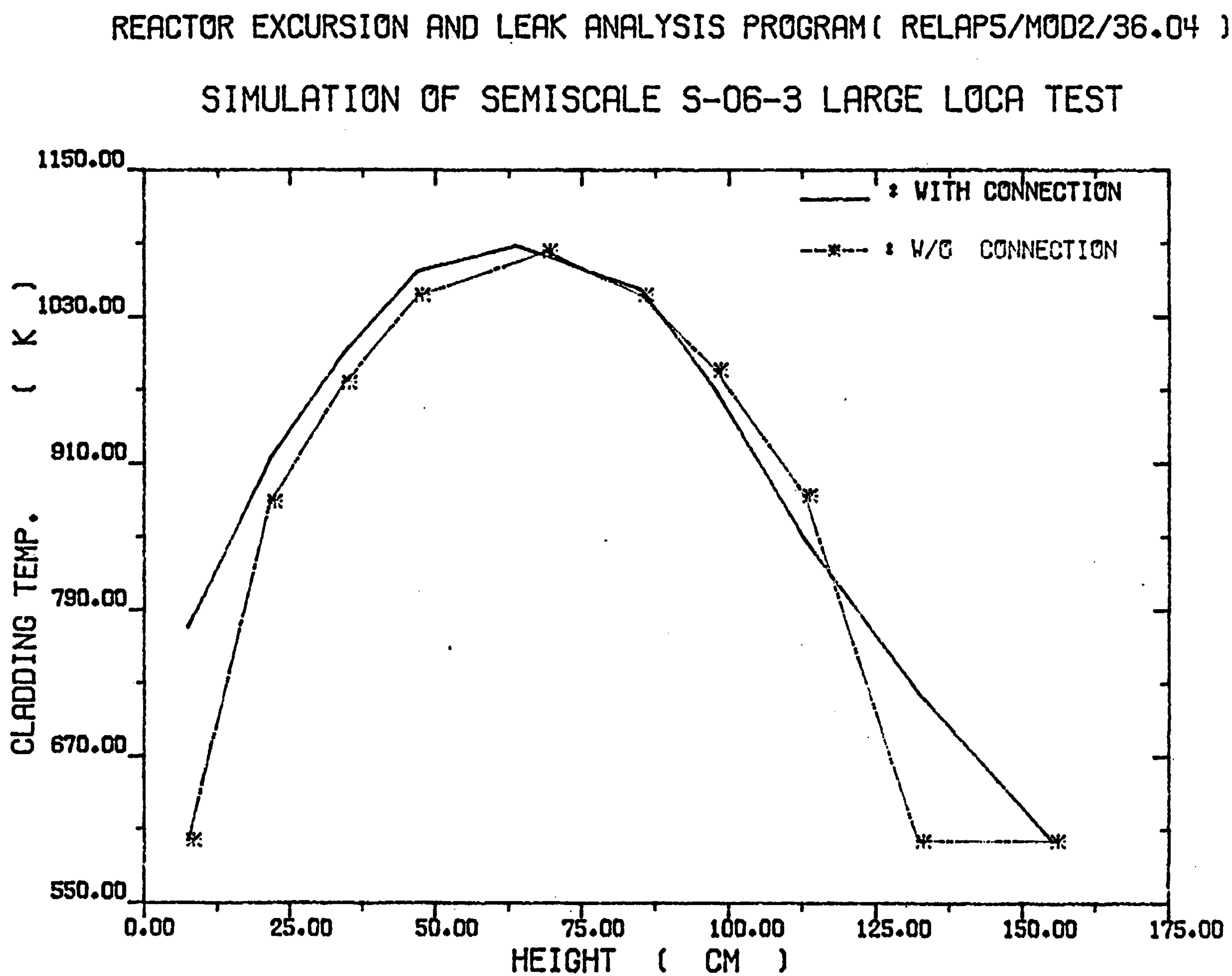

Fig. 4-43. High Power Rod Peak Cladding Temperatures versus Elevation

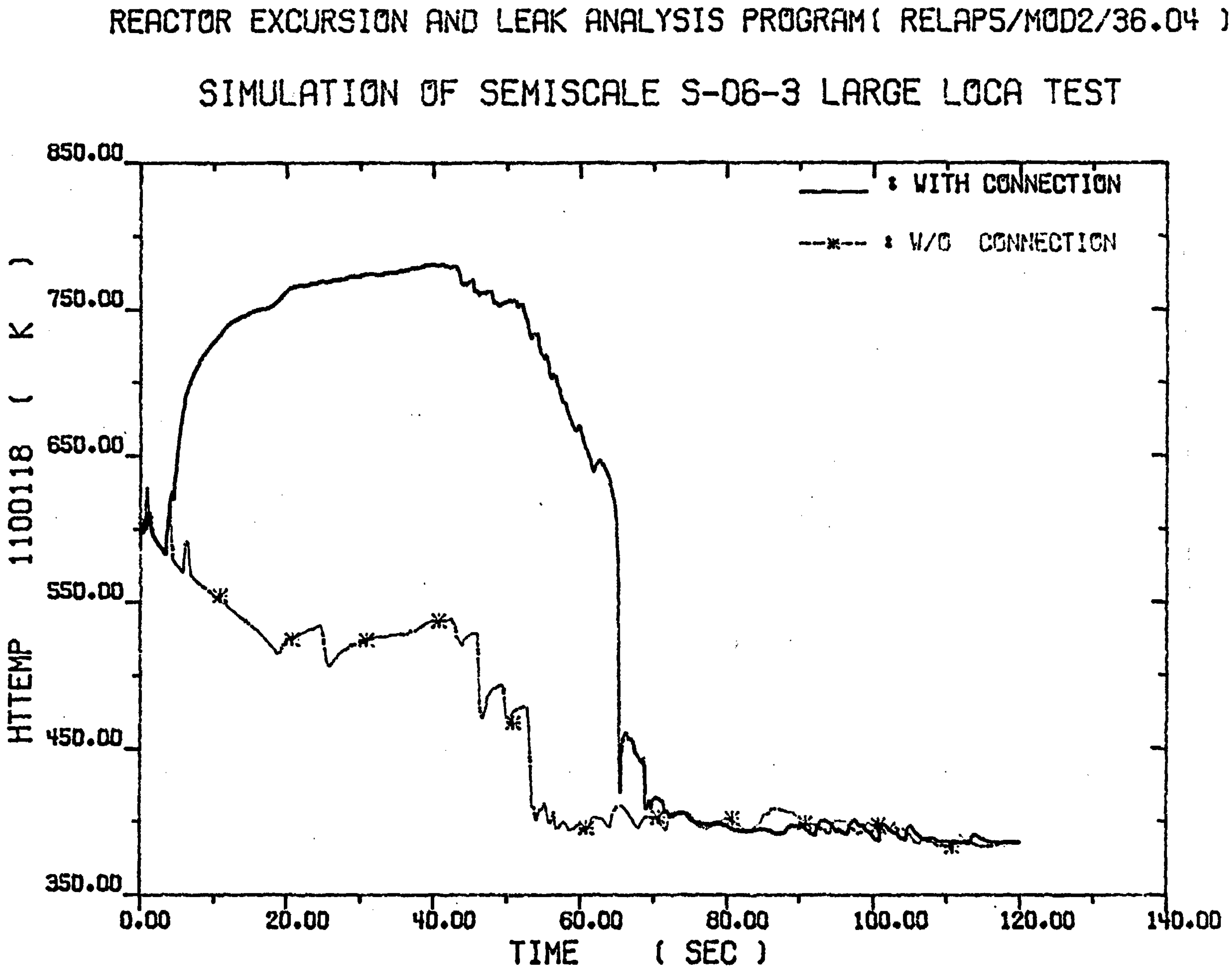

Fig. 4-44. High Power Rod Bottom Section Cladding Temperatures

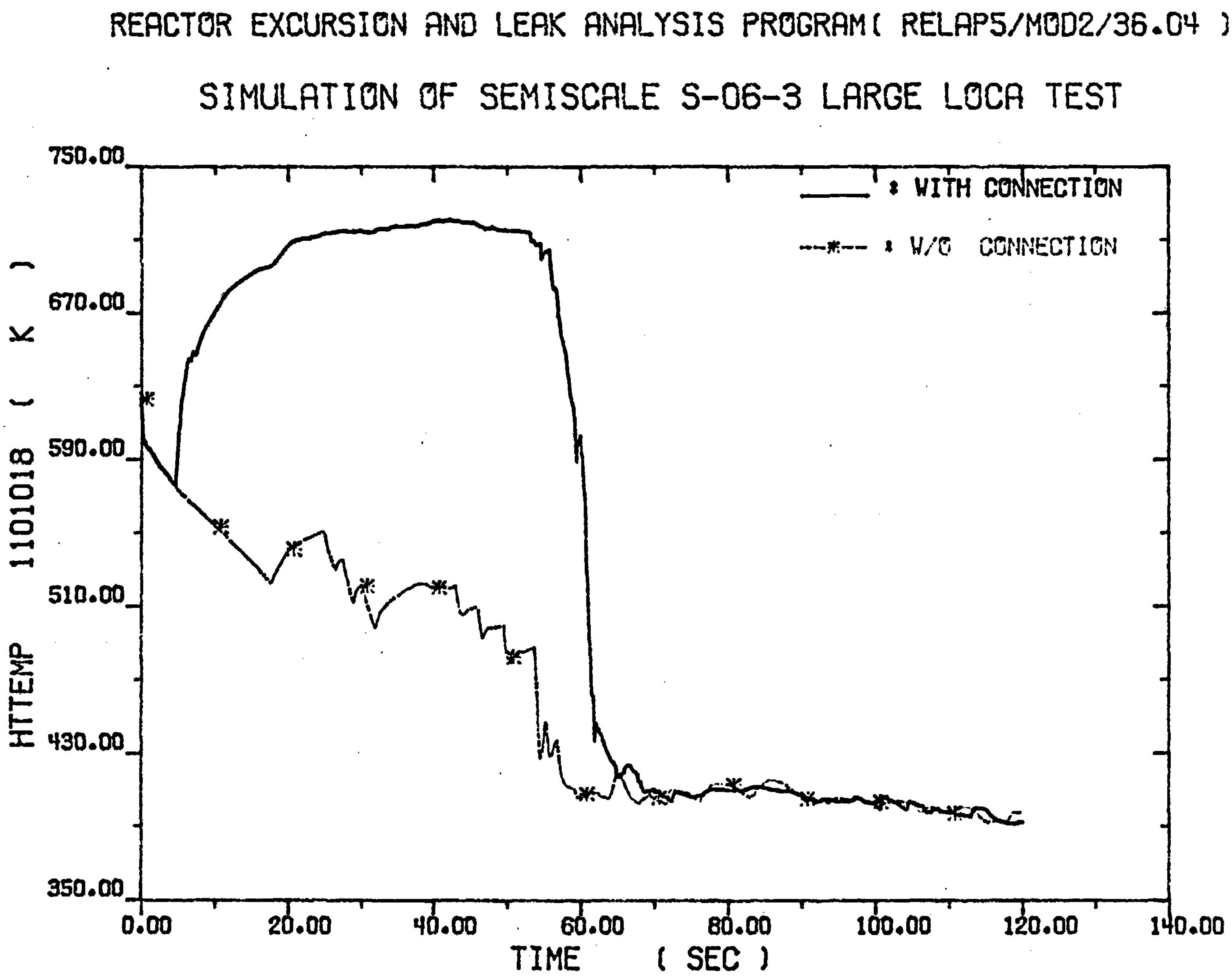

Fig. 4-45. High Power Rod Top Section Cladding Temperatures

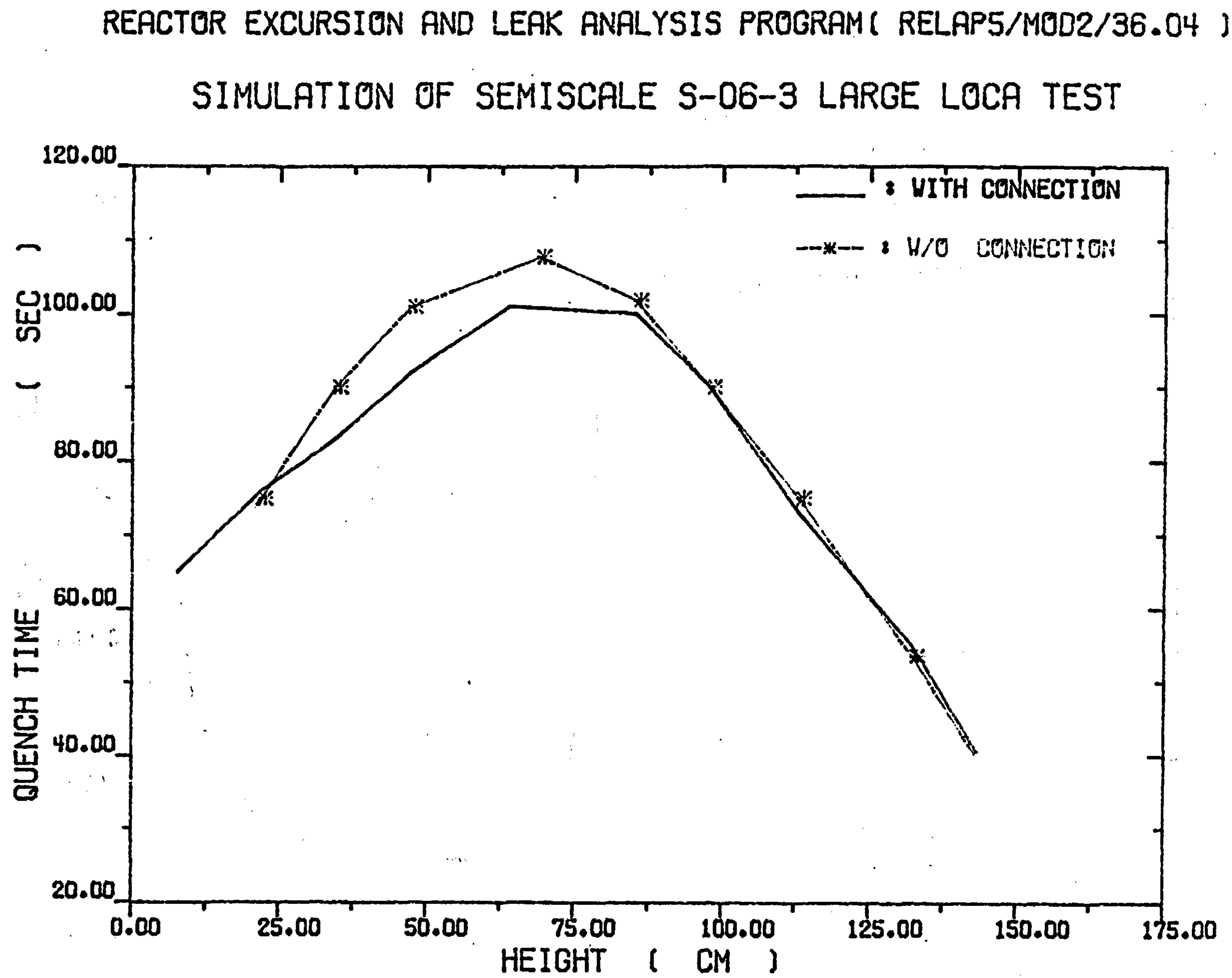

Fig. 4-46. High Power Rod Quench Time versus Elevation

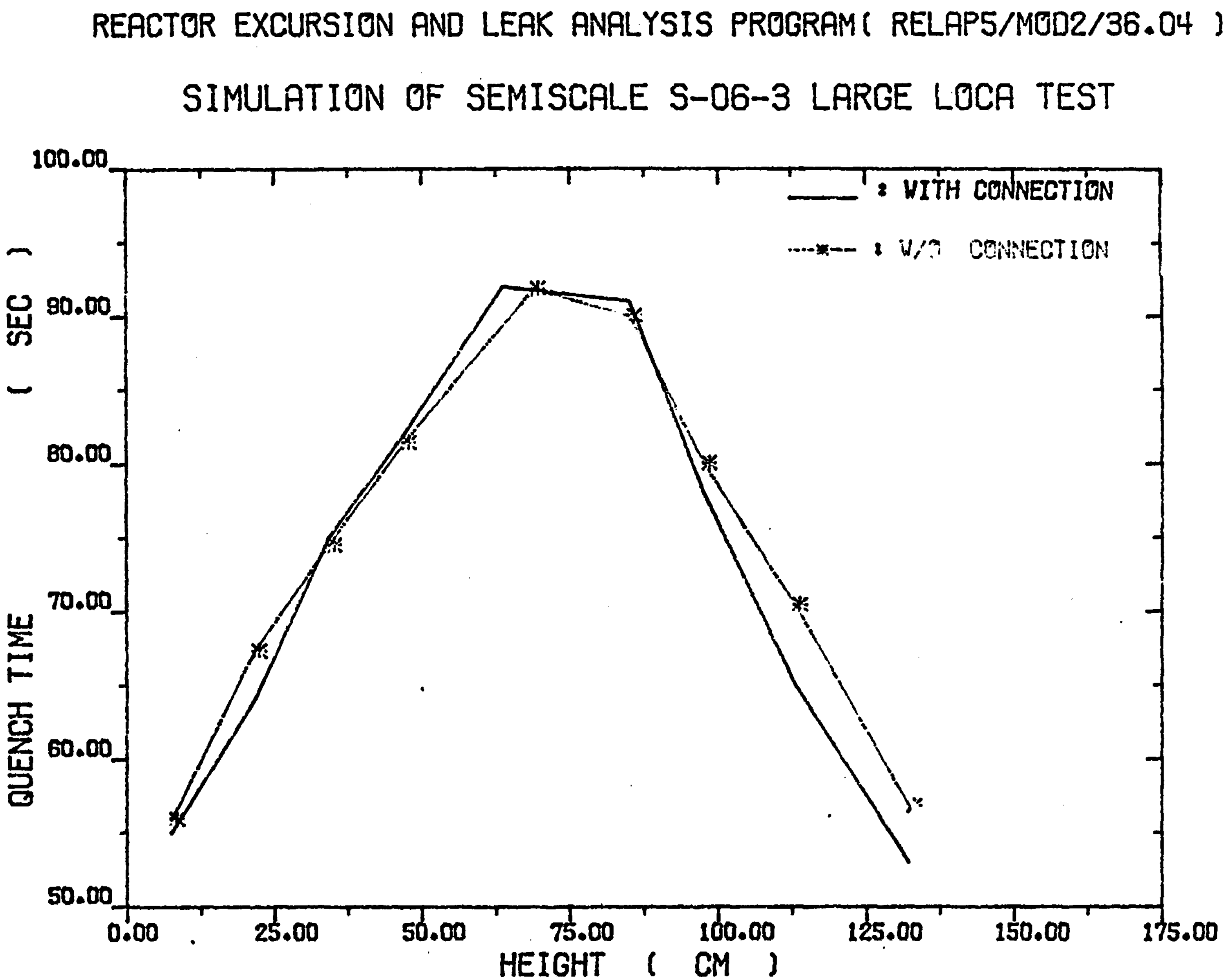

Fig. 4-47. Low Power Rod Quench Time versus Elevation

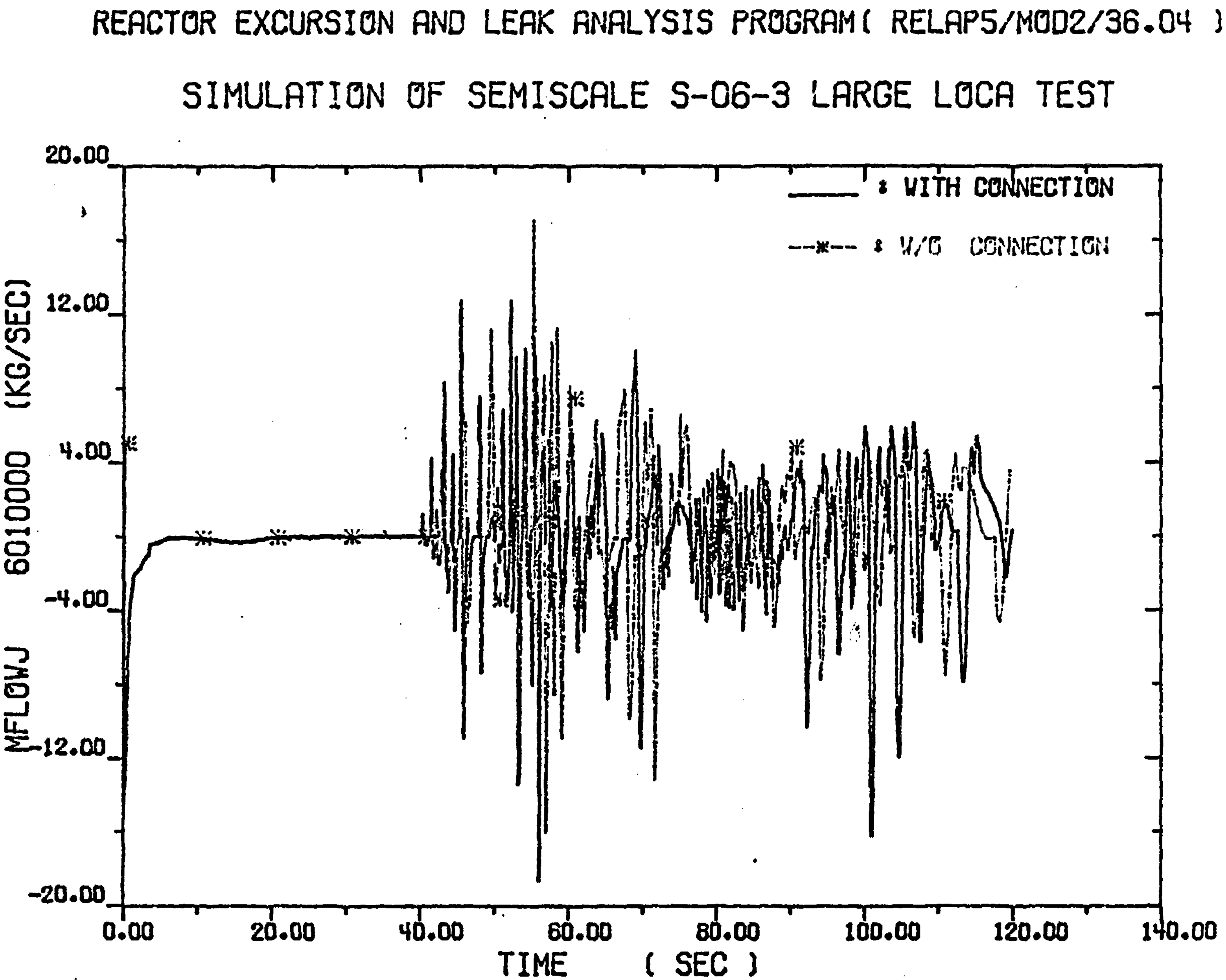

Fig. 4-48. Core Inlet Flow Rates

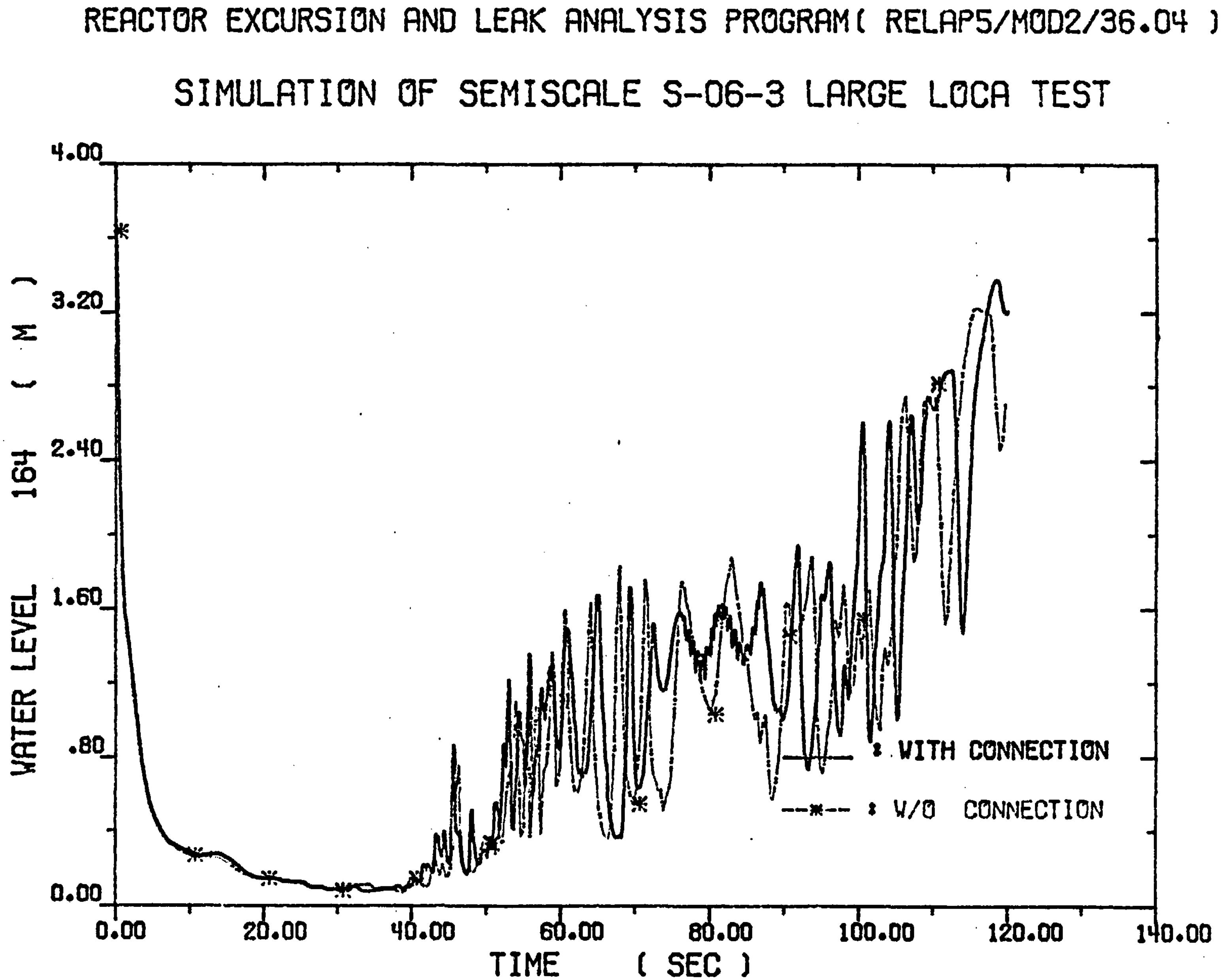

Fig. 4-49. Collapsed Water Levels across the Core

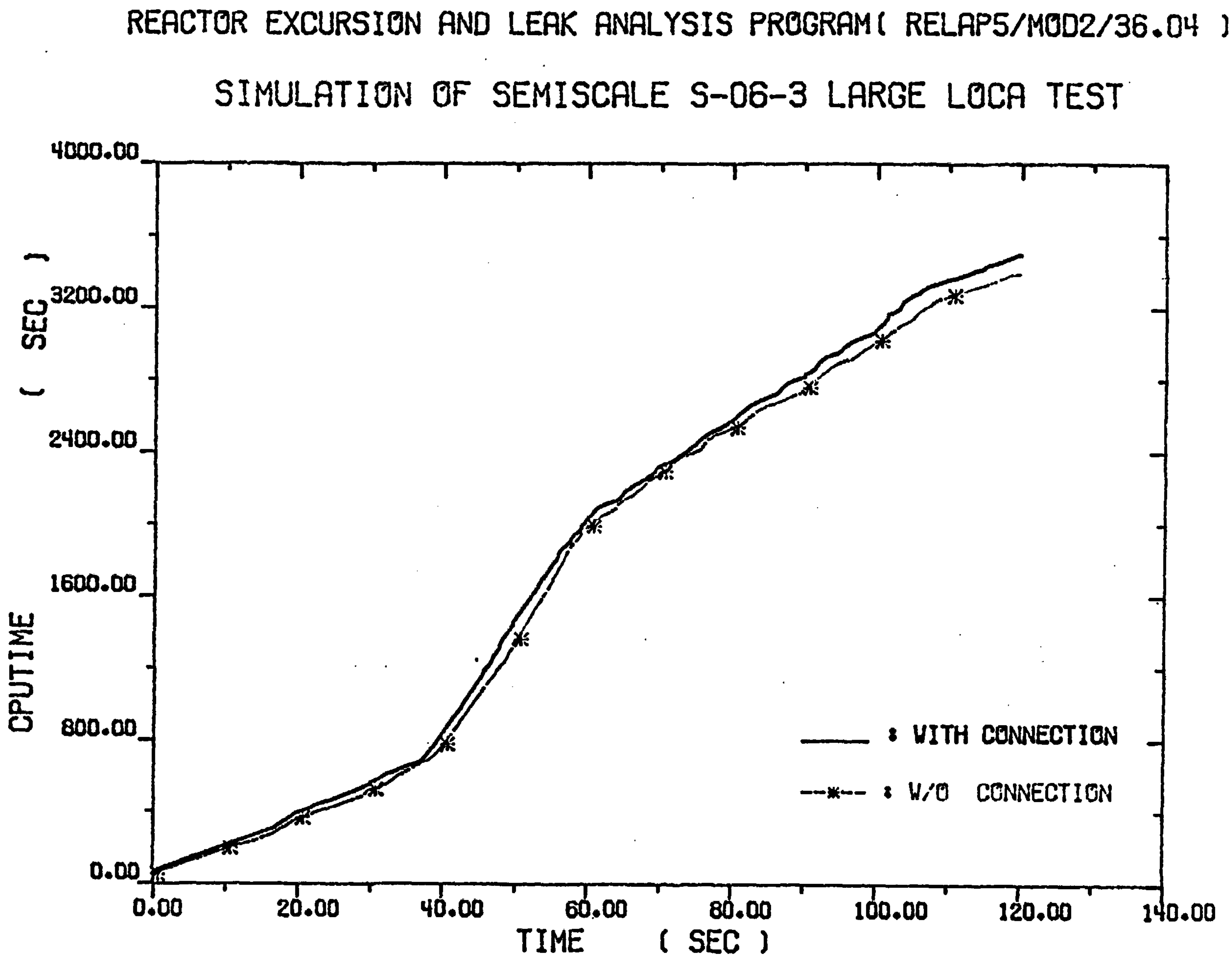

Fig. 4-50. Comparison of CPU Time

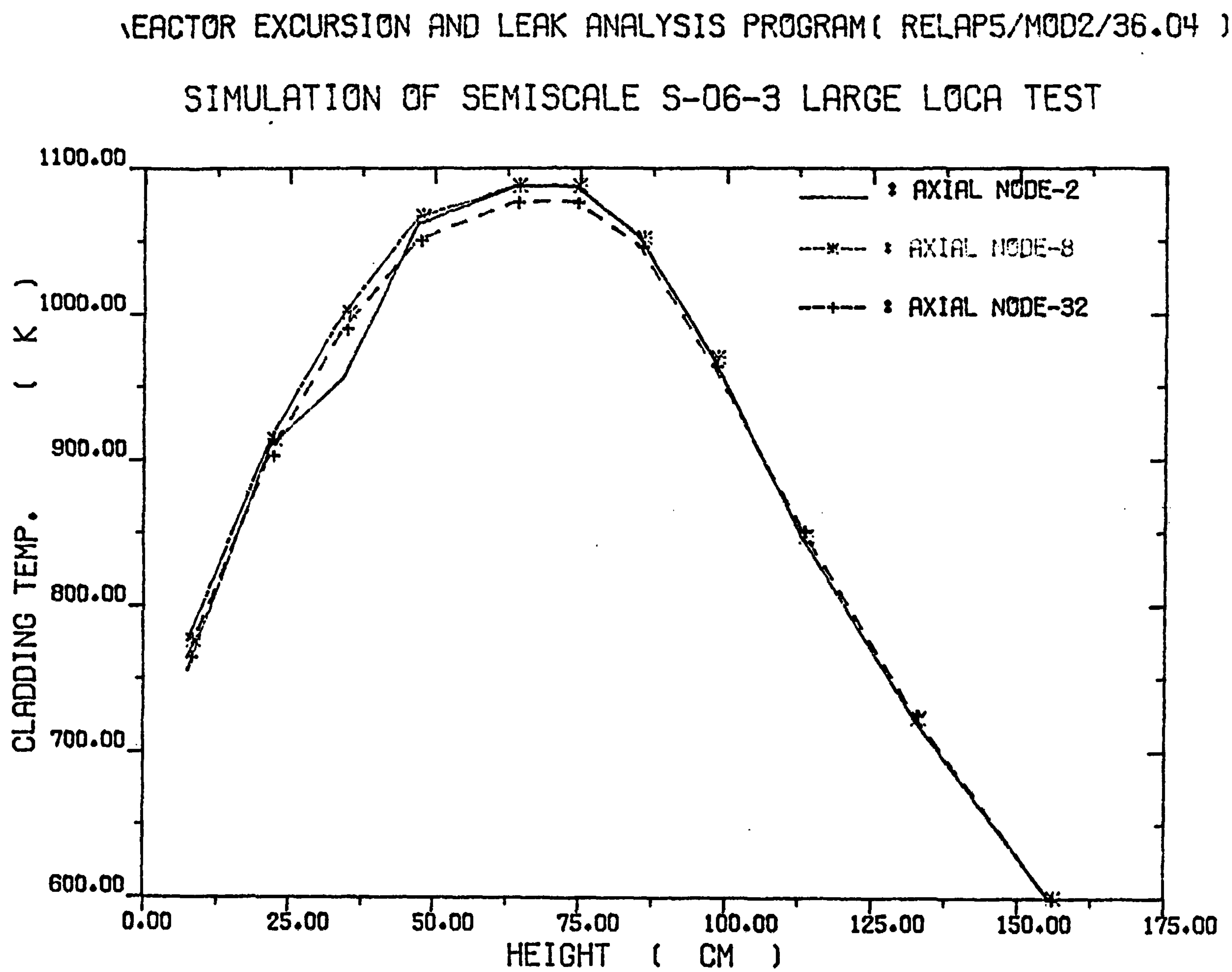

Fig. 4-51. High Power Rod Peak Cladding Temperatures versus Elevation

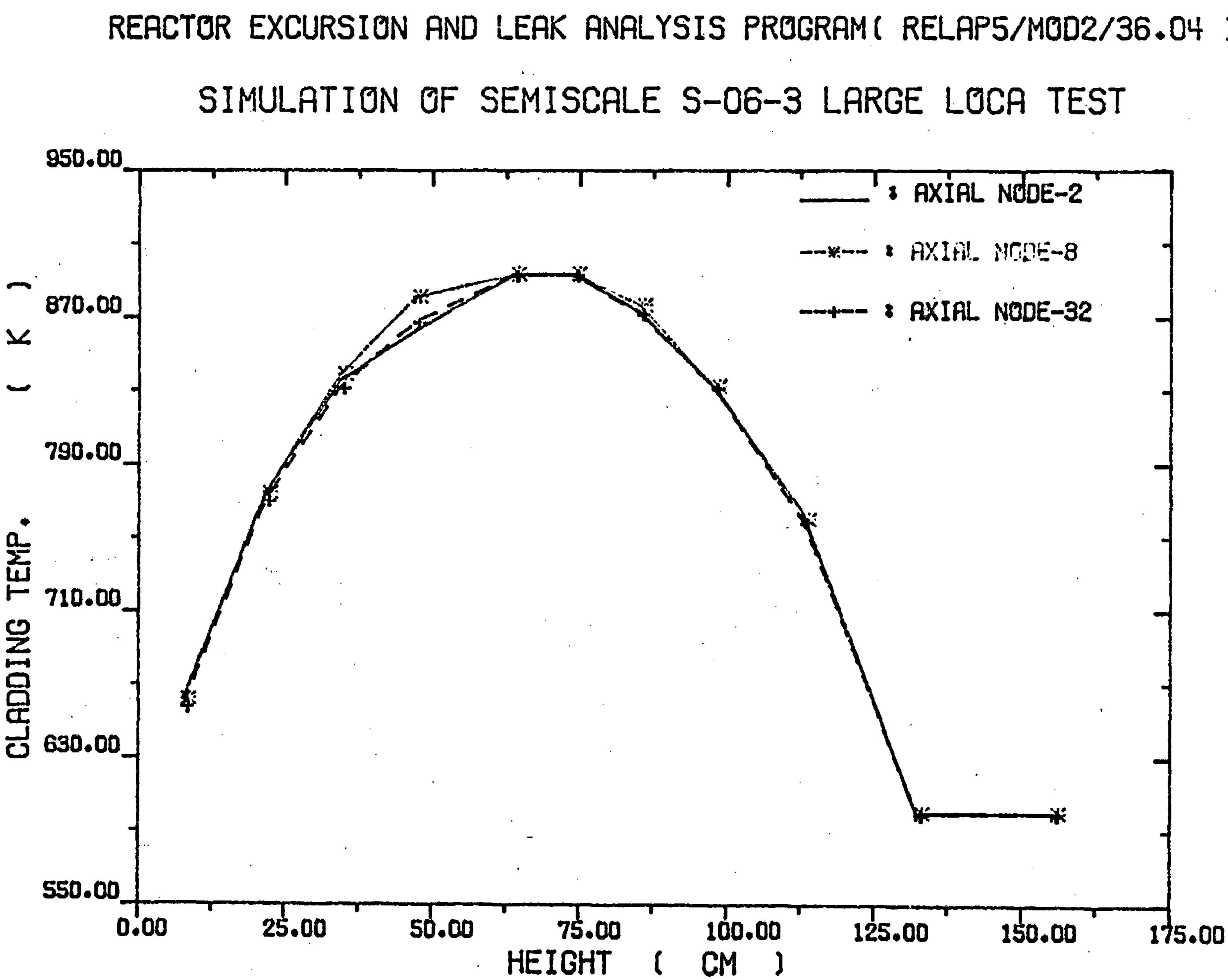

Fig. 4-52. Low Power Rod Peak Cladding Temperatures versus Elevation

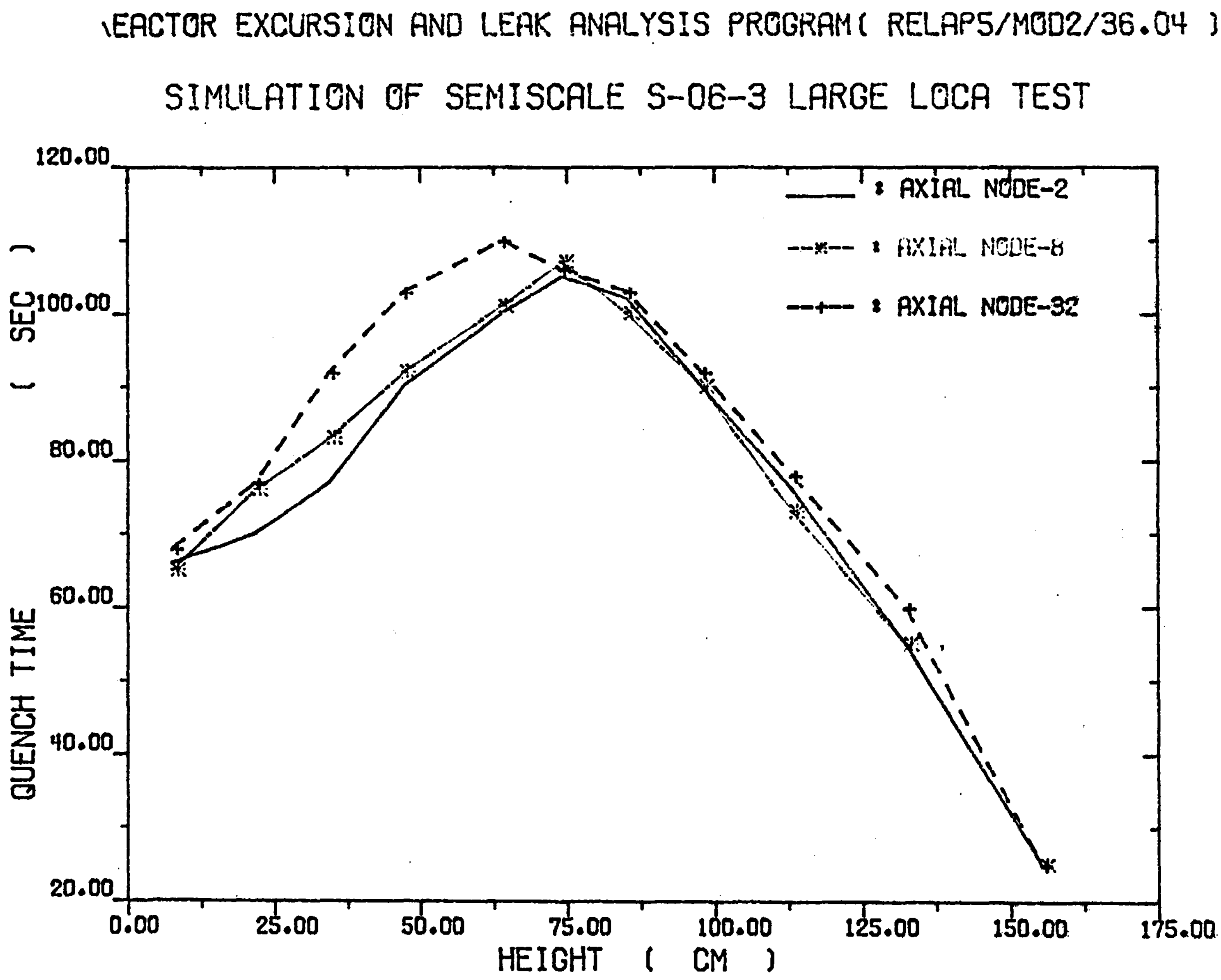

Fig. 4-53. High Power Rod Quench Time versus Elevation

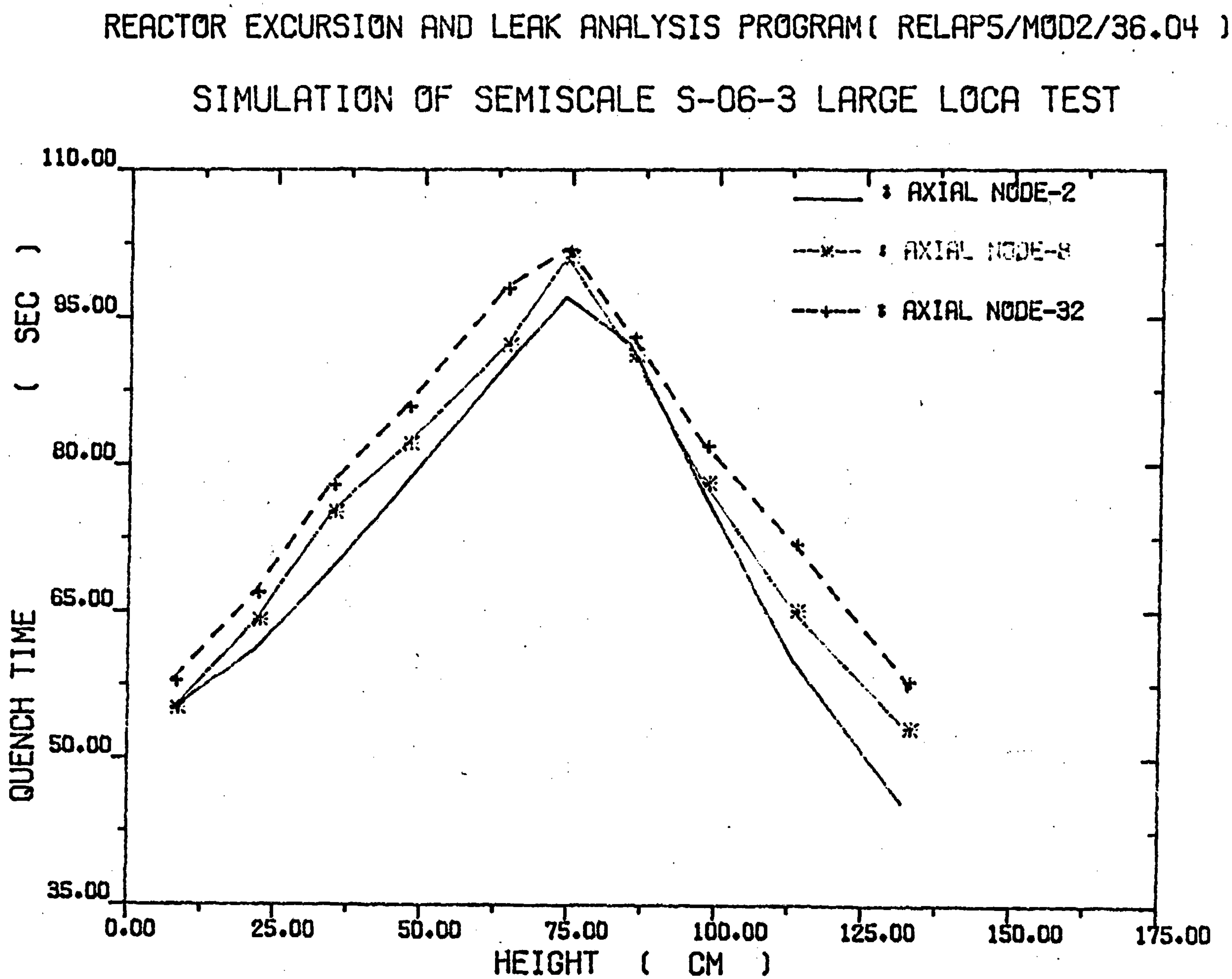

Fig. 4-54. Low Power Rod Quench Time versus Elevation

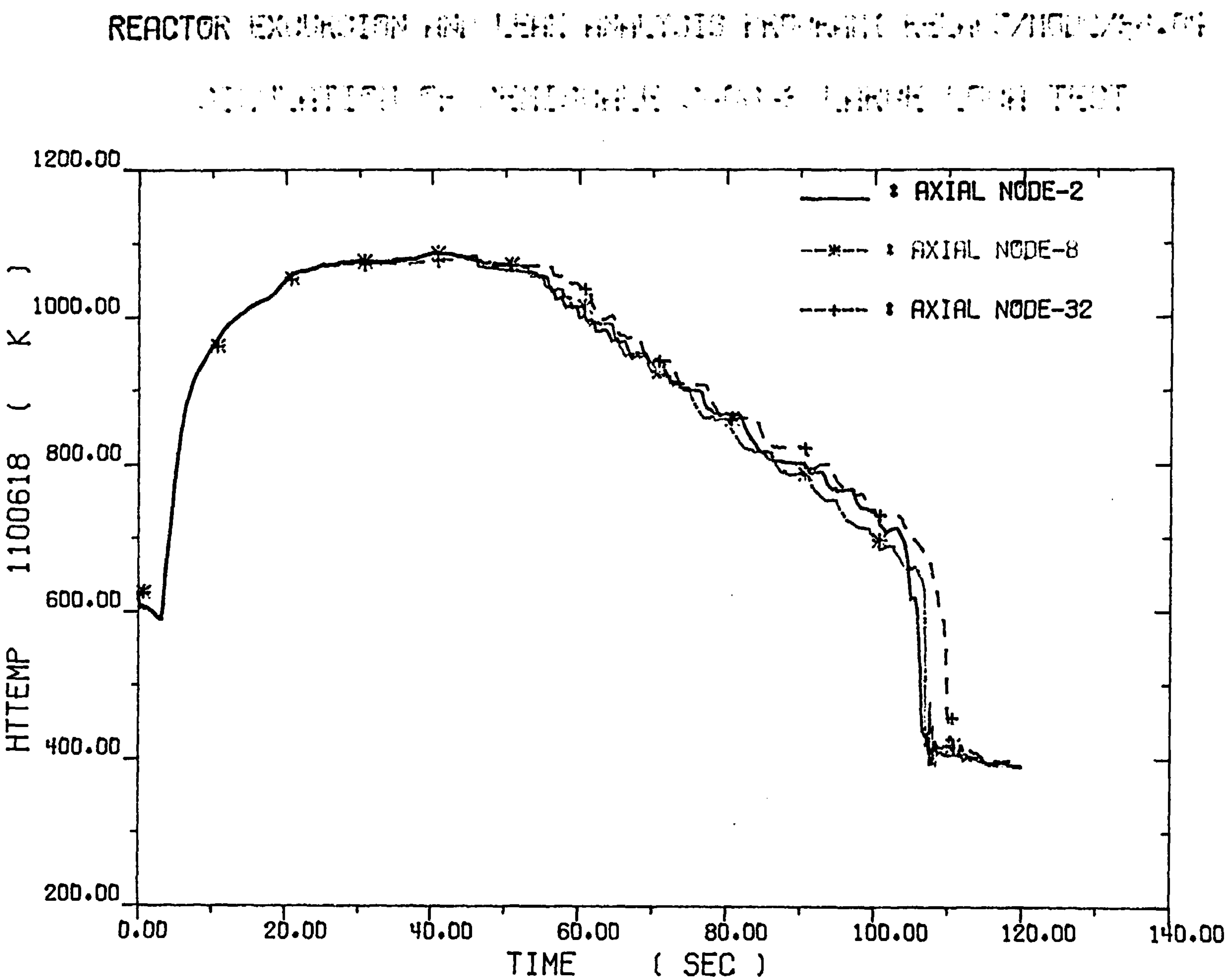

Fig. 4-55. High Power Rod Hot Spot Cladding Temperatures

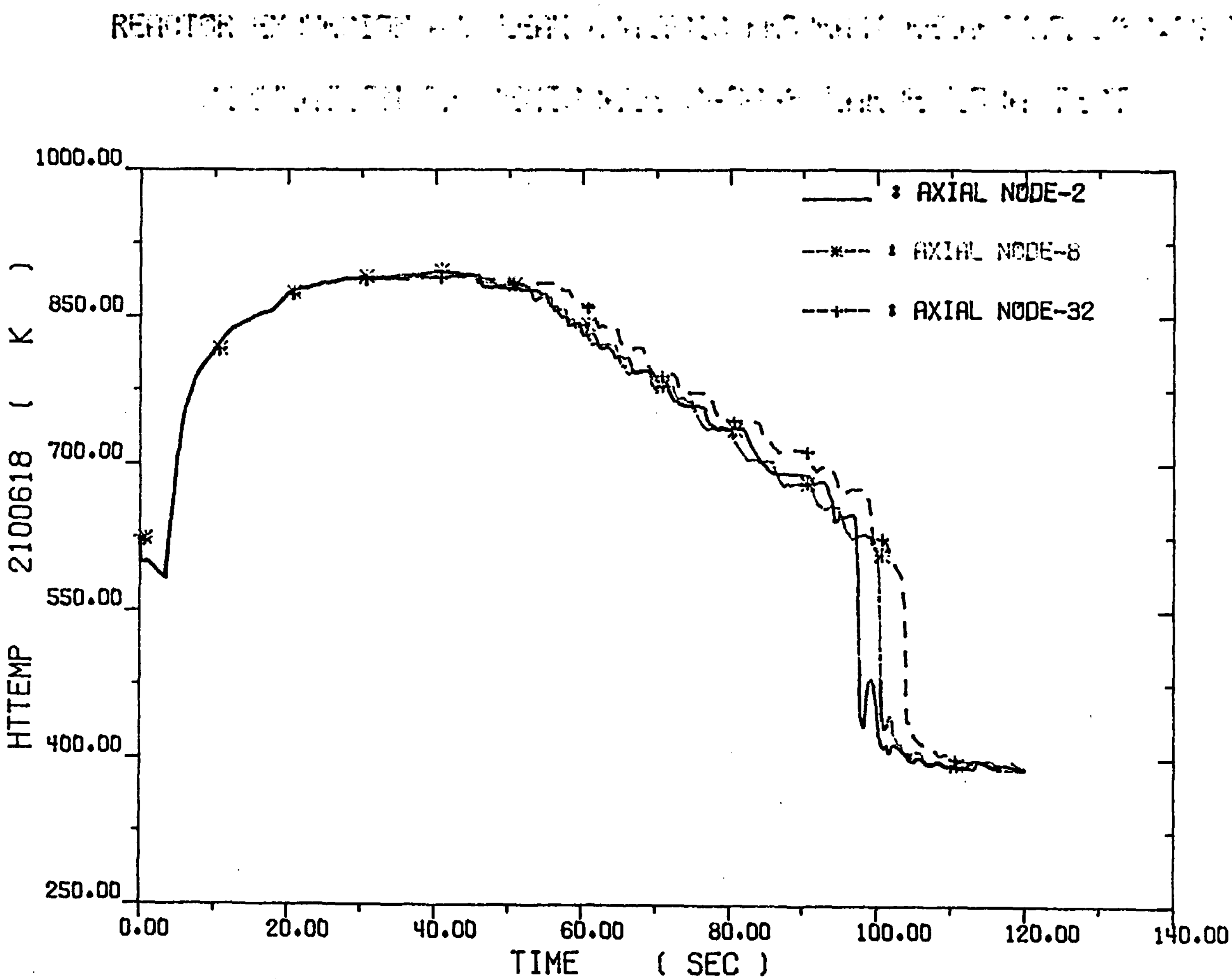

Fig. 4-56. Low Power Rod Hot Spot Cladding Temperatures

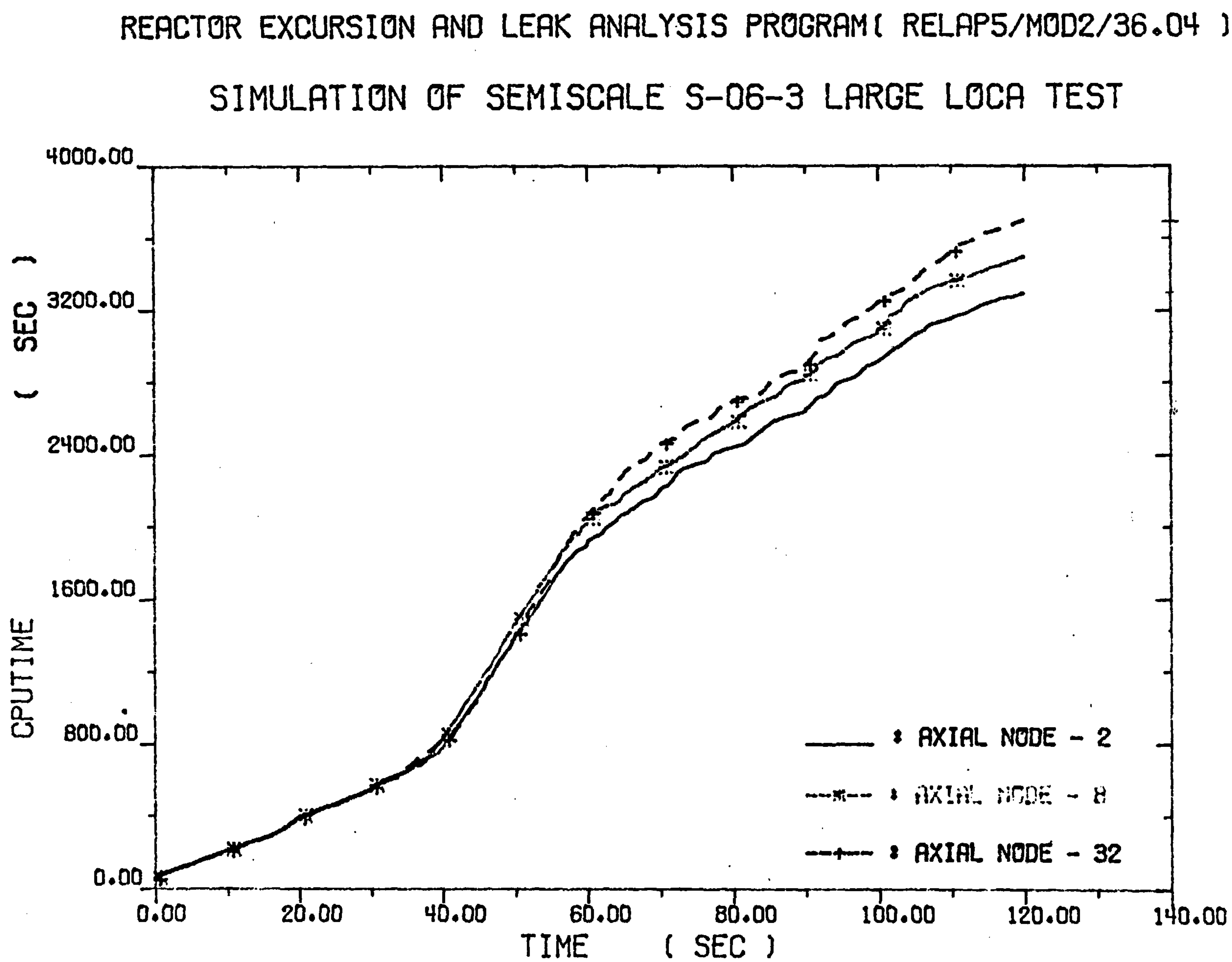

Fig. 4-57. Comparison of CPU Time

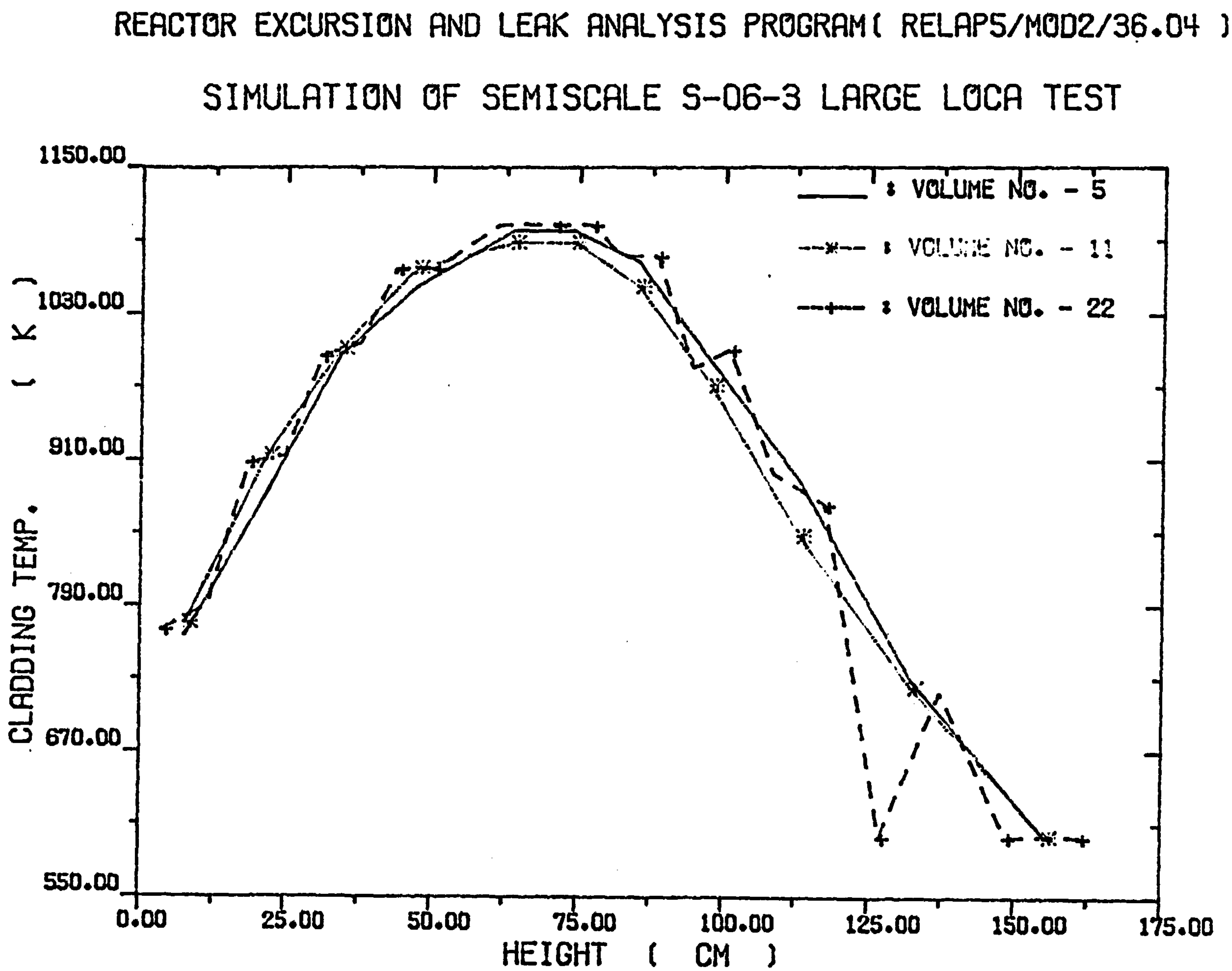

Fig. 4-58. High Power Rod Peak Cladding Temperatures versus Elevation

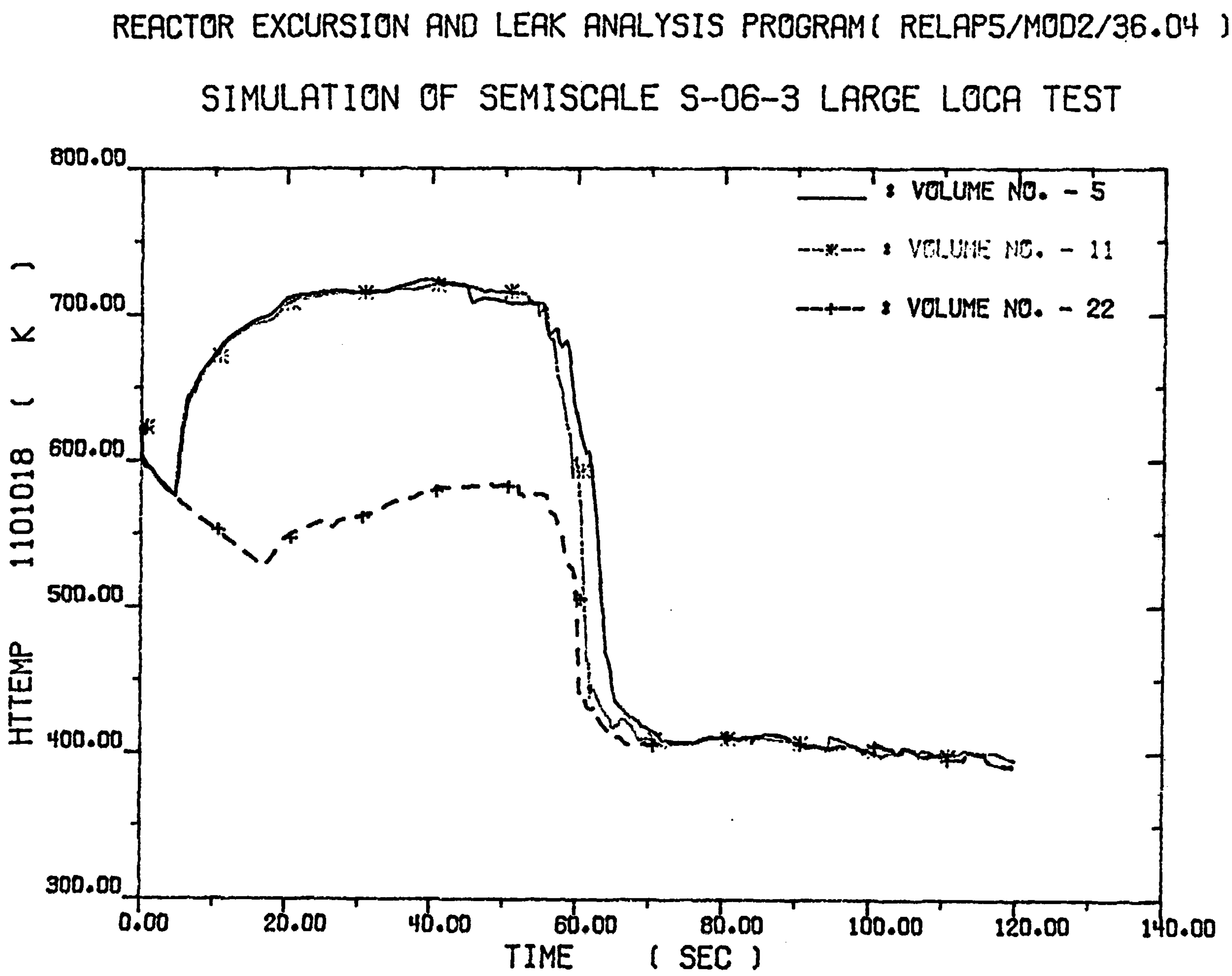

Fig. 4-59. High power Rod Top Section Cladding Temperatures

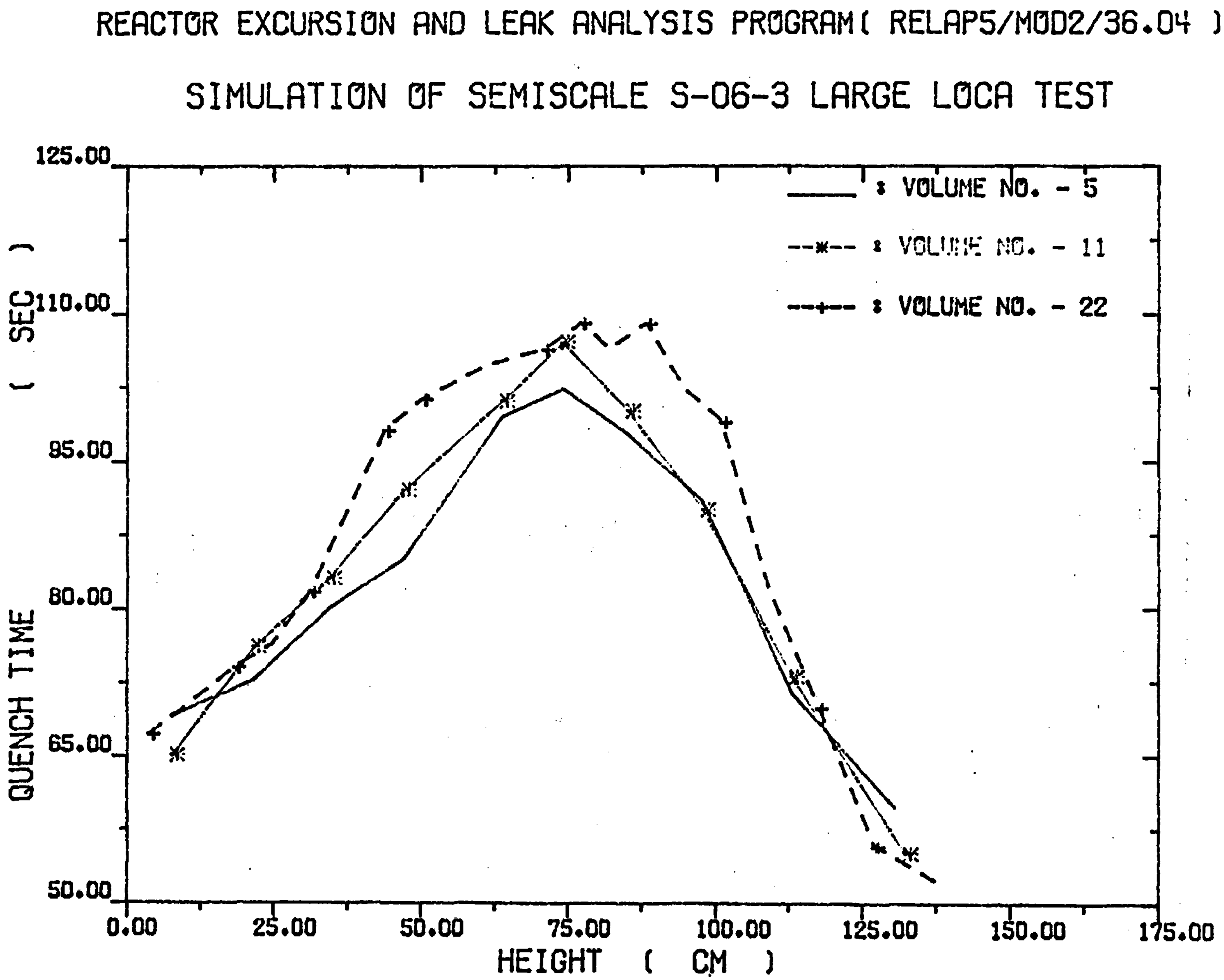

Fig. 4-60. High Power Rod Quench Time versus Elevation

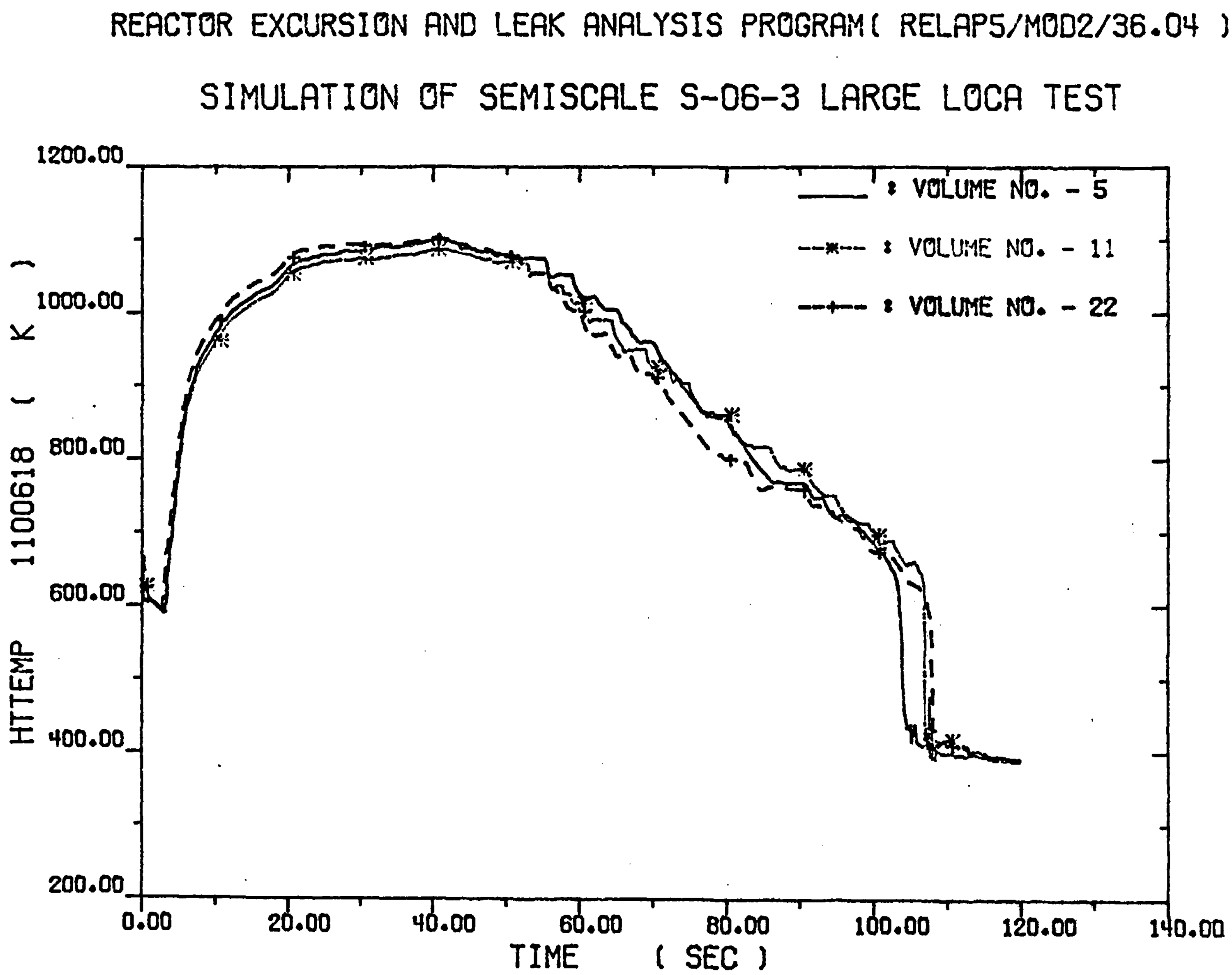

Fig. 4-61. High Power Rod Cladding Temperatures

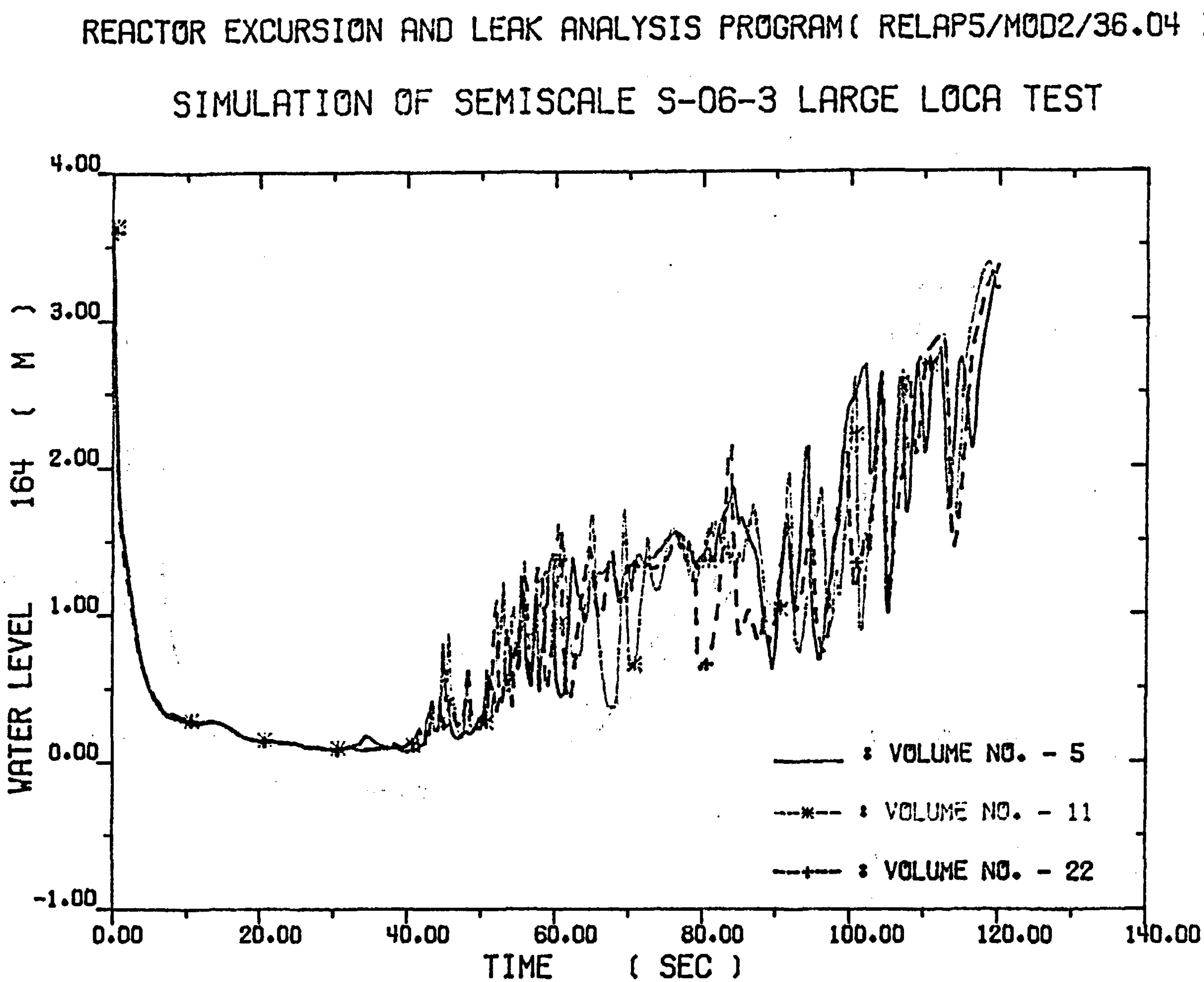

Fig. 4-62. Collapsed Water Levels across The Core

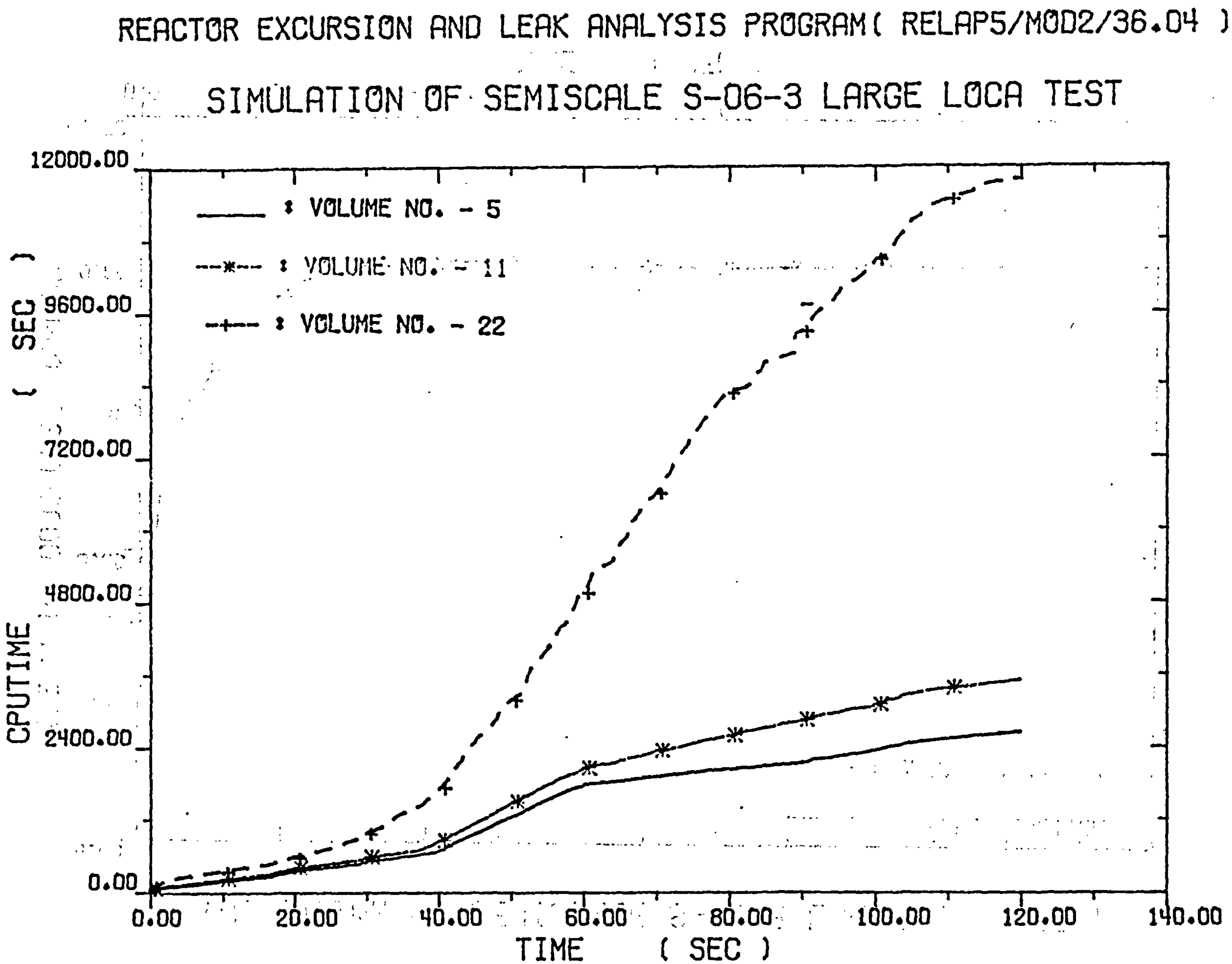

Fig. 4-63. Comparison of CPU Time

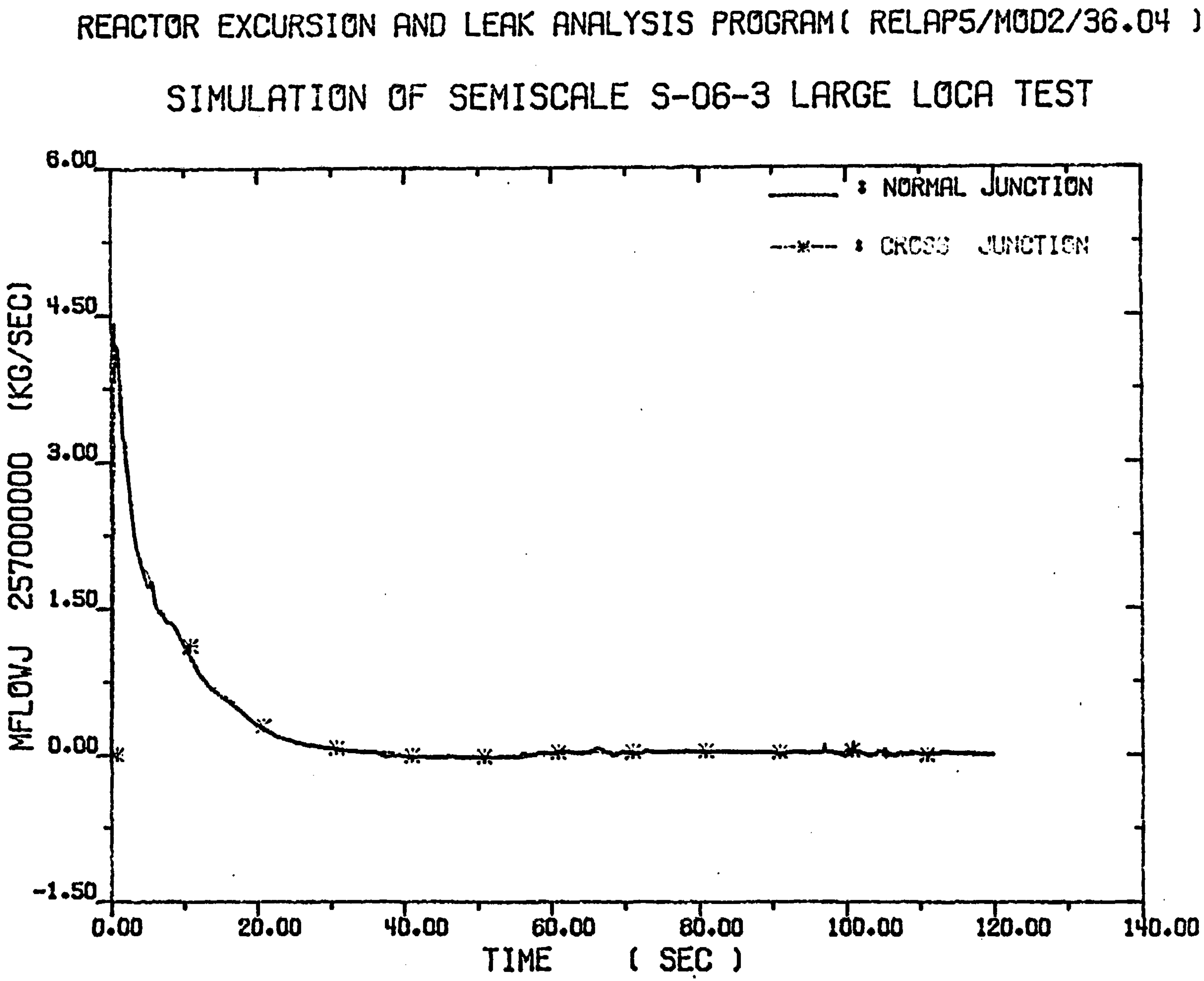

Fig. 4-64. Break Flow Rates near Pump Side

REACTOR EXCURSION AND LEAK ANALYSIS PROGRAM(RELAP5/MOD2/36.04)

SIMULATION OF SEMISCALE S-06-3 LARGE LOCA TEST

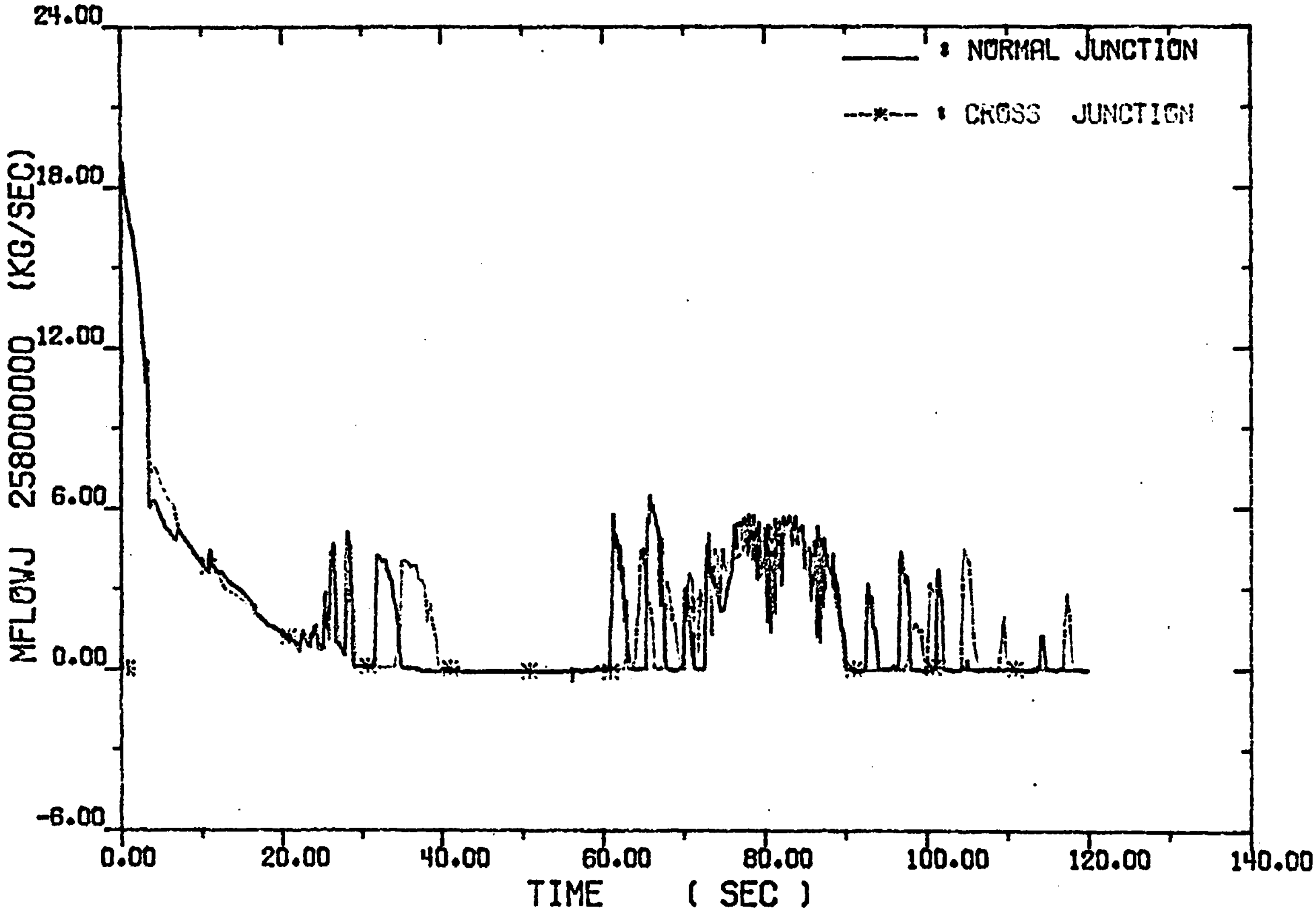

Fig. 4-65. Break Flow Rate near Vessel Side

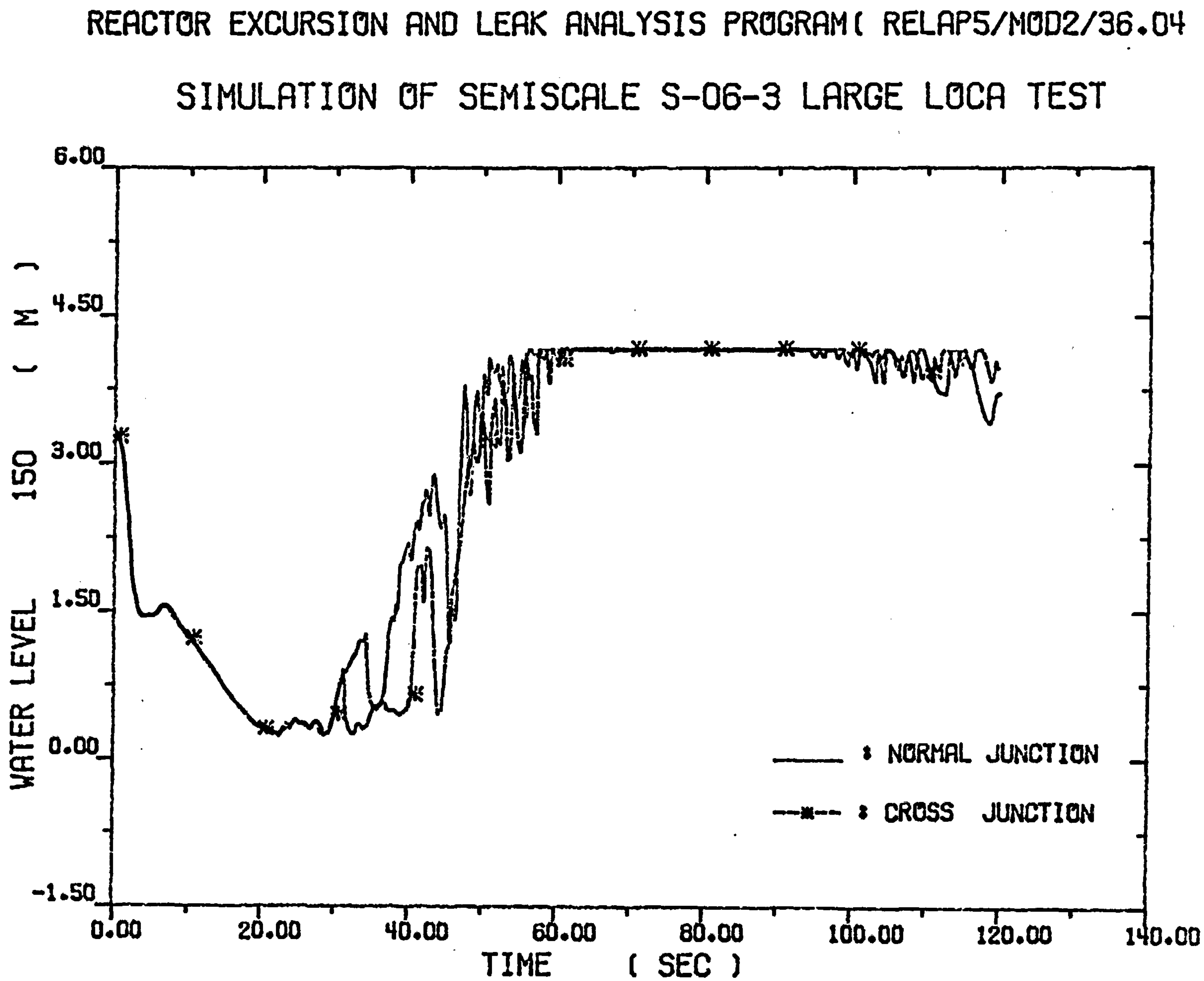

Fig. 4-66. Collapsed Water Levels across The Downcomer

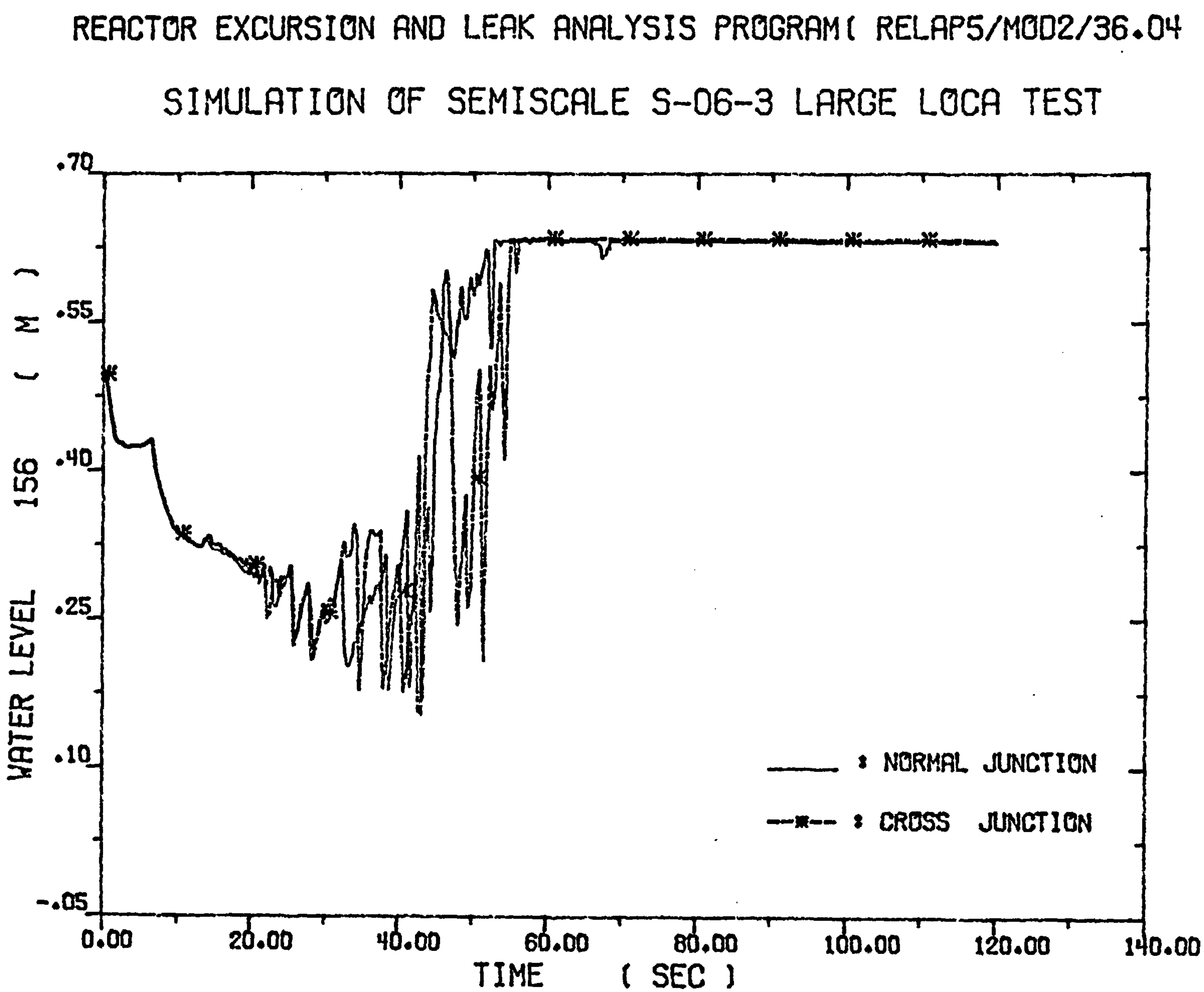

Fig. 4-67. Collapsed Water Levels across The Lower Plenum

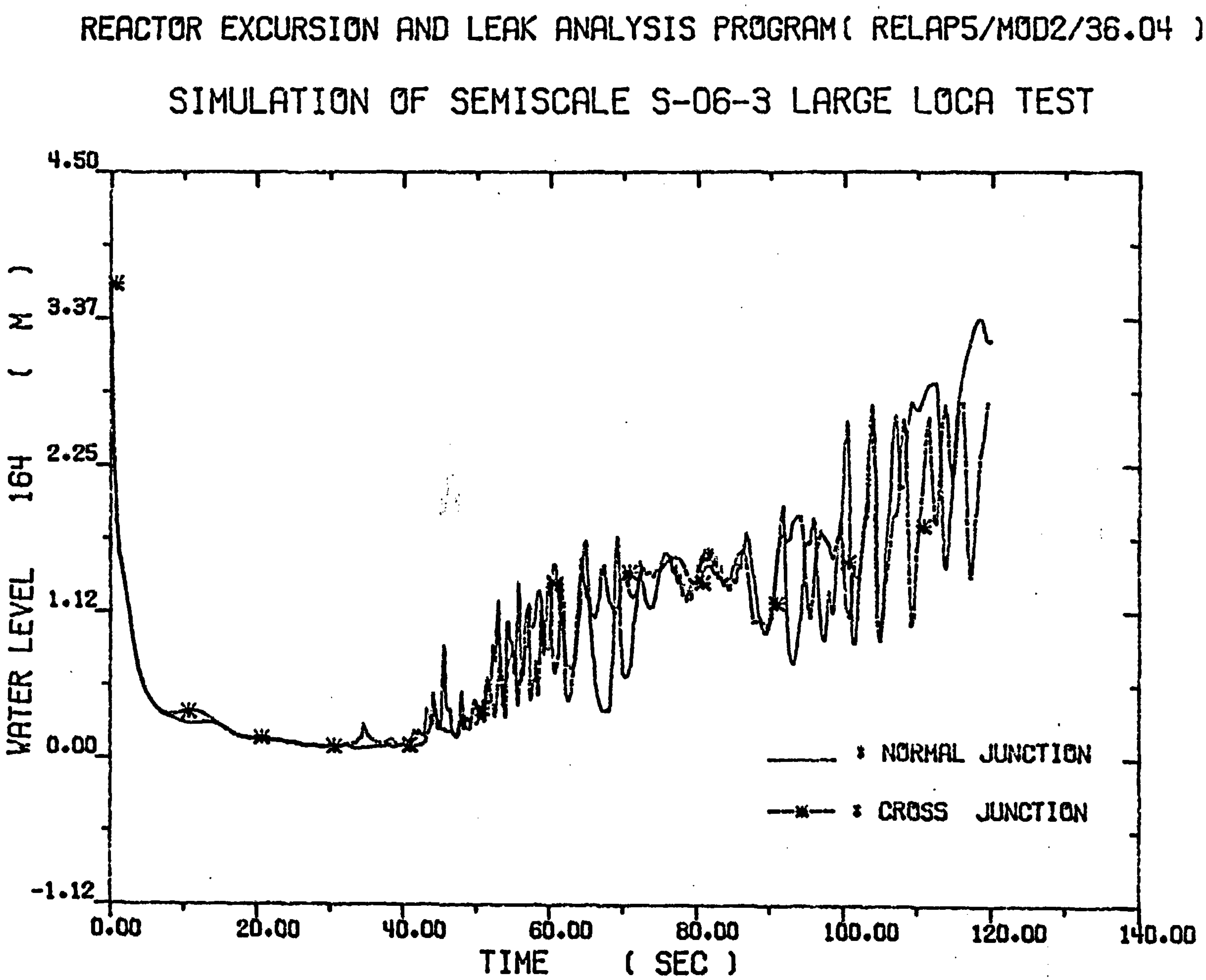

Fig. 4-68. Collapsed Water Levels across The Core

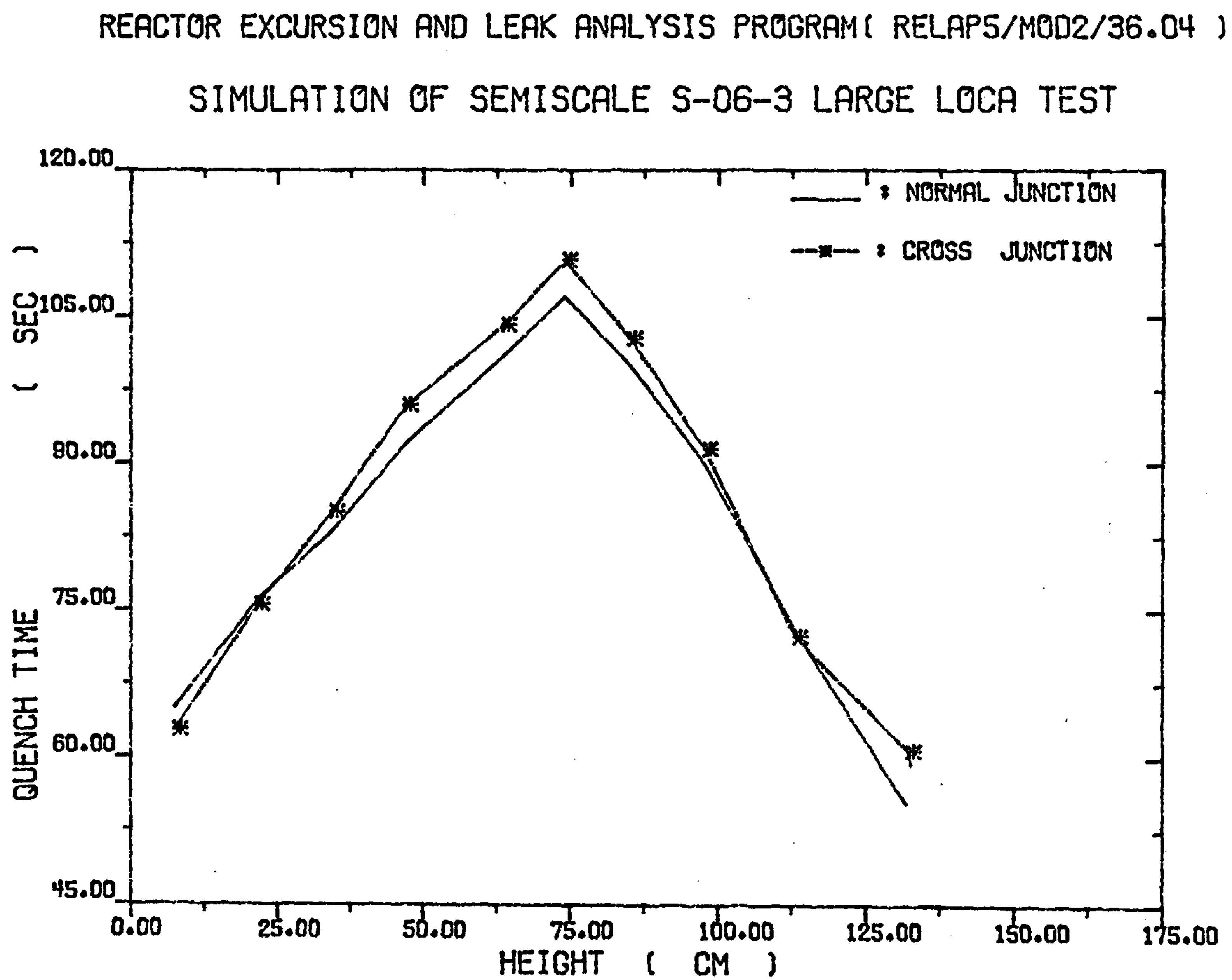

Fig. 4-69. High Power Rod Quench Time versus Elevation

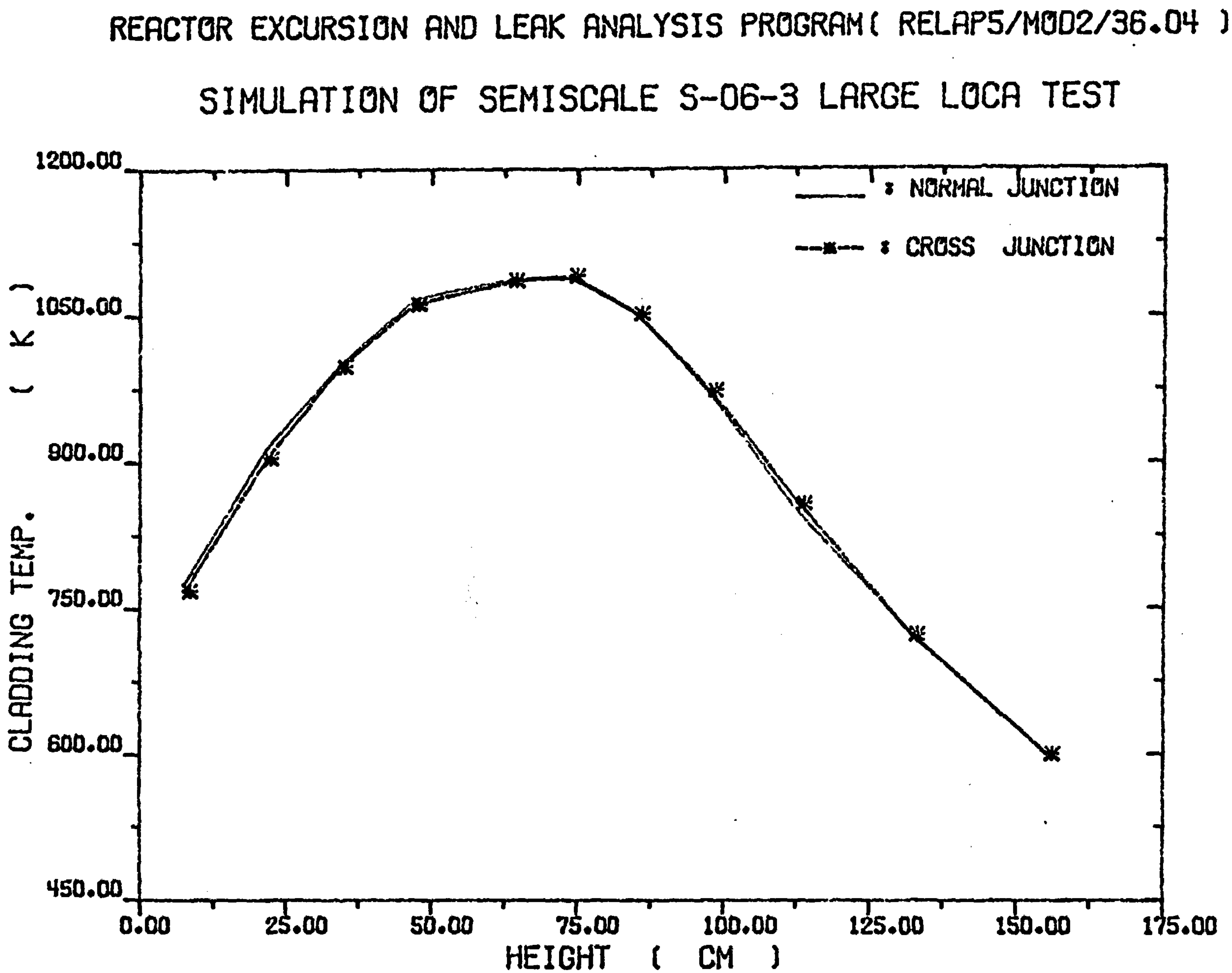

Fig. 4-70. High Power Rod Peak Cladding Temperatures versus Elevation

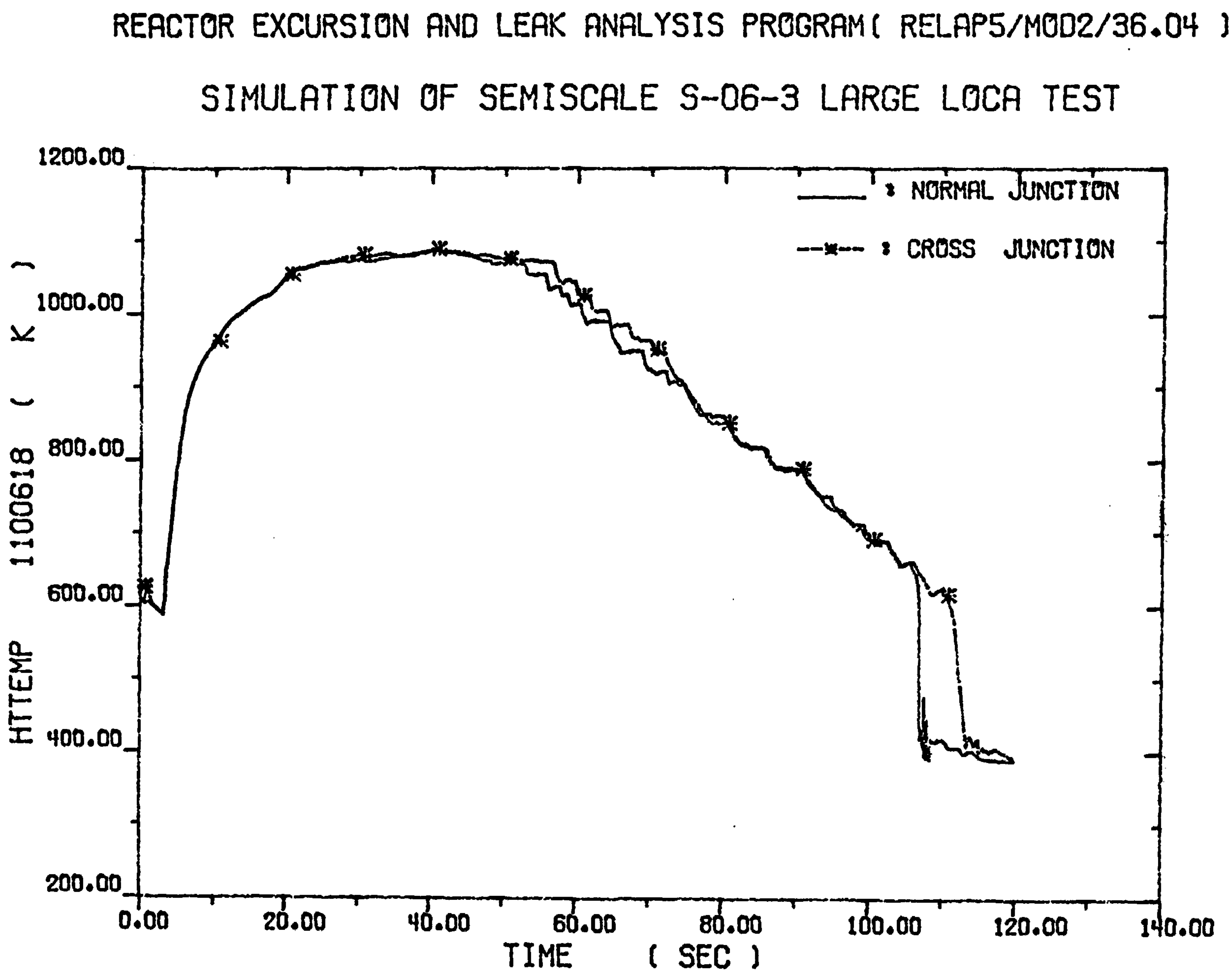

Fig. 4-71. High Power Rod Hot Spot Cladding Temperatures

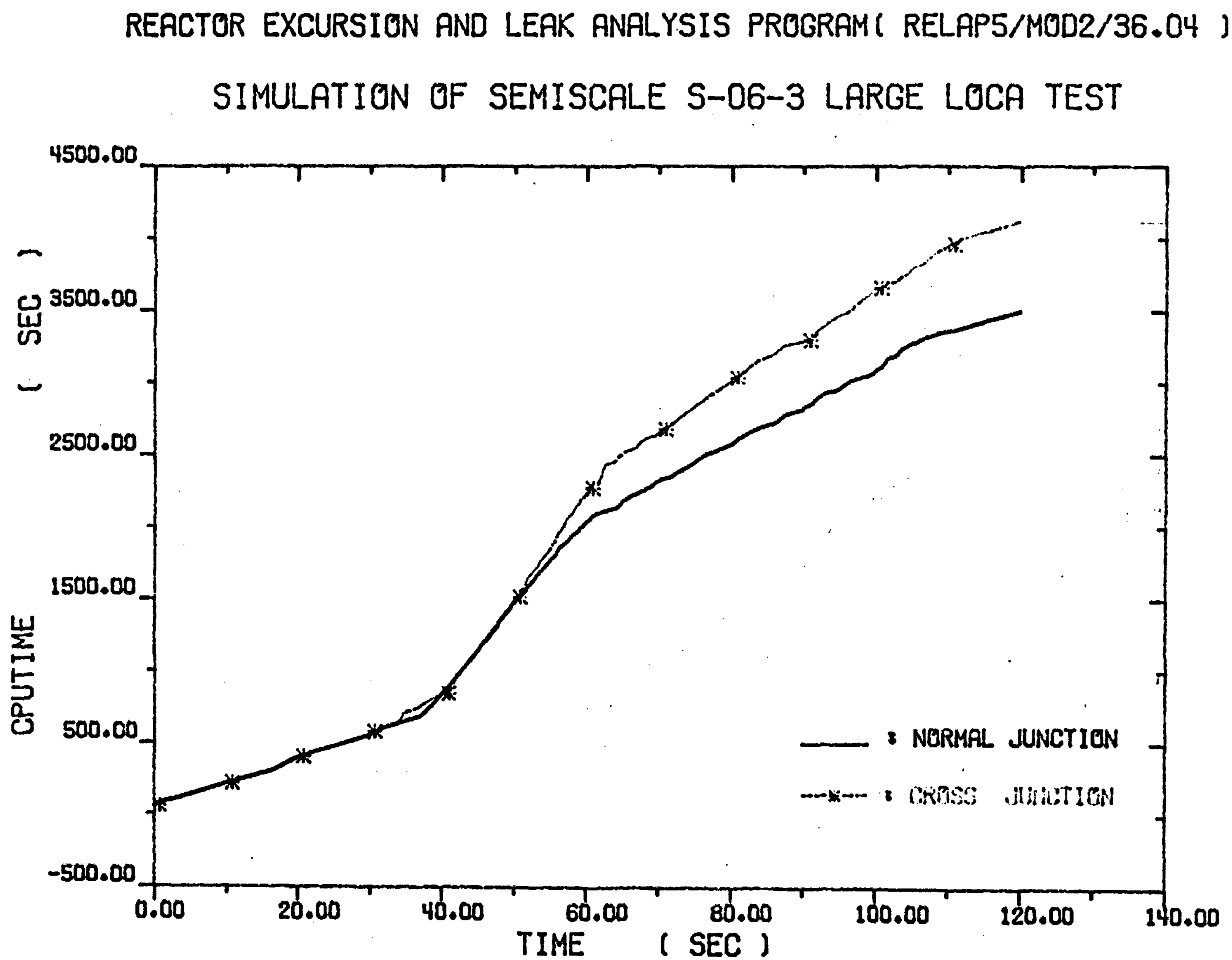

Fig. 4-72. Comparison of CPU Time

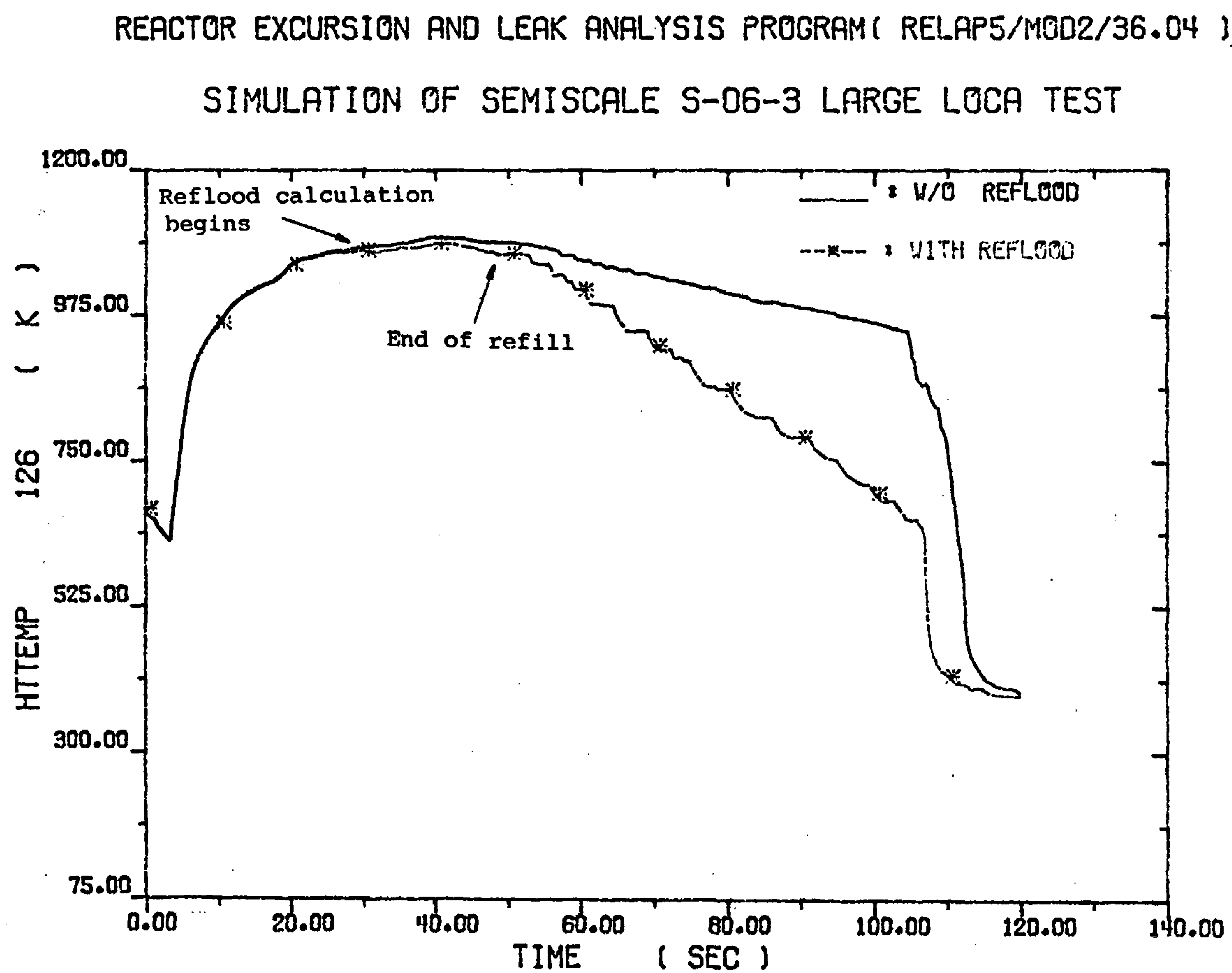

Fig. 4-73. Comparison of Peak Cladding Temperatures from with and without Reflood Calculations

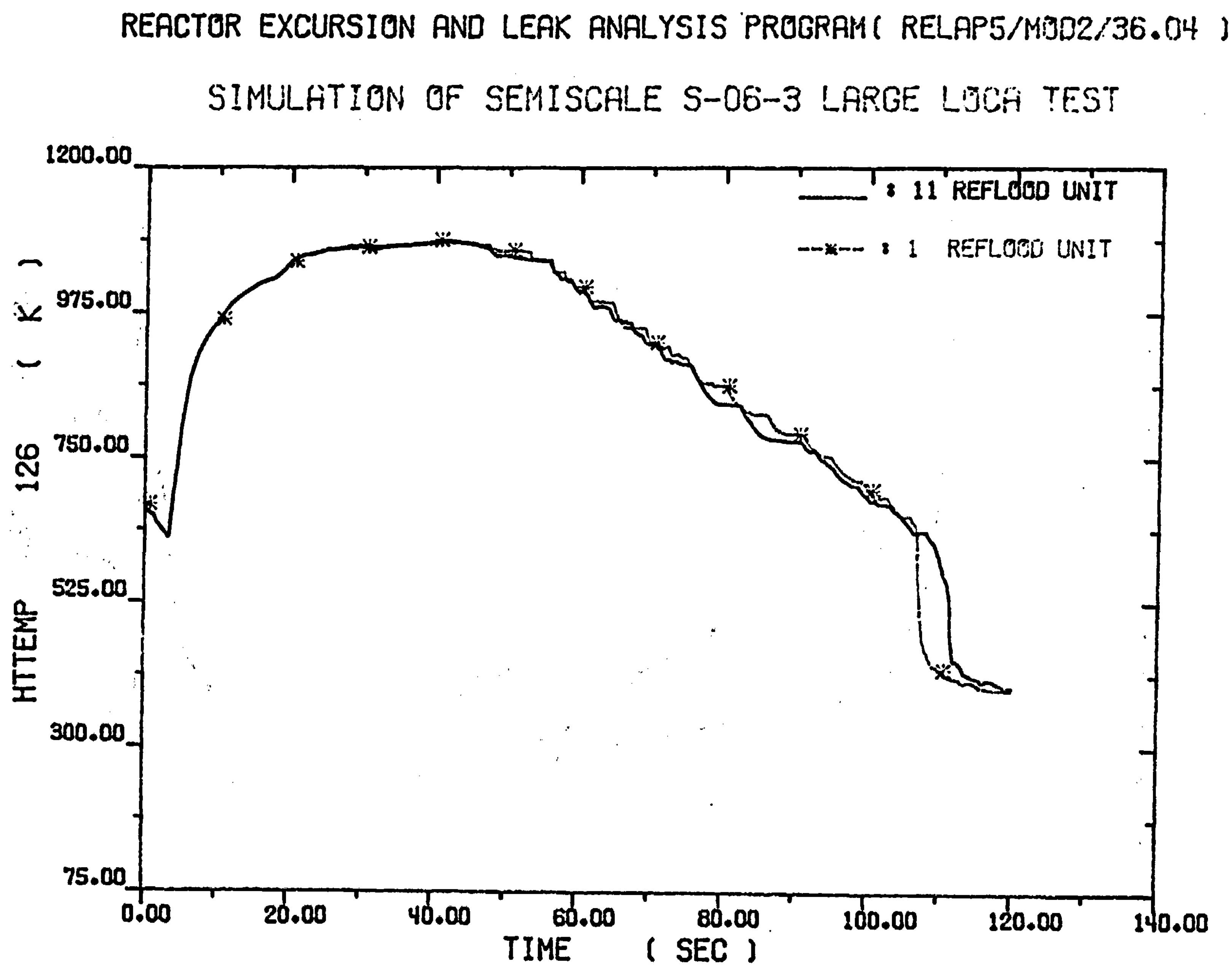

Fig. 4-74. Comparison of Peak Cladding Temperatures from 1 Reflood Unit and 11 Reflood Unit in Series

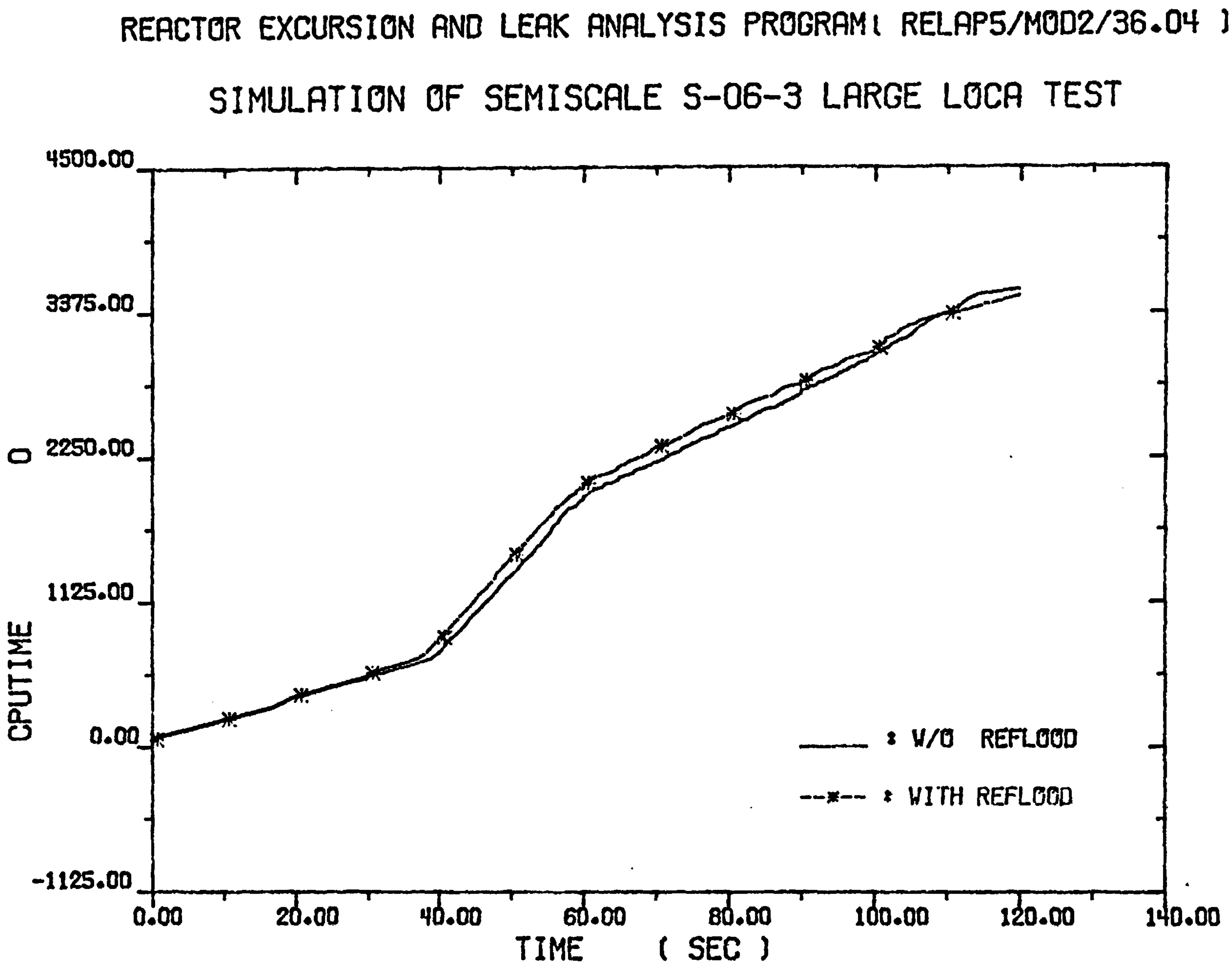

Fig. 4-75. Comparison of CPU Time

5. RUN STATISTICS

The computer run statistics of the RELAP5 simulations is summarized in Table 5-1. The CPU time is for a FACOM M200 computer which is compatible to IBM MVS system. All simulations were calculated using same maximum and minumum time steps, and was 5.0×10^{-2} and 1.0×10^{-2} seconds respectively.

Table 5-1 Run Time Statistics for S-06-3 Simulations

Parameter	Incore Rodial Connections		Heat Slab Intervals for Reflood			Core Axial Volumes			Modeling of Vessel Entrances		Reflood Model	
	With	Without	2	8	32	5	11	22	Normal	X-Flow	With	W/O
Real Time (sec)	120	120	120	120	120	120	120	120	120	120	120	120
CPU Time (sec)	3520	3370	3290	3520	3700	2643	3520	11792	3520	4130	3520	3572
Actual Time Steps	9131	9027	9042	9131	9322	7639	9131	24008	9131	9367	9131	9283
Cell Number	95	95	95	95	95	83	95	117	95	95	95	95
$\frac{\text{CPU} \times 10^3}{\text{Cell} \times \text{Step}}$	4.06	3.93	3.83	4.06	4.18	4.17	4.06	4.20	4.06	4.64	4.06	4.05

6. CONCLUSIONS AND RECOMMENDATIONS

Generally speaking, RELAP5 calculation correctly simulates responses of vital parameters and catches associated important phenomena except the CCFL which takes place in the blowdown and refill periods and makes the latter-on consequency deviated. Through extensive comparisons with measurement and important sensitivity studies elaborated in the previous section, the following conclusions are reached with suggestions :

1. The calculated break flow rates from both sides matched the data very well especially for the break near the pump side. As for the flow from the break near the vessel side, before the accumulator injection began, it also matched the data well. However, owing to the inability to simulate CCFL and the over-estimation of liquid downflow for a given steam upflow [11], some differences appeared between the calculated and measured break flow rates after the accumulator injection. Once ECC bypass and downcomer penetration phenomena can be caught well via the installation of CCFL model and the modification of interfacial drag between vapor and liquid in the code, prediction of the break flow from the vessel side probably can be improved.
2. Pressurizer responses under large LOCA were simulated well provided the noding of pressurizer was fine enough. As revealed from our sensitivity study, if the noding is fine enough the pressure two-slope behavior resulted from the

pressurizer emptiness can even be calculated.

3. Before the accumulator injection began, water levels within the reactor vessel were predicted well. However, due to the inability to simulate ECC bypass and downcomer penetration phenomena, calculated water levels rose again earlier than what were measured. Therefore, the termination of refill phase and the begining of reflood phase were all shifted ahead in the calculation.
4. Superheated steam in the lower and upper plena was predicted resonably well as compared to test data. Besides, core flow reversal phenomenon caused by the condensation induced from the ECC injection was also simulated, which was elucidated in the comparison of lower plenum coolant temperature responses.
5. The prediction of the highest cladding temperatures along the fuel elevations was quite well especially for the low power rods. As for the high power rods, the peak position moved a little upward and the value was lower about 30 K. Also concluded are the more effective precursor cooling prior to the quench and the earlier rewet of fuel rods in the calculation. Once the current interfacial drag model and film boiling correlation can be improved, and the CCFL model can be installed, those deficiencies probably can be diminished.
6. Whether the radial connections between the hot and average channels were modelled or not almost had no effect on the

predictions of peak cladding temperatures. However, cladding temperature responses of both ends of high power rods were affected. In the base calculation in which the radial connections were simulated, both ends experienced CHF soon after breaks occurred, while in the calculation without radial connection both ends remained in the status of no temperature excursion throughout the simulation. Besides, the radial disconnection between the hot and average channels caused the lower part of high power rods rewetted a little late as compared to results with radial connections.

7. The maximum number of heat slab axial interval for 2-D reflood calculation almost had no effect on the calculation of peak cladding temperatures along the fuel. Nevertheless, it had a little effect on the calculation of fuel quench time. Generally speaking, refinement of 2-D reflood calculation made the fuel rewetted a little late. This tendancy probably was resulted from the special feature of Semiscale MOD-1 system. The rewetting rate of Semiscale MOD-1 is about 1.8 cm/sec.

8. The number of axial hydraulic volumes representing the core showed some influence upon the thermal responses of fuel rods. As depicted in the previous section, the number of axial hydraulic volumes representing the core did not affect the prediction of peak cladding temperatures too much. However, it resulted in a tendancy showing that except at

ends of fuel, fine noding of the core might result in a later quench, but the postponed time was only about several seconds.

9. In the base calculation, the entrances of four legs entering the vessel were modelled with normal junctions. The effect of using cross-flow junctions to replace those has been investigated. Although the replacement had no effect on the break flow calculation, the filled-up time of lower plenum was postponed a little and so was the core water level ascending time. As a result, the fuel quench time was a little put off in the calculation with cross-flow junction, but the peak cladding temperature prediction was not affected at all.

10. Defeating normal reflood calculation would heavily affect the response of hot spot cladding temperature. Through sensitivity study, it was identified that different heat transfer package used majorly contributed to such difference instead of the effect of two-dimensional conduction. Since such discrepancy appears in the stage of film boiling which is not necessarily related to the reflood, it is suggested that the difference and the applicability of these two packages should be further verified.

11. Generally speaking, modelings with in-core radial connection, larger number of heat slab axial interval for 2-D reflood calculation, larger number of hydraulic volumes

representing the core, or cross-flow junctions on vessel entrances would cost more CPU time, especially for the last two modelings. Particularly the total CPU time used in the calculation with 22 axial volumes representing the core was about 3.4 times of that used in the base calculation in which only 11 axial volumes were involved.

7. REFERENCE

1. Brent L. Collins, Morris L. Patton, Jr. et. al., "Experiment Data Report for Semiscale Mod-1 Test S-06-3 (LOFT Counterpart test)," NUREG/CR-0251, TREE-1123, July 1987
2. V. Ransom et. al., "RELAP5/MOD2 Code Manual," NUREG/CR-4312, EGG-2396, August 1985
3. E. M. Feldman and D. J. Olson, "Semiscale Mod-1 Program and System Description for the Blowdown Heat Transfer Tests (Test Series 2)," ANCR-1230, August 1975
4. C. G. Branson Ltr to L. P. Leach, "Transmittal of Configuration Control Writeup for LOFT Simplified Hot Pin Model," CGB-8-75, October 2, 1975
5. L. E. Hochreiter, K. Riedle, "Reflood Heat Transfer and Hydraulics in Pressurizer Water Reactors," Symposium on the Thermal and Hydraulic Aspects of Nuclear Reactor Safety, Atlanta, U. S., Nov. 1977
6. G. G. Loomis, "Summary of the Semiscale Program (1965-1986)," NUREG/CR-4945, EGG-2509, July 1987
7. U. S. Nuclear Regulatory Commission, "Compendium of ECCS Research for Realistic LOCA Analysis," NUREG-1230, April 1987
8. Private Communication, "Code Improvement Plan for TRAC-PF1 and RELAP5," U.S. Nuclear Regulatory Commision, November 1987
9. Yassin A. Hassan, "Analysis of Flecht and Flecht-Seaset Reflood Tests with RELAP5/MOD2," Nuclear Technology, Vol. 74 Aug. 1986

10. George E. Forsythe, Michael A. Malcolm, and Cleve B. Moler, Computer Methods for Mathematical Computations, Prentice-Hall, Inc. 1987

11. M. Dillistone & C. G. Richards, "Counter-Current Flow Modelling in RELAP5," Third International Code Assessment and Application Program (ICAP) Specialist Meeting, Grenoble, France, March 1988

APPENDIX A

INPUT DATA LISTING

```
=    SEMISCALE S-06-3 LARGE BREAK LOCA TEST - COUNTERPART OF L2-3 TEST
*
0000100  NEW  TRANSNT
*0000101  INP-CHK
0000102  BRITISH SI
0000104  NOACTION
0000201  0.17  1.0-6 1.0-2 00002 17 100 100
0000202  30.0  1.0-6 5.0-2 00002  2 100 100
*
********************************************************************
********* TRIP SIGNALS *********
********************************************************************
*
501  TIME 0 GT NULL 0 1.0+9               L -1.0 *STDY-ST INITIALIZATION
502  TIME 0 LT NULL 0 1.0+9               L -1.0 *IN-CORE CROSS JUNCTION
*                                                  CONTRAL
402  TIME 0 GT NULL 0    0.0              L -1.0 *LOCA STARTS
403  P 112010000 LE NULL 0 150.0          L -1.0 *LPIS STARTS
404  P 112010000 LE NULL 0 600.0          L -1.0 *ACCUMULATOR VALVE OPEN
405  P 112010000 LE NULL 0 1800.0         L -1.0 *HPIS START
406  TIME 0 GT NULL 0 1.0+6               L -1.0 *PUMP SHUT OFF
407  TIME 0 LT NULL 0  36.0               L -1.0 *PZR VALVE CLOSE AT 36.0S
*
********************************************************************
********* MINOR EDIT *********
********************************************************************
*
*** SYSTEM PRESSURE (KPA)
*
301  CNTRLVAR 100             * PRZ P
302  CNTRLVAR 101             * S/G P
*
*** BREAK FLOW RATE (KG/S)
*
303  MFLOWJ   258000000       * NEAR VESSEL
304  MFLOWJ   257000000       * NEAR PUMP
*
*** INTACT LOOP FLOW RATE ( KG/S )
*
305  MFLOWJ   101030000       * HOT LEG
306  MFLOWJ   112020000       * COLD LEG
307  MFLOWJ   158000000       * PRZ SURGE FLOW
*
*** IN VESSEL FLOW RATE ( KG/S )
*
308  MFLOWJ   006010000
*
*** ECCS FLOW RATE
*
309  MFLOWJ   351000000       * HPIS
310  MFLOWJ   352000000       * LPIS
311  MFLOWJ   353000000       * ACCU.
*
*** INTACT LOOP FLOW RATE ( L/S )
*
312  CNTRLVAR 104             * HOT LEG
313  CNTRLVAR 107             * COLD LEG
314  CNTRLVAR 110             * PRZ
*
*** IN VESSEL FLOW RATE ( L/S )
*
315  CNTRLVAR 113
```

```
*
*** COOLANT TEMPERATURES IN LOOPS (K)
*
316  TEMPF    214010000        * BL - COLD LEG
317  TEMPF    201010000        * BL - HOT  LEG
*
318  TEMPF    112010000        * IL - COLD LEG
319  TEMPF    101010000        * IL - HOT  LEG
*
*** COOLANT TEMPERATURE IN VESSEL (K)
*
320  TEMPF    007010000        * CORE INLET
321  TEMPF    029010000        * UPPER PLEN.
*
322  TEMPF    002010000        * DEC. 1
323  TEMPF    003010000        * DEC. 2
324  TEMPF    004010000        * DEC. 3
325  TEMPF    004020000        * DEC. 4
326  TEMPF    004030000        * DEC. 4
*
*** PEAK CLADDING TEMPERATURES (HOT CHANNEL) (K)
*
327  CNTRLVAR 122              * DEC. 2
328  CNTRLVAR 123              * DEC. 3
329  CNTRLVAR 124              * DEC. 4
330  CNTRLVAR 126              * DEC. 5
331  CNTRLVAR 128              * DEC. 7
332  CNTRLVAR 130              * DEC. 9
*
*** PEAK CLADDING TEMPERATURES (AVERAGE CHANNEL) (K)
*
333  CNTRLVAR 133              * DEC. 3
334  CNTRLVAR 136              * DEC. 5
335  CNTRLVAR 138              * DEC. 7
*
*** DIFFERENTIAL PRESSURE
*
336  CNTRLVAR 141              * ACROSS DOWNCOMER
337  CNTRLVAR 142              * ACROSS LOW PLEN.
338  CNTRLVAR 143              * ACROSS CORE
*
*************************************************************************
********* HYDRAULIC MODELING ************
*************************************************************************
*
****************************************
******  REACTOR VESSEL ******
****************************************
*
****************************
*****  UPPER DOWNCOMER *****
****************************
*
0010000  UPPER  BRANCH
0010001  1          0
0010101  0.110896 0.0 0.032404 0.0 90. 0.2922 0.0 0.2153 0
0010200  3          2291.1    556.07
0011101  001000000 002000000 0.110896 0.0 0.0 01000
0011201  -4.5404-9 -4.6086-9 0.0
*
****************************
*****  DOWNCOMER  **********
```

```
***************************
*
0020000  DCM-1      ANNULUS
0020001  1
0020101  0.110896   1
0020301  0.0        1
0020401  0.0363961  1
0020501  0.0        1
0020601  -90.0      1
0020701  -0.3282    1
0020801  0.0        0.2153    1
0021001  00         1
0021201  3          2291.2    553.72 0.0     0.0     0.0     1
*
0510000  DCM-2    SNGLJUN
0510101  002010000 003000000 0.110896 0.0 0.0 01000
0510201  0          2.1277    2.1277    0.0
*
0030000  DCM-2 ANNULUS
0030001  1
0030101  0.110896   1
0030301  0.0        1
0030401  0.1032     1
0030501  0.0        1
0030601  -90.0      1
0030701  -0.9306    1
0030801  0.0        0.2153    1
0031001  00         1
0031201  3          2291.4    553.72 0.0     0.0     0.0     1
*
0520000  DCM-3      SNGLJUN
0520101  003010000 004000000 0.0583 1.5 1.5 01000
0520201  0          4.0473    4.0473    0.0
*
0040000  DCM-3 ANNULUS
0040001  3
0040101  0.0583                   3
0040201  0.0583                   2
0040301  0.0                      3
0040401  0.258                    3
0040501  0.0                      3
0040601  -90.                     3
0040701  -4.19                    3
0040801  0.0 0.078                3
0040901  0.3 0.3                  2
0041001  0                        3
0041101  01000                    2
0041201  3        2292.0    553.73    0.0       0.0       0.0       1
0041202  3        2293.3    553.75    0.0       0.0       0.0       2
0041203  3        2294.5    553.76    0.0       0.0       0.0       3
0041300  0
0041301  4.0473    4.0473    0.0       1
0041302  4.0473    4.0473    0.0       2
*
***************************
***** LOWER PLENUM *********
***************************
*
0050000  LPLNUM-1 SNGLVOL
0050101  0.138779 0.0 0.2324 0.0 90. 1.6746 0.0 0.5508 0
0050200  3         2295.7    556.08
*
```

```
0060000  LPLNUM-2 BRANCH
0060001  3          0
0060101  0.2383 0.0 0.5306 0.0 90. 0.7333 0.0 0.5508 0
0060200  3          2295.3    553.77
0061101  006010000 007000000 0.03142 0.1897 0.3144 01000
0061201  7.5096     7.5096    0.0
0062101  005010000 006000000 0.2383 0.0 0.0 01000
0062201  3.48981-9 3.52221-9 0.0
0063101  004010000 006010000 0.0583 1.5 1.5 01000
0063201  4.0472     4.0472    0.0
*
0070000  LPLNUM-3 BRANCH
0070001  2          0
0070101  0.0687 0.0 0.1310 0.0 90. 1.777 0.0 0.3053 0
0070200  3          2294.7    553.76
0071101  007010000 018000000 0.00234 1.28 1.28 01000
0071201  10.101     10.101    0.0
0072101  007010000 008000000 0.02106 1.28 1.28 01000
0072201  10.081     10.081    0.0
*
***************************
***** REACTOR CORE *********
***************************
*
***** AVERAGE CHANNEL
*
0080000  AVG-1 BRANCH
0080001  1          0
0080101  0.046251   0.0 0.0231255 0.0 90. 0.500 0.0 0.0352 0
0080200  3          2293.7    557.19
0081101  008010000 009000000 0.046251 0.000 0.000 01000
0081201  4.5950     4.5950    0.0
*
0090000  AVG-2 BRANCH
0090001  1          0
0090101  0.046251   0.0 0.01928667 0.0 90. 0.417 0.0 0.0352 0
0090200  3          2293.5    562.05
0091101  009010000 010000000 0.046251 0.189 0.189 01000
0091201  4.6236     4.6236    0.0
*
0100000  AVG-3 BRANCH
0100001  1          0
0100101  0.046251 0.0 0.01928667 0.0 90. 0.4165 0.0 0.0352 0
0100200  3          2293.3    568.24
0101101  010010000 011000000 0.046251 0.000 0.000 01000
0101201  4.6547     5.0434    0.0
*
0110000  AVG-4 BRANCH
0110001  1          0
0110101  0.046251 0.0 0.01928667 0.0 90. 0.4165 0.0 0.0352 0
0110200  0          2293.2    569.86    1049.2    7.3050-4
0111101  011010000 121000000 0.046251 0.189 0.189 01000
0111201  4.7052     5.2194    0.0
*
1210000  AVG-5 BRANCH
1210001  1          0
1210101  0.046251 0.0 0.0241431 0.0 90. 0.522 0.0 0.0352 0
1210200  0          2293.0    581.70    1049.3    2.7018-3
1211101  121010000 122000000 0.046251 0.000 0.000 01000
1211201  4.7808     5.2677    0.0
*
1220000  AVG-5 BRANCH
```

```
1220001  1          0
1220101  0.046251 0.0 0.0143841 0.0 90. 0.311 0.0 0.0352 0
1220200  0          2292.8    588.68    1049.3    4.9582-3
1221101  122010000 013000000 0.046251 0.000 0.000 01000
1221201  4.8167     5.2803    0.0
*
0130000  AVG-6 BRANCH
0130001  1     0
0130101  0.046251 0.0 0.01928667 0.0 90. 0.417 0.0 0.0352 0
0130200  0          2292.7    597.48    1049.3    8.7321-3
0131101  013010000 014000000 0.046251 0.189 0.189 01000
0131201  4.9021     5.3948    0.0
*
0140000  AVG-7 BRANCH
0140001  1     0
0140101  0.046251 0.0 0.01928667 0.0 90. 0.417 0.0 0.0352 0
0140200  0          2292.5    605.09    1049.3    1.1511-2
0141101  014010000 015000000 0.046251 0.000 0.000 01000
0141201  4.9382     5.3964    0.0
*
0150000  AVG-8 BRANCH
0150001  1     0
0150101  0.046251 0.0 0.02696434 0.0 90. 0.583 0.0 0.0352 0
0150200  0          2292.3    613.74    1049.3    1.1848-2
0151101  015010000 016000000 0.046251 0.189 0.189 01000
0151201  5.0182     5.7090    0.0
*
0160000  AVG-9 BRANCH
0160001  1     0
0160101  0.046251 0.0 0.03084942 0.0 90. 0.667 0.0 0.0352 0
0160200  0          2292.1    619.80    1049.3    8.3583-3
0161101  016010000 017000000 0.046251 0.00 0.00 01000
0161201  4.9668     5.5086    0.0
*
0170000  AVG-10 BRANCH
0170001  1     0
0170101  0.046251 0.0 0.0385271 0.0 90. 0.833 0.0 0.0352 0
0170200  0          2291.8    623.40    1049.3    6.5256-3
0171101  017010000 028000000 0.046251 5.48 5.48 01000
0171201  5.1134     5.6039    0.0
*
***** HOT CHANNEL
*
0180000  HOT-1 BRANCH
0180001  1     0
0180101  5.139-3     0.0 2.5695-3 0.0 90. 0.500 0.0 0.0465 0
0180200  3          2293.7    560.27
0181101  018010000 019000000 5.139-3 0.000 0.000 01000
0181201  4.8036     5.1952    0.0
*
7180000  HOT-1 SNGLJUN
7180101  018000000 008000000 0.0      0.000 0.000 01003
7180201  0 -0.16029   -0.16029  0.0
*7180300  TRPVLV
*7180301  502
*
0190000  HOT-2 BRANCH
0190001  1     0
0190101  5.139-3     0.0 2.142963-3 0.0 90. 0.417 0.0 0.0465 0
0190200  0          2293.5    561.12    1049.2    7.9919-4
0191101  019010000 020000000 5.139-3 0.189 0.189 01000
0191201  4.9025     0.4809    0.0
```

```
*
7190000  HOT-2 SNGLJUN
7190101  019000000 009000000 0.0     0.0   0.0   01003
7190201  0 -3.640-2  -3.6401-2 0.0
*7190300  TRPVLV
*7190301  502
*
0200000  HOT-3 BRANCH
0200001  1     0
0200101  5.139-3 0.0 2.142963-3 0.0 90. 0.4165 0.0 0.0465 0
0200200  0          2293.3    573.78    1049.2    4.1320-3
0201101  020010000 021000000 5.139-3 0.000 0.000 01000
0201201  5.1048    5.6785    0.0
*
7200000  HOT-3 SNGLJUN
7200101  020000000 010000000 0.0     0.000 0.000 01003
7200201  0 -0.10952  -0.10951  0.0
*7200300  TRPVLV
*7200301  502
*
0210000  HOT-4 BRANCH
0210001  1     0
0210101  5.139-3 0.0 2.142963-3 0.0 90. 0.4165 0.0 0.0465 0
0210200  0          2293.2    588.00    1049.2    1.0527-2
0211101  021010000 221000000 5.139-3 0.189 0.189 01000
0211201  5.2565    5.9073    0.0
*
7210000  HOT-4 SNGLJUN
7210101  021000000 011000000 0.0     0.0   0.0   01003
7210201  0 -2.8042-2 -2.8043-2 0.0
*7210300  TRPVLV
*7210301  502
*
2210000  HOT-5 BRANCH
2210001  1   0
2210101  5.139-3 0.0 2.776518-3 0.0 90. 0.522 0.0 0.0465 0
2210200  0          2293.0    605.99    1049.3    2.8523-2
2211101  221010000 222000000 5.139-3 0.000 0.000 01000
2211201  5.5160    6.1136    0.0
*
7010000  HOT-5 SNGLJUN
7010101  221000000 121000000 0.0     0.000 0.000 01003
7010201  0 -4.1567-2 -4.1565-2 0.0
*7220300  TRPVLV
*7220301  502
*
2220000  HOT-5 BRANCH
2220001  1   0
2220101  5.139-3 0.0 1.598229-3 0.0 90. 0.311 0.0 0.0465 0
2220200  0          2292.8    615.59    1049.3    4.2628-2
2221101  222010000 023000000 5.139-3 0.000 0.000 01000
2221201  5.8204    6.4024    0.0
*
7220000  HOT-5 SNGLJUN
7220101  222000000 122000000 0.0     0.000 0.000 01003
7220201  0 -0.14836  -0.14836  0.0
*7220300  TRPVLV
*7220301  502
*
0230000  HOT-6 BRANCH
0230001  1     0
0230101  5.139-3 0.0 2.142963-3 0.0 90. 0.417 0.0 0.0465 0
```

```
0230200  0          2292.7    627.67    1049.3    6.6780-2
0231101  023010000 024000000 5.139-3 0.189 0.189 01000
0231201  5.9319     6.5635    0.0
*
7230000  HOT-6 SNGLJUN
7230101  023000000 013000000 0.0      0.0    0.0    01003
7230201  0 0.12113   0.12114   0.0
*7230300  TRPVLV
*7230301  502
*
0240000  HOT-7 BRANCH
0240001  1      0
0240101  5.139-3 0.0 2.142963-3 0.0 90. 0.417 0.0 0.0465 0
0240200  0          2292.5    636.62    1049.3    8.7912-2
0241101  024010000 025000000 5.139-3 0.000 0.000 01000
0241201  6.4234     7.0303    0.0
*
7240000  HOT-7 SNGLJUN
7240101  024000000 014000000 0.0      0.000 0.000 01003
7240201  0          -0.26137  -0.26138  0.0
*7240300  TRPVLV
*7240301  502
*
0250000  HOT-8 BRANCH
0250001  1      0
0250101  5.139-3 0.0 2.996037-3 0.0 90. 0.583 0.0 0.0465 0
0250200  0          2292.3    647.23    1049.3    0.10824
0251101  025010000 026000000 5.139-3 0.189 0.189 01000
0251201  6.4754     7.5740    0.0
*
7250000  HOT-8 SNGLJUN
7250101  025000000 015000000 0.0      0.0    0.0    01003
7250201  0 0.17333   0.17334   0.0
*7250300  TRPVLV
*7250301  502
*
0260000  HOT-9 BRANCH
0260001  1      0
0260101  5.139-3 0.0 3.427713-3 0.0 90. 0.667 0.0 0.0465 0
0260200  0          2292.1    651.37    1049.3    0.10184
0261101  026010000 027000000 5.139-3 0.000 0.000 01000
0261201  7.3318     8.8039    0.0
*
7260000  HOT-9 SNGLJUN
7260101  026000000 016000000 0.0      0.000 0.000 01003
7260201  0          -0.74936  -0.74840  0.0
*7260300  TRPVLV
*7260301  502
*
0270000  HOT-10 BRANCH
0270001  1      0
0270101  5.139-3 0.0 4.280787-3 0.0 90. 0.833 0.0 0.0465 0
0270200  0          2291.8    655.73    1049.3    8.7247-2
0271101  027010000 028000000 5.139-3 5.48  5.48  01000
0271201  5.9912     8.0134    0.0
*
7270000  HOT-10 SNGLJUN
7270101  027000000 017000000 0.0      0.0    0.0    01003
7270201  0 1.2947    1.2948    0.0
*7270300  TRPVLV
*7270301  502
*
```

```
***************************
***** UPPER PLENUM *********
***************************
*
0280000  U-PLENUM PIPE
0280001  3
0280101  0.0612                   3
0280201  0.0612                   2
0280301  0.0                      3
0280401  0.2076                   3
0280501  0.0                      3
0280601  90.                      3
0280701  2.31066                  2
0280702  2.31068                  3
0280801  0.0 0.0489               3
0280901  0.0 0.0                  2
0281001  0                        3
0281101  01000                    2
0281201  0          2290.7    627.98    1049.4    2.1727-3  0.0      1
0281202  0          2289.9    628.10    1049.5    2.3636-4  0.0      2
0281203  0          2289.1    628.08    1049.5    2.5600-5  0.0      3
0281300  0
0281301  4.3265     4.5824    0.0       1
0281302  4.3205     4.5683    0.0       2
*
***************************
***** UPPER HEAD  **********
***************************
*
0290000  U-PLENUM BRANCH
0290001  1      0
0290101  0.0612 0.0 0.2444 0.0 90. 2.7207 0.0 0.0489 0
0290200  0          2288.5    588.57    1049.6    3.6719-4
0291101  028010000 029000000 0.0612 0.0 0.0 01000
0291201  -4.7269-6 0.23717   0.0
*
*********************************************
*******    INTACT     LOOP    ****************
*********************************************
*
***************************
***** HOT   LEG  **********
***************************
*
1010000  H-LEG-1 BRANCH
1010001  3    0
1010101  0.0376 6.5032 0.0 0.0 90.0 0.001 0.0 0.2188 0
1010200  0          2287.3    628.02    1049.6    1.9392-6
1011101  101010000 102000000 0.0376 0.0 0.0 01000
1011201  7.0291     7.0382    0.0
1012101  114000000 101010000 0.003 486.0 486.0 01001
1012201  -2.2407-2 -1.4553-2 0.0
1013101  028010000 101000000 0.02058 1.6835 1.6835 01000
1013201  12.846     13.143    0.0
*
1020000  H-LEG-2 SNGLVOL
1020101  0.0376 4.4808 0.0 0.0 90. 0.6967 0.0 0.2188 0
1020200  0          2287.2    627.97    1049.7    2.0145-7
*
***************************
***** S/G PRIMARY SIDE *****
***************************
```

```
*
***** INLET PLENUM
*
1510000  S/G-IN SNGLJUN
1510101  102010000 103000000 0.01396 1.6632 1.6632 01000
1510201  0         18.931    19.046    0.0
*
1030000  SG-INLET SNGLVOL
1030101  0.2670 0.0 0.3200 0.0 90. 1.1983 0.0 0.5038 0
1030200  0         2284.4    627.92    1049.8    1.5287-8
*
***** TUBE REGION
*
1520000  TUBE-1 SNGLJUN
1520101  103010000 104000000 4.76-2 7.5346 7.5346 01000
1520201  0         5.5524    5.5532    0.0
*
1040000  TUBE-1 SNGLVOL
1040101  0.0476   0.0 0.2673311 0.0 90. 5.6162 0.0 0.0355 0
1040200  0         2282.0    583.64    1050.0    7.9091-10
*
1530000  TUBE-2 SNGLJUN
1530101  104010000 105000000 0.0476 0.2 0.2 01000
1530201  0         5.2109    5.2109    0.0
*
1050000  TUBE-2 SNGLVOL
1050101  0.0476 0.0 0.13365 0.0 90.0 2.80777 0.0 0.0355 0
1050200  3         2280.4    573.04
*
1540000  TUBE-3 SNGLJUN
1540101  105010000 106000000 0.0  0.0 0.0 01000
1540201  0         5.1029    5.1029    0.0
*
1060000  TUBE-3 SNGLVOL
1060101  0.0476 0.0 0.13365 0.0 -90.0 -2.80777 0.0 0.0355 0
1060200  3         2280.2    563.83
*
1550000  TUBE-4 SNGLJUN
1550101  106010000 107000000 0.0476 0.1915 0.1915 01000
1550201  0         5.0310    5.0310    0.0
*
1070000  TUBE-4 SNGLVOL
1070101  0.0476   0.0 0.2673311 0.0 -90. -5.6162 0.0 0.0355 0
1070200  3         2281.3    553.43
*
1560000  SG-4 SNGLJUN
1560101  107010000 108000000 0.0476 8.593 8.593 01000
1560201  0         4.9559    4.9559    0.0
*
1080000  SG-OUTLT SNGLVOL
1080101  0.2670 0.0 0.3200 0.0 -90. -1.1983 0. 0.5038 0
1080200  3         2281.2    553.43
*
1570000  S/G-OUT SNGLJUN
1570101  108010000 109000000 0.01396 1.771 1.771 01000
1570201  0         16.898    16.898    0.0
*
****************************
***** CROSS OVER LEG  ******
****************************
*
1090000  CRX-LEG SNGLVOL
```

```
1090101  0.0376 0.0 0.390 0.0 -90. -3.083 0.0 0.2185 0
1090200  3           2279.2    553.43
*
***************************
*****  COOLANT PUMP   ******
***************************
*
1100000  PUMP PUMP
1100101  0.0468 0.0 0.16 0.0 90. 2.0051 0
1100108  109010000 0.0376 3.333 3.333 01000
1100109  111000000 0.0376 3.4323 3.4323 01000
1100200  3           2286.4    553.68
1100201  0           6.2742    6.2742    0.0
1100202  0           6.2757    6.2757    0.0
1100301  0 0 0 -1 0 406 1
1100302  3560. 0.5131 180. 192. 34.8 38.3 62.3 0. 0. 6.7 0. 0.
1106100  0 CNTRLVAR 7
1106101  -1.0  1826.8
1106102   0.0  0.0
1106103  1.0+6 1.0+6
*
***************************
*****  COLD LEG    *********
***************************
*
1110000  C-LEG-1 SNGLVOL
1110101  0.0378 0.0 0.1661 0.0 0.0 0.0 0.0 0.2188 0
1110200  3           2292.9    553.71
*
1120000  C-LEG-2 BRANCH
1120001  2           0
1120101  0.0378 0.0 0.1661 0.0 0.0 0.0 0.0 0.2188 0
1120200  3           2292.2    553.72
1121101  111010000 112000000 0.0376 3.4079 3.4079 01000
1121201  6.2753    6.2753    0.0
1122101  112010000 002000000 0.0378 6.0022 5.9848 01000
1122201  6.2422    6.2422    0.0
*
**************************************************
************  BLOWDOWN LOOP  ******************
**************************************************
*
***************************
*****  HOT  LEG    *********
***************************
*
2010000  HOT-LEG BRANCH
2010001  2           0
2010101  0.0376 0.0 0.1070 0.0 90. 0.7552 0.0 0.2188 0
2010200  0           2288.8    609.11     1049.5     1.0351-7
2011101  028010000 201000000 0.0205 0.86 0.86 01000
2011201  -1.0026-6 0.23430     0.0
2012101  201010000 202000000 0.00267 0.83 0.83 01000
2012201  -6.9790-7 9.9987-2    0.0
*
***************************
*****  SIMULATED S/G  ******
***************************
*
2020000  S/G-1 SNGLVOL
2020101  0.0387418 0.0 0.3227 0.0 90. 8.3295 0.0 0.2226 0
2020200  3           2287.4    604.05
```

```
*
2510000  SG-1 SNGLJUN
2510101  202010000 203000000 0.007813 14.15 14.15 01000
2510201  0         -1.4383-7  -1.4272-7  0.0
*
2030000  SG-2 SNGLVOL
2030101  0.0349861 0.0 0.3262 0.0 -90. -9.3237 0.0 0.2226 0
2030200  3          2287.6    604.11
*
2520000  SG-2 SNGLJUN
2520101  203010000 204000000 0.00267 0.83 0.83 01000
2520201  0         -2.5336-7 -2.4541-7  0.0
*
***************************
*****  CROSS OVER LEG ******
***************************
*
2040000  CRX-LEG1 SNGLVOL
2040101  0.0156 0. 0.064 0.0 -90. -3.667 0.0 0.1407 0
2040200  3          2289.5    604.12
*
2530000  CRX-LEG SNGLJUN
2530101  204010000 205000000 2.634-3 3.653 3.653 01000
2530201  0          -2.8048-7 -2.8373-7 0.0
*
2050000  CRX-LEG2 SNGLVOL
2050101  0.0294 0.0 0.0534 0. -90. -0.7545 0.0 0.2187 0
2050200  3          2290.2    604.11
*
***************************
*****  SIMULATED PUMP ******
***************************
*
2540000  SIMU SNGLJUN                    *5.759
2540101  205010000 206000000 0.00267 8.97  8.97  01000
2540201  0          2.8103-9  4.2998-9  0.0
*
***************************
*****  COLE  LEG  I  *******
***************************
*
2060000  C-LEG-1 SNGLVOL
2060101  0.0123 0.0 0.0658 0.0 90. 4.7703 0. 0.12 0
2060200  3          2289.6    604.12
*
2550000  C-LEG-1 SNGLJUN
2550101  206010000 207000000 1.225-2 0.0 0.0 01000
2550201  0          -1.1159-7 -1.1151-7 0.0
*
2070000  C-LEG-2 SNGLVOL
2070101  0.41 0.0 0.06466 0.0 -90. -0.0508 0.0 0.1616 0
2070200  3          2288.9    604.11
*
2560000  C-LEG-2 SNGLJUN
2560101  207010000 208000000 0.01556 8.36 8.36 01000
2560201  0          -2.9764-8 -4.5474-8 0.0
*
2080000  NOZZLE SNGLVOL
2080101  0.41 0.0 0.03313 0.0 0.0 0.0 0.0 0.1616 0
2080200  3          2288.9    604.11
*
***************************
```

```
*****  COLD  LEG  II *******
***************************
*
2140000  COLD-LEG  BRANCH
2140001  1         0
2140101  0.0376 0.0 0.0670 0.0 0.0 0.0 0.0 0.2188 0
2140200  3         2291.3    551.91
2141101  002010000 214000000 0.0205 0.428 0.428 00000
2141201  1.3049-7  1.3040-7  0.0
*
2610000  BD-LOOP SNGLJUN
2610101  214010000 213000000 0.03755 0.42 0.42 00000
2610201  0         4.6833-8  4.6833-8  0.0
*
2130000  COLD-LEG SNGLVOL
2130101  0.0376 0.0 0.1000 0.0 0.0 0.0 0.0 0.2188 0
2130200  3         2291.3    551.90
*
2600000  BD-LOOP SNGLJUN
2600101  213010000 212000000 0.01556 1.097 1.097 00000
2600201  0         6.2975-8  6.2975-8  0.0
*
2120000  DOMER SNGLVOL
2120101  0.01556 0.0 0.022 0.0 0.0 0.0 0.0 0.14075 0
2120200  3         2291.3    551.91
*
2590000  BD-LOOP SNGLJUN
2590101  212010000 211000000 0.01556 8.36 8.36 00000
2590201  0         -2.0805-8  -2.0804-8  0.0
*
2110000  NOZZLE SNGLVOL
2110101  0.01556 0.0 0.02992 0.0 90. 0.0094 0.0 0.14075 0
2110200  3         2291.3    551.90
*
******************************************************************
*******  BROKEN LOOP REFLOOD BYPASS LINES  ************************
******************************************************************
*
*2150000  REFLOOD1 BRANCH
*2150001  2         0
*2150101  0.03755 0.0 0.185 0.0 -90. -0.199 0.0 0.2188 00
*2150200  3  2289.1  604.13
*2151101  201000000 215000000 0.03755 1.5 1.5 01000
*2152101  215010000 216000000 0.03755 0.0 0.0 01000
*2151201  0.0 0.0 0.0
*2152201  0.0 0.0 0.0
*
*2160000  REFLOOD2 BRANCH
*2160001  1         0
*2160101  0.03755 0.0 0.230 0.0 -90. -0.5094 0.0 0.2188 00
*2160200  3  2291.5  551.90
*2161101  216010000 214000000 0.03755 1.5 1.5 01000
*2161201  0.0 0.0 0.0
*
******************************************************************
***********  MODELING OF BREAK  **********************************
******************************************************************
*
*******************************************
*****  BREAK CONTROL VALVES   *************
*******************************************
*
```

```
***** BREAK VALVE NEAR VESSEL
*
2580000  BREAK VALVE
2580101  211010000 210000000 0.00262 0.053 0.053 00000
2580201  1 0.0 0.0 0.0
2580300  TRPVLV
2580301  402
*
***** BREAK VALVE NEAR PUMP
*
2570000  BREAK VALVE
2570101  208010000 209000000 0.00262 0.053 0.053 00000
2570201  1 0.0 0.0 0.0
2570300  TRPVLV
2570301  402
*
******************************************
*****  SIMULATED CONTAINMENT  ************
******************************************
*
2100000  PRE-SUPP TMDPVOL
2100101  7.79 0.0 1.1+2 0.0 -90. -8.3 0.0 3.4 0
2100200  2 402
2100201  -1.00000             35.7617          1.0
2100202  0.000000             35.7617          1.0
2100203  0.684931             27.7347          1.0
2100204  5.342465             40.3288          1.0
2100205  7.534246             35.0697          1.0
2100206  9.726027             36.0385          1.0
2100207  10.54794             35.0697          1.0
2100208  12.46575             36.7305          1.0
2100209  13.56164             34.9313          1.0
2100210  15.20547             36.4537          1.0
2100211  16.84931             35.0697          1.0
2100212  17.94520             35.6233          1.0
2100213  19.04109             35.9001          1.0
2100214  20.13698             34.5161          1.0
2100215  21.23287             34.9313          1.0
2100216  24.24657             34.7929          1.0
2100217  26.71232             35.4849          1.0
2100218  29.17808             34.1010          1.0
2100219  30.00000             34.9313          1.0
2100220  30.54794             35.2081          1.0
2100221  34.10958             34.6545          1.0
2100222  36.84931             34.9313          1.0
2100223  37.67123             34.6545          1.0
2100224  39.04109             34.7929          1.0
2100225  39.58904             34.1010          1.0
2100226  40.41095             34.7929          1.0
2100227  49.45205             34.7929          1.0
2100228  500.0000             34.7929          1.0
*
2090000  PRE-SUPP TMDPVOL
2090101  7.79 0.0 1.1+2 0.0 -90. -9.058 0.0 3.4 0
2090200  2 402
2090201  -1.00000             35.7617          1.0
2090202  0.000000             35.7617          1.0
2090203  0.684931             27.7347          1.0
2090204  5.342465             40.3288          1.0
2090205  7.534246             35.0697          1.0
2090206  9.726027             36.0385          1.0
2090207  10.54794             35.0697          1.0
```

```
2090208  12.46575              36.7305            1.0
2090209  13.56164              34.9313            1.0
2090210  15.20547              36.4537            1.0
2090211  16.84931              35.0697            1.0
2090212  17.94520              35.6233            1.0
2090213  19.04109              35.9001            1.0
2090214  20.13698              34.5161            1.0
2090215  21.23287              34.9313            1.0
2090216  24.24657              34.7929            1.0
2090217  26.71232              35.4849            1.0
2090218  29.17808              34.1010            1.0
2090219  30.00000              34.9313            1.0
2090220  30.54794              35.2081            1.0
2090221  34.10958              34.6545            1.0
2090222  36.84931              34.9313            1.0
2090223  37.67123              34.6545            1.0
2090224  39.04109              34.7929            1.0
2090225  39.58904              34.1010            1.0
2090226  40.41095              34.7929            1.0
2090227  49.45205              34.7929            1.0
2090228  500.0000              34.7929            1.0
*
**********************************************************************
***************  PRESSURIZER  *****************************************
**********************************************************************
*
****************************************
*****  PRESSURIZER SURGE LINE   ********
****************************************
*
***** PRZ SURGE LINE
*
1140000  SUR-LINE PIPE
1140001  3
1140101  0.0030               3
1140201  0.0030               2
1140301  0.0                  3
1140401  0.004333333          3
1140501  0.0                  3
1140601 -90.0                 1
1140602  0.0                  2
1140603  90.0                 3
1140701 -0.6963               1
1140702  0.0                  2
1140703  0.6963               3
1140801  0.0 0.0613           3
1140901  0.0 0.0              2
1141001  0                    3
1141101  01000                2
1141201  0        2287.4   626.78   1049.6   2.3130-9  0.0      1
1141202  3        2287.5   617.74   0.0      0.0       0.0      2
1141203  3        2287.4   625.98   0.0      0.0       0.0      3
1141300  0
1141301  2.2406-2 2.2381-2 0.0      1
1141302  2.2406-2 2.2406-2 0.0      2
*
***** PRZ ISOLATION VALVE ( 36.0 SEC CLOSE)
*
1580000  TO/PRESS VALVE
1580101  113000000 114010000 0.003 486.0 486.0 01000
1580201  0        -2.2388-2 -2.2388-2  0.0
1580300  TRPVLV
```

```
1580301  407
*
****************************************
*****        PRESSURIZER        *******
****************************************
*
***** PRESSURIZER VESSEL
*
1130000  PRESSUZR PIPE
1130001  13
1130101  0.2517413              13
1130201  0.2517413              12
1130301  0.0                    13
1130401  0.0386                 10
1130402  0.193                  13
1130501  0.0                    13
1130601  90.                    13
1130701  0.153332               10
1130702  0.76666                13
1130801  0.0 0.5701             13
1130901  0.0 0.0                12
1131001  0                      13
1131101  01000                  12
1131201  3        2287.3   642.70   0.0      0.0        0.0     1
1131202  3        2287.3   654.21   0.0      0.0        0.0     2
1131203  0        2287.2   694.02   1049.7   4.6802-8   0.0    3
1131204  0        2287.2   694.18   1049.7   1.0972-7   0.0    4
1131205  0        2287.1   694.20   1049.7   1.8184-7   0.0    5
1131206  0        2287.1   694.20   1049.7   2.5304-7   0.0    6
1131207  0        2287.1   694.19   1049.7   3.4760-7   0.0    7
1131208  0        2287.0   694.14   1049.7   3.9372-7   0.0    8
1131209  0        2287.0   693.71   1049.7   5.8438-7   0.0    9
1131210  0        2286.9   690.87   1049.7   8.5141-9   0.0    10
1131211  0        2286.8   681.39   1049.7   0.28438    0.0    11
1131212  0        2286.8   694.16   1049.6   1.00000    0.0    12
1131213  0        2286.7   694.16   1049.7   1.00000    0.0    13
1131300  0
1131301  2.4877-6  2.4878-6  0.0      1
1131302  2.4877-6  2.0136-3  0.0      2
1131303  2.4877-6  6.0293-3  0.0      3
1131304  2.4869-6  1.0169-2  0.0      4
1131305  2.4855-6  1.3915-2  0.0      5
1131306  2.4835-6  1.7757-2  0.0      6
1131307  2.4807-6  2.0707-2  0.0      7
1131308  2.4778-6  2.5205-2  0.0      8
1131309  2.4740-6  1.7595-2  0.0      9
1131310  2.4731-6  1.1621    0.0      10
1131311  -0.84703  6.9574-6  0.0      11
1131312  -1.8910-3 2.0025-6  0.0      12
*
****************************************
*****  PRZ PRESSURE CONTROL    *******
****************************************
*
1590000  PRE-GG1 VALVE
1590101  113010000 116000000 1.0 0.0 0.0 01000
1590201  0         0.0       0.0      0.0
1590300  TRPVLV
1590301  501
*
1160000  PRE-GG TMDPVOL
1160101  1.0 0.0 1.0+4 0.0 0.0 0.0 0.0 1.0 00
```

```
1160200  2
1160201  0.0  2286.7    1.0
*
*************************************
*****   PRZ DESIRED MASS CONTRAL  ******
*************************************
*
1600000  PRZMASS TMDPJUN
1600101  115000000 113000000 1.0
1600200  1 501 CNTRLVAR 215
1600201  -1.01+3   0.0   0.0 0.0
*1600202  -1.0+3   -1.0+3 0.0 0.0
*1600203. 0.0       0.0   0.0 0.0
*1600204  1.0+3     1.0+3 0.0 0.0
*
1150000  PREMASS TMDPVOL
1150101  1.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0 00
1150200  1 0 TEMPF 113010000
1150201  -1.0  583.0  0.0
1150202   0.0  0.000  0.0
1150203  1000. 1000.  0.0
*
*****************************************************************
**********   EMERGENEY  CORE  COOLING  SYSTEM        ***************
*****************************************************************
*
****************************************
******  ACCUMULATOR OF INTACT LOOP  ********
****************************************
*
***** ACCUM. ISO VALVE OPEN WHEN VOL.28 PRESSURE BELOW 600.PSIA
*
*3530000  ACCUM VALVE
*3530101  303000000 112000000 0.00499 283.79 283.79 00100
*3530201  1 0.0 0.0 0.0
*3530300  TRPVLV
*3530301  404
*
3530000   ACCULTR TMDPJUN
3530101   303000000 112000000 0.00499
3530200   1   402
3530201   0.0          0.0                 0.0         0.0
3530202   15.8         0.0                 0.0         0.0
3530203   15.8260002 0.109409988           0.0         0.0
3530204   16.1737976 0.125513524E-01       0.0         0.0
3530205   16.5216064 0.594413616E-01       0.0         0.0
3530206   16.8694000 0.587309003E-01       0.0         0.0
3530207   17.2173004 0.163404346E-01       0.0         0.0
3530208   17.5650940 0.852545351E-02       0.0         0.0
3530209   17.9129028 0.710454211E-02.      0.0         0.0
3530210   18.2606964 0.637040854           0.0         0.0
3530211   18.6085968 1.28118610            0.0         0.0
3530212   18.9564056 1.62125683            0.0         0.0
3530213   19.3041992 1.87630939            0.0         0.0
3530214   19.6519928 2.11857510            0.0         0.0
3530215   19.9998932 2.25711346            0.0         0.0
3530216   20.3477020 2.42146301            0.0         0.0
3530217   20.6954956 2.57113171            0.0         0.0
3530218   21.0433044 2.70588112            0.0         0.0
3530219   21.3912048 2.82523823            0.0         0.0
3530220   21.7389984 2.91759586            0.0         0.0
3530221   22.0868073 2.98390579            0.0         0.0
```

3530222	22.7825012	3.07957840	0.0	0.0
3530223	24.1737976	3.24961567	0.0	0.0
3530224	25.5650940	3.39359951	0.0	0.0
3530225	26.9564056	3.40354824	0.0	0.0
3530226	28.3477020	3.38010406	0.0	0.0
3530227	29.7389984	3.47554111	0.0	0.0
3530228	30.7823944	3.39810085	0.0	0.0
3530229	32.1737061	3.47435570	0.0	0.0
3530230	32.8694000	3.36234188	0.0	0.0
3530231	33.5650024	3.26429939	0.0	0.0
3530232	34.2606964	3.32018757	0.0	0.0
3530233	35.3041992	3.36281490	0.0	0.0
3530234	35.9998016	3.46133327	0.0	0.0
3530235	37.7389069	3.46441078	0.0	0.0
3530236	38.4346008	3.45043755	0.0	0.0
3530237	39.1302032	3.45706940	0.0	0.0
3530238	40.1737061	3.39810085	0.0	0.0
3530239	41.9127960	3.42699528	0.0	0.0
3530240	42.6085052	3.43291187	0.0	0.0
3530241	43.3040924	3.41609859	0.0	0.0
3530242	43.6519928	3.39218044	0.0	0.0
3530243	44.3475952	3.37299919	0.0	0.0
3530244	46.0867004	3.38199806	0.0	0.0
3530245	46.7823944	3.36329079	0.0	0.0
3530246	48.1737061	3.36186886	0.0	0.0
3530247	49.9127960	3.34126472	0.0	0.0
3530248	50.9562988	3.32350540	0.0	0.0
3530249	51.6519012	3.31663704	0.0	0.0
3530250	52.3475952	3.25482559	0.0	0.0
3530251	53.7389069	3.23422146	0.0	0.0
3530252	54.0867004	3.22332859	0.0	0.0
3530253	54.4344940	3.20414829	0.0	0.0
3530254	54.7823944	3.19798946	0.0	0.0
3530255	55.4779968	3.18851852	0.0	0.0
3530256	55.8258057	3.20201588	0.0	0.0
3530257	56.8692932	3.14494228	0.0	0.0
3530258	57.5650024	3.13002300	0.0	0.0
3530259	57.9127960	3.11747169	0.0	0.0
3530260	58.9562988	3.08573723	0.0	0.0
3530261	59.9996948	3.06750202	0.0	0.0
3530262	61.7389069	3.02795219	0.0	0.0
3530263	63.4779968	3.00687790	0.0	0.0
3530264	64.1735992	3.00166798	0.0	0.0
3530265	64.5214996	2.98627567	0.0	0.0
3530266	64.8692932	2.99266911	0.0	0.0
3530267	66.2606049	2.97774982	0.0	0.0
3530268	67.6519012	2.99195862	0.0	0.0
3530269	67.9996948	2.67698956	0.0	0.0
3530270	68.6954041	2.27037334	0.0	0.0
3530271	69.0431976	2.64999104	0.0	0.0
3530272	69.3910065	2.53324127	0.0	0.0
3530273	69.7388000	3.10752487	0.0	0.0
3530274	70.4344940	3.83242512	0.0	0.0
3530275	70.7823029	4.10832024	0.0	0.0
3530276	71.4779968	4.72451782	0.0	0.0
3530277	71.8258057	5.31372261	0.0	0.0
3530278	72.5213928	5.95005512	0.0	0.0
3530279	72.8692932	6.12885094	0.0	0.0
3530280	73.5648956	6.81941414	0.0	0.0
3530281	73.9127045	7.12348747	0.0	0.0
3530282	74.6083984	7.85857010	0.0	0.0
3530283	74.9562073	8.08710098	0.0	0.0

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3530284    75.6519012 8.89986134           0.0          0.0
3530285    75.9996948 9.01495647           0.0          0.0
3530286    76.6952972 9.34650135           0.0          0.0
3530287    77.3910065 9.51985264           0.0          0.0
3530288    77.7388000 9.69533539           0.0          0.0
3530289    86.7623029 9.66549492           0.0          0.0
3530290    87.1300964 6.90348530           0.0          0.0
3530291    87.4779053 2.65212345           0.0          0.0
3530292    87.8256989 1.39509583           0.0          0.0
3530293    88.1735992 0.802102923          0.0          0.0
3530294    88.5213928 0.458953440          0.0          0.0
3530295    88.8692017 0.224266589          0.0          0.0
3530296    89.2169952 0.523363008E-01      0.0          0.0
3530297    89.5648956 0.111304447E-01      0.0          0.0
3530298    89.9127045 0.0                  0.0          0.0
3530299    300.0      0.0                  0.0          0.0
*
*****
*
3030000  ACCUMULR TMDPVOL
3030101  0.0 4.29 4.69 0.0 90.0 4.29 0.0 1.0 0
3030200  3
3030201  0.0  600. 85.
*3031101  112000000 4.9900-3 283.79 283.79 01000
*3032200  3.0 2.7441365 1.0 0.0 0.0574 1 0.0 0.0
***************************************
******  LOW PRESSURE INJECTION     ********
***************************************
*
3520000  LPIS TMDPJUN
3520101  302000000 112000000 4.99-3
3520200  1 402    *403
3520201   0.0        0.0               0.0      0.0
3520202   25.2171936 0.0               0.0      0.0
3520203   25.5650940 0.810508490       0.0      0.0
3520204   25.9129028 1.03220463        0.0      0.0
3520205   26.2606964 0.279370129       0.0      0.0
3520206   26.6085052 0.378514588       0.0      0.0
3520207   27.6519928 0.499138594       0.0      0.0
3520208   28.3477020 0.501946330       0.0      0.0
3520209   29.3910980 0.544770241       0.0      0.0
3520210   29.7389984 0.561514199       0.0      0.0
3520211   31.4781036 0.568414748       0.0      0.0
3520212   32.1737061 0.556101918       0.0      0.0
3520213   34.2606964 0.592329860       0.0      0.0
3520214   34.9562988 0.599061131       0.0      0.0
3520215   37.3910980 0.621724725       0.0      0.0
3520216   39.1302032 0.630959332       0.0      0.0
3520217   41.9127960 0.640159965       0.0      0.0
3520218   65.2171021 0.668945968       0.0      0.0
3520219   70.0867004 0.632312238       0.0      0.0
3520220   90.6083069 0.669791818       0.0      0.0
3520221   98.6083069 0.668269634       0.0      0.0
3520222   125.738693 0.668776870       0.0      0.0
3520223   126.782104 0.672633052       0.0      0.0
3520224   146.260300 0.678451359       0.0      0.0
3520225   149.390793 0.676996708       0.0      0.0
3520226   150.782104 0.678417325       0.0      0.0
3520227   208.173203 0.691271186       0.0      0.0
3520228   209.216705 0.688362300       0.0      0.0
3520229   210.955795 0.689647675       0.0      0.0
3520230   211.303604 0.690358162       0.0      0.0
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3520231    212.347107 0.689884484        0.0     0.0
3520232    212.694901 0.690256596        0.0     0.0
3520233    213.390594 0.689106584        0.0     0.0
3520234    216.173203 0.690188825        0.0     0.0
3520235    216.520996 0.689749241        0.0     0.0
3520236    217.912292 0.691203773        0.0     0.0
3520237    218.607895 0.690899312        0.0     0.0
3520238    218.955795 0.688971221        0.0     0.0
3520239    219.651398 0.689952135        0.0     0.0
3520240    219.999207 0.689985812        0.0     0.0
3520241    221.042694 0.691305220        0.0     0.0
3520242    221.390503 0.688768089        0.0     0.0
3520243    222.434006 0.691914022        0.0     0.0
3520244    222.781799 0.689140320        0.0     0.0
3520245    223.825302 0.690459371        0.0     0.0
3520246    224.173096 0.689850569        0.0     0.0
3520247    227.651398 0.694180489        0.0     0.0
3520248    228.347000 0.690662503        0.0     0.0
3520249    300.000000 0.693233192        0.0     0.0
*
3020000  LPISPOOL TMDPVOL
3020101  1.0 0.0 1.+4 0.0 0.0 0.0 0.0 1.0 0
3020200  1
3020201  0.0 85. 0.0
*
******************************************
******  HIGH PRESSURE INJECTION    ********
******************************************
*
3510000  HPIS TMDPJUN
3510101  301000000  112000000 0.00499
3510200  1  402   * 405
3510201   0.0          0.0               0.0       0.0
3510202   0.173799992 0.528852269E-01    0.0       0.0
3510203   0.869499981 0.218777098E-01    0.0       0.0
3510204   1.21730042 0.219791532E-01     0.0       0.0
3510205   1.91300011 0.319373980E-01     0.0       0.0
3510206   2.26080036 0.298240148E-01     0.0       0.0
3510207   2.95639992 0.392074399E-01     0.0       0.0
3510208   3.30430031 0.389030986E-01     0.0       0.0
3510209   3.99989986 0.359781832E-01     0.0       0.0
3510210   4.34770012 0.399175324E-01     0.0       0.0
3510211   5.04339981 0.408135951E-01     0.0       0.0
3510212   6.08689976 0.399682447E-01     0.0       0.0
3510213   6.78250027 0.402387679E-01     0.0       0.0
3510214   7.47819996 0.408305116E-01     0.0       0.0
3510215   8.52159977 0.330363587E-01     0.0       0.0
3510216   8.86950016 0.291477405E-01     0.0       0.0
3510217   10.2608004 0.277951695E-01     0.0       0.0
3510218   10.6085997 0.215395652E-01     0.0       0.0
3510219   12.3477001 0.218438953E-01     0.0       0.0
3510220   13.3912001 0.229090378E-01     0.0       0.0
3510221   13.7390003 0.228245035E-01     0.0       0.0
3510222   14.4347000 0.250900462E-01     0.0       0.0
3510223   15.1302996 0.403063893E-01     0.0       0.0
3510224   16.8694000 0.389030986E-01     0.0       0.0
3510225   18.2606964 0.407628827E-01     0.0       0.0
3510226   20.3477020 0.325122438E-01     0.0       0.0
3510227   21.0433044 0.348623283E-01     0.0       0.0
3510228   22.0868073 0.248195343E-01     0.0       0.0
3510229   23.1302948 0.210154429E-01     0.0       0.0
3510230   24.8694000 0.279473364E-01     0.0       0.0
```

3510231	25.2171936	0.299254581E-01	0.0	0.0
3510232	25.9129028	0.208632767	0.0	0.0
3510233	26.9564056	0.141799271	0.0	0.0
3510234	27.3041992	0.501124784E-01	0.0	0.0
3510235	28.6954956	0.915178061E-01	0.0	0.0
3510236	29.3910980	0.111704826	0.0	0.0
3510237	29.7389984	0.932761431E-01	0.0	0.0
3510238	30.0868073	0.854820013E-01	0.0	0.0
3510239	30.4346008	0.131739676	0.0	0.0
3510240	30.7823944	0.153279126	0.0	0.0
3510241	31.1302948	0.727509856E-01	0.0	0.0
3510242	31.8258972	0.909598470E-01	0.0	0.0
3510243	32.1737061	0.489120819E-01	0.0	0.0
3510244	32.8694000	0.552353114E-01	0.0	0.0
3510245	33.2171936	0.854650736E-01	0.0	0.0
3510246	34.2606964	0.163068414	0.0	0.0
3510247	34.9562988	0.161005616	0.0	0.0
3510248	35.9998016	0.684565902E-01	0.0	0.0
3510249	36.3475952	0.752532482E-01	0.0	0.0
3510250	37.0433044	0.884745717E-01	0.0	0.0
3510251	37.3910980	0.757266283E-01	0.0	0.0
3510252	38.4346008	0.720747113E-01	0.0	0.0
3510253	38.7823944	0.114173234	0.0	0.0
3510254	39.1302032	0.915685296E-01	0.0	0.0
3510255	39.4781036	0.146972895	0.0	0.0
3510256	40.1737061	0.146161079	0.0	0.0
3510257	40.5214996	0.148781836	0.0	0.0
3510258	41.2171936	0.120750129	0.0	0.0
3510259	41.5650024	0.937157273E-01	0.0	0.0
3510260	41.9127960	0.121815264	0.0	0.0
3510261	42.9562988	0.148832679	0.0	0.0
3510262	43.6519928	0.157235324	0.0	0.0
3510263	43.9998016	0.105888784	0.0	0.0
3510264	45.0433044	0.131435335	0.0	0.0
3510265	45.7389069	0.159450293	0.0	0.0
3510266	46.7823944	0.162290633	0.0	0.0
3510267	47.4779968	0.162341356	0.0	0.0
3510268	48.8692932	0.121003687	0.0	0.0
3510269	49.2171936	0.146144271	0.0	0.0
3510270	49.9127960	0.128764033	0.0	0.0
3510271	50.2606049	0.158249915	0.0	0.0
3510272	50.9562988	0.990245342E-01	0.0	0.0
3510273	51.3040924	0.104231894	0.0	0.0
3510274	58.9562988	0.170642674	0.0	0.0
3510275	59.9996948	0.163051307	0.0	0.0
3510276	65.9127960	0.165739715	0.0	0.0
3510277	69.0431976	0.150726080	0.0	0.0
3510278	69.7388000	0.161749482	0.0	0.0
3510279	72.8692932	0.153279126	0.0	0.0
3510280	73.2171021	0.150066853	0.0	0.0
3510281	86.7823029	0.158266723	0.0	0.0
3510282	89.9127045	0.178081751	0.0	0.0
3510283	95.4779053	0.165722728	0.0	0.0
3510284	95.8256989	0.167075157	0.0	0.0
3510285	97.5648041	0.172248840	0.0	0.0
3510286	107.999603	0.176052988	0.0	0.0
3510287	111.477798	0.173499942	0.0	0.0
3510288	124.347397	0.205318987	0.0	0.0
3510289	150.434204	0.216917157	0.0	0.0
3510290	174.781998	0.217542887	0.0	0.0
3510291	190.434097	0.206570089	0.0	0.0
3510292	193.216705	0.230679512	0.0	0.0

```
3510293   258.955566 0.196983874       0.0      0.0
3510294   272.172852 0.178453743       0.0      0.0
3510295   285.390137 0.188935995       0.0      0.0
3510296   287.477051 0.182071805       0.0      0.0
3510297   294.781494 0.171927571       0.0      0.0
3510298   298.955322 0.201853037       0.0      0.0
3510299   300.000000 0.179113150       0.0      0.0
*
3010000  HPISPOOL TMDPVOL
3010101  1.0 0.0 1.+4 0.0 0.0 0.0 0.0 1.0 0
3010200  1
3010201  0.0 85. 0.0
*
*****************************************************************************
*********** SECONDARY SIDE OF STEAM GENERATOR INTACT LOOP ************
*****************************************************************************
*
*********************************************
******  FEED   WATER   SYSTEM      ********
*********************************************
*
4510000  FEED TMDPJUN
4510101  401000000 402000000 0.012
4510200  1 402
4510201  -0.0    1.2229  0.0 0.0
4510202  0.0     1.2229  0.0 0.0
4510203  10.     0.60933 0.0 0.0
4510204  20.       0.0   0.0 0.0
4510205  300.      0.0   0.0 0.0
*
4010000  FEEDPOOL TMDPVOL
4010101  1.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0 0
4010200  3
4010201  0.0 950.0 434.93
*
*********************************************
******     STEAM      GENERATOR      ********
*********************************************
*
*****  DOWNCOMER
*
4030000 DCM BRANCH
4030001  1 0
4030101  0.004 0.0 0.4357 0.0 -90.0 -9.66 0.0 0.0 0
4030200  0          947.70    529.81    1111.7    7.1670-4
4031101  403010000 402000000 0.0 0.0 0.0 01000
4031201  4.0187     2.8488    0.0
*
*****  EVAPORATOR
*
4020000  S/G PIPE
4020001  3
4020101  0.036 3
4020201  0.036 2
4020301  0.0  3
4020401  2.2780 1 1.13976 2 0.5017 3
4020501  0.0 3
4020601  90. 3
4020701  5.6162 1 2.80777 2 1.23603 3
4020801  0.0 0.0 3
4020901  0.0 0.0 2
4021001  0       3
```

```
4021101  01000   2
4021201  0          948.17     529.79     1111.7     0.91100    0.0        1
4021202  0          947.57     530.66     1111.7     0.96187    0.0        2
4021203  0          947.28     530.62     1111.7     0.97061    0.0        3
4021300  0
4021301  8.2296     10.734     0.0        1
4021302  11.845     16.658     0.0        2
*
*****  SEPARATOR
*
4040000 S/G SEPARATR
4040001 3              0
4040101 0.04 0.0 0.4405 0.0 90.0  0.977 0.0 0.0 0
4040200 0          947.20     530.61     1111.7     0.85131
4041101 404010000 405000000 0.0 0.0 0.0 01000
4041201  13.607    14.425 0.0
4042101 404000000 403000000 0.0 0.0 0.0 01000
4042201  4.0791    4.1595 0.0
4043101 402010000 404000000 0.0 0.0 0.0 01000
4043201  15.368    16.514 0.0
*
*****  STEAM DOME
*
4050000 S/G PIPE
4050001 5
4050101 0.04 5
4050201 0.04 4
4050301 0.0  5
4050401 0.4405 5
4050501 0.0 5
4050601 90. 5
4050701 0.977 5
4050801 0.0 0.0 5
4050901 0.0 0.0 4
4051001 0        5
4051101 01000    4
4051201 0          947.16     530.60     1111.7     1.00000    0.0        1
4051202 0          947.11     530.59     1111.7     1.00000    0.0        2
4051203 0          947.07     530.59     1111.7     1.00000    0.0        3
4051204 0          947.02     530.58     1111.7     1.00000    0.0        4
4051205 0          946.98     530.57     1111.7     1.00000    0.0        5
4051300 0
4051301 14.426     14.426     0.0        1
4051302 14.427     14.427     0.0        2
4051303 14.427     14.427     0.0        3
4051304 14.428     14.428     0.0        4
*
*******************************************
******      STEAM     LINE          ********
*******************************************
*
4520000  OUTLET TMDPJUN
4520101  405010000 406000000 0.021
*4520201  0          27.582    27.582    0.0
4520200  1  402
4520201  -0.0    0.0 1.21868    0.0
4520202  0.0     0.0 1.27868    0.0
4520203  8.0     0.0 1.27868    0.0
4520204  12.30   0.0 0.41433    0.0
4520205  22.5    0.0 0.14622    0.0
4520206  22.9    0.0 0.0        0.0
4520207  300.    0.0 0.0        0.0
```

```
*
4060000  OUTLET TMDPVOL
4060101  1.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0 0
4060200  2
4060201  0.0 947.0 1.0
*
****************************************
******  S/G SESIRED MASS CONTRAL    ********
****************************************
*
4530000  S/GMASS TMDPJUN
4530101  407000000 403000000 0.0
4530200  1 501 CNTRLVAR 6
4530201  -1.01+3   0.0   0.0 0.0
*4530202  -1.0+3   -1.0+3 0.0 0.0
*4530203  0.0       0.0   0.0 0.0
*4530204  1.0+3     1.0+3 0.0 0.0
*
4070000  S/GMASS TMDPVOL
4070101  1.0 0.0 1.0 0.0 0.0 0.0 0.0 1.0 00
4070200  3
4070201  0.0   950.0 434.93
*
************************************************************
*******************  CONTROL VARIABLES *************************
************************************************************
*
**************************************
*****  PUMP SPEED CTR FOR FLOW(4.993 KG/S)
**************************************
*
20500100 ILMERR SUM 1.0 0.0 1
20500101 4.993 -1.0 MFLOWJ 110020000
*
20500200 ILPSPD INTEGRAL 190.98 3650.0 1
20500201 CNTRLVAR 1
*
*
**************************************
***** S/G DESIRED MASS CONTRAL(22.128 KG)
**************************************
*
20500500 S/G SUM 1.0 0.0 1
20500501 0.0 0.064510 RHO 402010000
20500502     0.032270 RHO 402020000
20500503     0.014210 RHO 402030000
20500504     0.012470 RHO 404010000
20500505     0.012470 RHO 405010000
20500506     0.012470 RHO 405020000
20500507     0.012470 RHO 405030000
20500508     0.012470 RHO 405040000
20500509     0.012470 RHO 405050000
20500510     0.012338 RHO 403010000
*
20500600 SG-ERR SUM 0.66138 0.0 1
20500601 22.128 -1.0 CNTRLVAR 5
*
**************************************
*****  PUMP SPEED CTR FOR TEST SIMULATION
**************************************
*
20500700 PUMP FUNCTION 1811.7 0.0 1
```

```
20500701 TIME 0 1
*
****************************************
***** TEMP DIFFERENCE ACROSS CORE   *****
****************************************
*
20501000 DT SUM 1.0 0.0 1
20501001 0.0 1.0 TEMPF 101010000
20501002     -1.0 TEMPF 111010000
*
****************************************
***** DESIRED PARM. FOR COMPARISON  *****
****************************************
*
*****
******** SYSTEM PRESSURES
*****
*
***      UPPER PLENUM PRESSURE
*
20509900 UP-PL-P SUM 1.0-3 0.0 1
20509901 0.0 1.0 P 029010000
*
***      PRZ PRESSURE
*
20510000 PRZ-P SUM 1.0-3 0.0 1
20510001 0.0 1.0 P 113130000
*
***      S/G PRESSURE
*
20510100 SG-P SUM 1.0-3 0.0 1
20510101 0.0 1.0 P 405010000
*
*****
******** VOLUMATRIC FLOW RATES
*****
*
***    INTACT LOOP HOT LEG
*
20510200 ILHLG-VF MULT 1.0 0.0 1
20510201 VELFJ 101030000 VOIDFJ 101030000
*
20510300 ILHLG-VG MULT 1.0 0.0 1
20510301 VELGJ 101030000 VOIDGJ 101030000
*
20510400 ILHLG-V SUM 28.316 0.0 1            * 28.316=FT**3/L
20510401 0.0 0.02058 CNTRLVAR 102
20510402      0.02058 CNTRLVAR 103
*
***    INTACT LOOP COLD LEG
*
20510500 ILCLG-VF MULT 1.0 0.0 1
20510501 VELFJ 112020000 VOIDFJ 112020000
*
20510600 ILCLG-VG MULT 1.0 0.0 1
20510601 VELGJ 112020000 VOIDGJ 112020000
*
20510700 ILCLG-V SUM 28.316 0.0 1            * 28.316=FT**3/L
20510701 0.0 0.0378 CNTRLVAR 105
20510702      0.0378 CNTRLVAR 106
*
***    INTACT PRZ SURGE FLOW
```

```
*
20510800 PRZ-VF MULT 1.0 0.0 1
20510801 VELFJ 101020000 VOIDFJ 101020000
*
20510900 PRZ-VG MULT 1.0 0.0 1
20510901 VELGJ 101020000 VOIDGJ 101020000
*
20511000 PRZ-V SUM 28.316 0.0 1          * 28.316=FT**3/L
20511001 0.0 0.0030 CNTRLVAR 108
20511002     0.0030 CNTRLVAR 109
*
***   IN VESSEL FLOW RATE
*
20511100 ICORE-VF MULT 1.0 0.0 1
20511101 VELFJ 006010000 VOIDFJ 006010000
*
20511200 ICORE-VG MULT 1.0 0.0 1
20511201 VELGJ 006010000 VOIDGJ 006010000
*
20511300 ICORE-V SUM 28.316 0.0 1        * 28.316=FT**3/L
20511301 0.0 0.03142 CNTRLVAR 111
20511302     0.03142 CNTRLVAR 112
*
*****
******** FUEL TEMP. TO BE COMPARED
*****
*
***      HOT FUEL RODS
*
20512100 HF-1  SUM 1.0 0.0 1
20512101 0.0 1.0 HTTEMP 001100112
*
20512200 HF-2  SUM 1.0 0.0 1
20512201 0.0 1.0 HTTEMP 001100212
*
20512300 HF-3  SUM 1.0 0.0 1
20512301 0.0 1.0 HTTEMP 001100312
*
20512400 HF-4  SUM 1.0 0.0 1
20512401 0.0 1.0 HTTEMP 001100412
*
20512500 HF-5  SUM 1.0 0.0 1
20512501 0.0 1.0 HTTEMP 001100512
*
20512600 HF-6  SUM 1.0 0.0 1
20512601 0.0 1.0 HTTEMP 001100612
*
20512700 HF-7  SUM 1.0 0.0 1
20512701 0.0 1.0 HTTEMP 001100712
*
20512800 HF-8  SUM 1.0 0.0 1
20512801 0.0 1.0 HTTEMP 001100812
*
20512900 HF-9  SUM 1.0 0.0 1
20512901 0.0 1.0 HTTEMP 001100912
*
20513000 HF-10 SUM 1.0 0.0 1
20513001 0.0 1.0 HTTEMP 001101012
*
***      AVERAGE FUEL RODS
*
20513100 AF-1  SUM 1.0 0.0 1
```

```
20513101 0.0 1.0 HTTEMP 002100112
*
20513200 AF-2  SUM 1.0 0.0 1
20513201 0.0 1.0 HTTEMP 002100212
*
20513300 AF-3  SUM 1.0 0.0 1
20513301 0.0 1.0 HTTEMP 002100312
*
20513400 AF-4  SUM 1.0 0.0 1
20513401 0.0 1.0 HTTEMP 002100412
*
20513500 AF-5  SUM 1.0 0.0 1
20513501 0.0 1.0 HTTEMP 002100512
*
20513600 AF-6  SUM 1.0 0.0 1
20513601 0.0 1.0 HTTEMP 002100612
*
20513700 AF-7  SUM 1.0 0.0 1
20513701 0.0 1.0 HTTEMP 002100712
*
20513800 AF-8  SUM 1.0 0.0 1
20513801 0.0 1.0 HTTEMP 002100812
*
20513900 AF-9  SUM 1.0 0.0 1
20513901 0.0 1.0 HTTEMP 002100912
*
20514000 AF-10 SUM 1.0 0.0 1
20514001 0.0 1.0 HTTEMP 002101012
*
*****
******** DIFFERENTIAL PRESSURE
*****
*
***      ACROSS DOWNCOMER
*
20514100 DCM-DP SUM 1.0-3 0.0 1
20514101 0.0  1.0 P 005010000 -1.2152 RHO 005010000
20514102      -1.0 P 003010000  0.1176 RHO 003010000
*
***      ACROSS LOW PLEN.
*
20514200 LPN-DP SUM 1.0-3 0.0 1
20514201 0.0  1.0 P 005010000  2.5015 RHO 005010000
20514202      -1.0 P 006010000  0.3724 RHO 006010000
*
***      ACROSS CORE
*
20514300 CORE-DP SUM 1.0-3 0.0 1
20514301 0.0  1.0 P 005010000 -1.2152 RHO 005010000
20514302      -1.0 P 029010000 -2.5284 RHO 029010000
*
*****
******** COLLAPSED WATER LEVEL    ( DESITY=990.0 KG/M**3 , 100.0 F )
*****
*
*****      ACROSS DOWNCOMER
*
*** W/L D-P
*
20514500 DCM-WL1 SUM 1.0307-4 0.0 1    * 1.0307-4=1/(9.8*990.0)
20514501 0.0  1.0+3 CNTRLVAR 141
*
```

```
*** W/L CALCULATED BY VOID
*
20514600 DCM-WLII SUM 1.0 0.0 1
20514601 0.0  0.1537 VOIDF 003010000
20514602      1.2771 VOIDF 004010000
20514603      1.2771 VOIDF 004020000
20514604      1.2771 VOIDF 004030000
20514605      0.2235 VOIDF 006010000
20514606      0.1315 VOIDF 005010000
*
20514700 DCM-WLII SUM 1.0 0.0 1
20514701 0.0  0.1537 VOIDG 003010000
20514702      1.2771 VOIDG 004010000
20514703      1.2771 VOIDG 004020000
20514704      1.2771 VOIDG 004030000
20514705      0.2235 VOIDG 006010000
20514706      0.1315 VOIDG 005010000
*
20514800 DCM-WLII MULT 0.0010101 0.0 1  * 0.0010101=1/990.0
20514801      RHOF        005010000
20514802      CNTRLVAR    146
*
20514900 DCM-WLII MULT 0.0010101 0.0 1
20514901      RHOG        005010000
20514902      CNTRLVAR    147
*
20515000 DCM-WLII SUM 1.0 0.0 1
20515001 0.0  1.0 CNTRLVAR 148
20515002      1.0 CNTRLVAR 149
*
*****    ACROSS LOW PLENUM
*
***      W/L CALCULATED BY D-P
*
20515100 LPN-WLI SUM 1.0307-4 0.0 1    * 1.0307-4=1/(9.8*990.0)
20515101 0.0  1.0+3 CNTRLVAR 142
*
***      W/L CALCULATED BY VOID
*
20515200 LPN-WLII SUM 1.0 0.0 1
20515201 0.0  0.1496 VOIDF 006010000
20515202      0.5104 VOIDF 005010000
*
20515300 LPN-WLII SUM 1.0 0.0 1
20515301 0.0  0.1496 VOIDG 006010000
20515302      0.5104 VOIDG 005010000
*
20515400 LPN-WLII MULT 0.0010101 0.0 1
20515401      RHOF        005010000
20515402      CNTRLVAR    152
*
20515500 LPN-WLII MULT 0.0010101 0.0 1
20515501      RHOG        005010000
20515502      CNTRLVAR    153
*
20515600 LPN-WLII SUM 1.0 0.0 1
20515601 0.0  1.0 CNTRLVAR 154
20515602      1.0 CNTRLVAR 155
*
*****     ACROSS CORE
*
***      W/L CALCULATED BY D-P
```

```
*
20515700 CDR-WLI SUM 1.0307-4 0.0 1     * 1.0307-4=1/(9.8*990.0)
20515701 0.0  1.0+3 CNTRLVAR 143
*
***      W/L CALCULATED BY VOID
*
20515800 CDR-WLII SUM 1.0 0.0 1
20515801 0.0  0.1315 VOIDF 005010000
20515802      0.2235 VOIDF 006010000
20515803      0.5416 VOIDF 007010000
20515804      0.1524 VOIDF 008010000
20515805      0.1271 VOIDF 009010000
20515806      0.1269 VOIDF 010010000
20515807      0.1269 VOIDF 011010000
20515808      0.1591 VOIDF 121010000
20515809      0.0948 VOIDF 122010000
20515810      0.1271 VOIDF 013010000
*
20515900 CDR-WLII SUM 1.0 0.0 1
20515901 0.0  0.1271 VOIDF 014010000
20515902      0.1777 VOIDF 015010000
20515903      0.2033 VOIDF 016010000
20515904      0.2539 VOIDF 017010000
20515905      0.7043 VOIDF 028010000
20515906      0.7043 VOIDF 028020000
20515907      0.7043 VOIDF 028030000
20515908      0.1541 VOIDF 029010000
20515909      1.0    CNTRLVAR 158
*
20516000 CDR-WLII SUM 1.0 0.0 1
20516001 0.0  0.1315 VOIDG 005010000
20516002      0.2235 VOIDG 006010000
20516003      0.5416 VOIDG 007010000
20516004      0.1524 VOIDG 008010000
20516005      0.1271 VOIDG 009010000
20516006      0.1269 VOIDG 010010000
20516007      0.1269 VOIDG 011010000
20516008      0.1591 VOIDG 121010000
20516009      0.0948 VOIDG 122010000
20516010      0.1271 VOIDG 013010000
*
20516100 CDR-WLII SUM 1.0 0.0 1
20516101 0.0  0.1271 VOIDG 014010000
20516102      0.1777 VOIDG 015010000
20516103      0.2033 VOIDG 016010000
20516104      0.2539 VOIDG 017010000
20516105      0.7043 VOIDG 028010000
20516106      0.7043 VOIDG 028020000
20516107      0.7043 VOIDG 028030000
20516108      0.1541 VOIDG 029010000
20516109      1.0    CNTRLVAR 160
*
20516200 CDR-WLII MULT 0.0010101 0.0 1
20516201      RHOF          005010000
20516202      CNTRLVAR      159
*
20516300 CDR-WLII MULT 0.0010101 0.0 1
20516301      RHOG          005010000
20516302      CNTRLVAR      161
*
20516400 CDR-WLII SUM 1.0 0.0 1
20516401 0.0 1.0 CNTRLVAR 162
```

```
20516402     1.0 CNTRLVAR 163
*
****************************************
***** PRZ DESIRED MASS CONTRAL(9.09 KG)**
****************************************
*
20519800 PRZMASS MULT 1.0 0.0 1
20519801 VOIDF 114010000 RHOF 114010000
*
20519900 PRZMASS MULT 1.0 0.0 1
20519901 VOIDF 114020000 RHOF 114020000
*
20520000 PRZMASS MULT 1.0 0.0 1
20520001 VOIDF 114030000 RHOF 114030000
*
20520100 PRZMASS MULT 1.0 0.0 1
20520101 VOIDF 113010000 RHOF 113010000
*
20520200 PRZMASS MULT 1.0 0.0 1
20520201 VOIDF 113020000 RHOF 113020000
*
20520300 PRZMASS MULT 1.0 0.0 1
20520301 VOIDF 113030000 RHOF 113030000
*
20520400 PRZMASS MULT 1.0 0.0 1
20520401 VOIDF 113040000 RHOF 113040000
*
20520500 PRZMASS MULT 1.0 0.0 1
20520501 VOIDF 113050000 RHOF 113050000
*
20520600 PRZMASS MULT 1.0 0.0 1
20520601 VOIDF 113060000 RHOF 113060000
*
20520700 PRZMASS MULT 1.0 0.0 1
20520701 VOIDF 113070000 RHOF 113070000
*
20520800 PRZMASS MULT 1.0 0.0 1
20520801 VOIDF 113080000 RHOF 113080000
*
20520900 PRZMASS MULT 1.0 0.0 1
20520901 VOIDF 113090000 RHOF 113090000
*
20521000 PRZMASS MULT 1.0 0.0 1
20521001 VOIDF 113100000 RHOF 113100000
*
20521100 PRZMASS MULT 1.0 0.0 1
20521101 VOIDF 113110000 RHOF 113110000
*
20521200 PRZMASS MULT 1.0 0.0 1
20521201 VOIDF 113120000 RHOF 113120000
*
20521300 PRZMASS MULT 1.0 0.0 1
20521301 VOIDF 113130000 RHOF 113130000
*
20521400 PRZMASS SUM 1.0 0.0 1
20521401 0.0 1.227-4 CNTRLVAR 198
20521402     1.227-4 CNTRLVAR 199
20521403     1.227-4 CNTRLVAR 200
20521404     1.093-3 CNTRLVAR 201
20521405     1.093-3 CNTRLVAR 202
20521406     1.093-3 CNTRLVAR 203
20521407     1.093-3 CNTRLVAR 204
```

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20521408      1.093-3 CNTRLVAR 205
20521409      1.093-3 CNTRLVAR 206
20521410      1.093-3 CNTRLVAR 207
20521411      1.093-3 CNTRLVAR 208
20521412      1.093-3 CNTRLVAR 209
20521413      1.093-3 CNTRLVAR 210
20521414      5.465-3 CNTRLVAR 211
20521415      5.465-3 CNTRLVAR 212
20521416      5.465-3 CNTRLVAR 213
*
20521500 PRZERR SUM 0.66138 0.0 1
20521501 9.09 -1.0 CNTRLVAR 214
**************************************************************
*******************  HEAT STRUCTURES **************************
**************************************************************
*
****************************************
*****     CORE (HOT CHANNEL)      *****
****************************************
*
10011000  11 18 2 1 0.0 1 1 8
10011100  0 1
10011101  1 0.002917 4 0.010034 4 0.014334 8 0.017584
10011201  1 1 3 5 1 9 2 17
10011301  0.0 1 1.0 5 0.0 17
10011401  1026.1 1  1026.1 2   1014.6 3   984.91 4   939.53 5
10011402  879.51 6  846.61 7   816.79 8   789.52 9   764.61 10
10011403  750.73 11 737.34 12  724.23 13  711.39 14  698.80 15
10011404  686.45 16 674.34 17  662.44 18
10011501  0    0    0    0    0.     11
10011601  018010000  0  1  0  0.22097    1
10011602  019010000  0  1  0  0.18429    2
10011603  020010000  0  1  0  0.18416    3
10011604  021010000  0  1  0  0.18399    4
10011605  221010000  0  1  0  0.23078    5
10011606  222010000  0  1  0  0.13750    6
10011607  023010000  0  1  0  0.18416    7
10011608  024010000  0  1  0  0.18416    8
10011609  025010000  0  1  0  0.25779    9
10011610  026010000  0  1  0  0.29461    10
10011611  027010000  0  1  0  0.36832    11
10011701  100    0.00966  0.     0.        1
10011702  100    0.01257  0.     0.        2
10011703  100    0.01617  0.     0.        3
10011704  100    0.01859  0.     0.        4
10011705  100    0.02481  0.     0.        5
10011706  100    0.01478  0.     0.        6
10011707  100    0.01859  0.     0.        7
10011708  100    0.01617  0.     0.        8
10011709  100    0.01760  0.     0.        9
10011710  100    0.01185  0.     0.        10
10011711  100    0.00499  0.     0.        11
10011801  0     0.        0.       0.      11
10011901  0     0.0465    0.0465   0.500   1
10011902  0     0.0465    0.0465   0.417   2
10011903  0     0.0465    0.0465   0.4165  4
10011904  0     0.0465    0.0465   0.522   5
10011905  0     0.0465    0.0465   0.311   6
10011906  0     0.0465    0.0465   0.417   8
10011907  0     0.0465    0.0465   0.583   9
10011908  0     0.0465    0.0465   0.677   10
10011909  0     0.0465    0.0465   0.833   11
```

```
*
****************************************
*****  CORE (AVERAGE CHANNEL)      ******
****************************************
*
10021000  11 18 2 1 0.0 1 1 8
10021100  0 1
10021101  1 0.002917 4 0.010084 4 0.014334 8 0.017584
10021201  1 1 3 5 1 9 2 17
10021301  0.0 1 1.0 5 0.0 17
10021401  1026.1 1  1026.1 2   1014.6 3   984.91 4   939.53 5
10021402  879.51 6  846.61 7   816.79 8   789.52 9   764.61 10
10021403  750.73 11 737.34 12  724.23 13  711.39 14  698.80 15
10021404  686.45 16 674.34 17  662.44 18
10021501  0    0    0    0    0.       11
10021601  008010000  0  1 0 1.7684782 1
10021602  009010000  0  1 0 1.4737318 2
10021603  010010000  0  1 0 1.4726050 3
10021604  011010000  0  1 0 1.4726050 4
10021605  121010000  0  1 0 1.8463593 5
10021606  122010000  0  1 0 1.1000340 6
10021607  013010000  0  1 0 1.4731967 7
10021608  014010000  0  1 0 1.4731958 8
10021609  015010000  0  1 0 2.0624742 9
10021610  016010000  0  1 0 2.3571156 10
10021611  017010000  0  1 0 2.9463945 11
10021701  100   0.044937 0.    0.    1
10021702  100   0.063580 0.    0.    2
10021703  100   0.081803 0.    0.    3
10021704  100   0.094019 0.    0.    4
10021705  100   0.125489 0.    0.    5
10021706  100   0.074765 0.    0.    6
10021707  100   0.094019 0.    0.    7
10021708  100   0.081803 0.    0.    8
10021709  100   0.089013 0.    0.    9
10021710  100   0.059916 0.    0.    10
10021711  100   0.025232 0.    0.    11
10021801  0   0.        0.        0.     11
10021901  0   0.0352    0.0523    0.500  1
10021902  0   0.0352    0.0523    0.417  2
10021903  0   0.0352    0.0523    0.4165 4
10021904  0   0.0352    0.0523    0.522  5
10021905  0   0.0352    0.0523    0.311  6
10021906  0   0.0352    0.0523    0.417  8
10021907  0   0.0352    0.0523    0.583  9
10021908  0   0.0352    0.0523    0.677 10
10021909  0   0.0352    0.0523    0.833 11
*
****************************************
*****    UPPER    PLENUM   I      *****
****************************************
*
10031000  4  18  2  1  0.
10031100  0   1
10031101  1 0.002917 4 0.010084 4 0.014334 8 0.017584
10031201  1 1 3 5 1 9 2 17
10031301  0.0 1 1.0 5 0.0 17
10031401  597.0  18
10031501  0     0     0     0     0.     4
10031601  028010000   010000  1    0  1.0211   3
10031602  029010000        0  1    0  1.2023   4
10031701  0     0.     0.     0.     4
```

```
10031801  0    0.      0.      0.      4
10031901  0    0.0465  0.      0.      4
*
**************************************
*****    UPPER    PLENUM    II      *****
**************************************
*
10041000  4  18  2  1  0.
10041100  0   1
10041101  1 0.002917 4 0.010084 4 0.014334 8 0.017584
10041201  1 1 3 5 1 9 2 17
10041301  0.0 1 1.0 5 0.0 17
10041401  597.0  18
10041501  0      0     0     0     0.    4
10041601  028010000  010000  1   0   9.19028  3
10041602  029010000        0  1   0   10.8211  4
10041701  0     0.       0.      0.      4
10041801  0     0.       0.      0.      4
10041901  0     0.03524 0.0478  0.      4
*
**************************************
*****    S/G     TUBES              *****
**************************************
*
14022000  4    6     2     1    0.01675
14022100  0    1
14022101  5    0.02075
14022201  2    5
14022301  0.0 5
14022401  560.0  6
14022501  104010000  0    1    0   40.40439 1
14022502  105010000  0    1    0   20.20211 2
14022503  106010000  0    1    0   20.20211 3
14022504  107010000  0    1    0   40.40439 4
14022601  402010000  0    1    0   50.0532  1
14022602  402020000  0    1    0   25.0265  2
14022603  402020000  0    1    0   25.0265  3
14022604  402010000  0    1    0   50.0532  4
14022701  0       0.       0.       0.       4
14022801  0       0.       0.       5.6162   4
14022901  0       0.       0.       5.6162   4
*
**************************************
***** DOWNCOMER SLAB :VESSEL SIDE *****
**************************************
*
10043000  3 11  2 1 0.28167
10043100  0  1
10043101  2 0.29167 1 0.29584 3 0.35604 4 0.44104
10043201  4 2 6 3 2 6 5 10
10043301  0.0  10
10043401  564.0 11
10043501  004010000 010000 1  0  7.415311  3
10043601  0         0        0  0  11.61092  3
10043701  0         0.      0.      0.        3
10043801  0         0.71    0.      0.        3
10043901  0         0.      0.      0.        3
*
**************************************
*****       UPPER PLENUM   III      *****
**************************************
*
```

```
10284000  4     5     2     1     0.2856
10284100  0     1
10284101  2     0.2956  1    0.29977   1    0.35997
10284201  4    2     6    3     5     4
10284301  0.0 4
10284401  590.0  5
10284501  028010000  010000  1  0  4.16184  3
10284502  029010000       0  1  0  4.88195  4
10284601          0       0  0  0  5.24558  3
10284602          0       0  0  0  6.15321  4
10284701  0      0.0     0.0     0.0   4
10284801  0      1.4387 0.0     0.0   4
10284901  0      0.0     0.0     0.0   4
*
*************************************
*****      PIPEING HEAT SLABS      *****
*************************************
*
10185000  12    6    2    1    0.1094
10185100  0     1
10185101  5     0.1458
10185201  2     5
10185301  0.0   5
10185401  570.0 6
10185501  214010000  0   1   0    1.220     1
10185502  101010000  0   1   0    4.482     2
10185503  102010000  0   1   0    3.088     3
10185504  109010000  0   1   0    6.590     4
10185505  112010000  0   1   0    5.440     5
10185506  201010000  0   1   0    1.700     6
10185507  202010000  0   1   0    5.895     7
10185508  203010000  0   1   0    6.625     8
10185509  204010000  0   1   0    1.170     9
10185510  206010000  0   1   0    1.200     10
*10185511  207010000  0   1   0    1.420     11
10185511  212010000  0   1   0    1.250     11
10185512  213010000  0   1   0    1.821     12
10185601  0        0        0   0    1.62592   1
10185602  0        0        0   0    5.97327   2
10185603  0        0        0   0    4.11545   3
10185604  0        0        0   0    8.78265   4
10185605  0        0        0   0    7.25002   5
10185606  0        0        0   0    2.26563   6
10185607  0        0        0   0    7.85641   7
10185608  0        0        0   0    8.82930   8
10185609  0        0        0   0    1.55929   9
10185610  0        0        0   0    1.59927   10
*10185611  0        0        0   0    1.89247   11
10185611  0        0        0   0    1.66590   11
10185612  0        0        0   0    2.42689   12
10185701  0        0.       0.      0.            12
10185801  0        0.052   0.      0.             1
10185802  0        0.6436  0.      0.             2
10185803  0        0.6436  0.      0.             3
10185804  0        0.556   0.      0.             4
10185805  0        0.463   0.      0.             5
10185806  0        0.144   0.      0.             6
10185807  0        0.5015  0.      0.             7
10185808  0        0.5625  0.      0.             8
10185809  0        0.100   0.      0.             9
10185810  0        0.100   0.      0.             10
*10185811  0        0.012   0.      0.             11
```

```
10185811  0        0.0776 0.     0.              11
10185812  0        0.0776 0.     0.              12
10185901  0        0.     0.     0.              12
*
****************************************
***** DCH HEAT SLABS :CORE BARREL SIDE **
****************************************
*
10046000  3  6  2  1  0.20313
10046100  0  1
10046101  2 0.22876 1 0.23293 2 0.24293
10046201  7   2   6   3    4     5
10046301  0.0 5
10046401  564.0 6
10046501  0          0           0        0      0.4037 3
10046601  004010000 010000       1        0      0.4828 3
10046701  0        0.       0.       0.      3
10046801  0        0.       0.       0.      3
10046901  0        0.71     0.       0.      3
*
****************************************
*****  LOWER   PLENUM   SLABS       *****
****************************************
*
10057000  2  11   2   1    0.25167
10057100  0   1
10057101  2   0.29167   1  0.29584   3  0.35604   4  0.44104
10057201  4  2  6  3  2  10
10057301  0.0 10
10057401  560.0 11
10057501  006010000  0   1   0   1.2977  1
10057502  005010000  0   1   0   2.9638  2
10057601  0    0    0    0     2.031944 1
10057602  0    0    0    0     4.640730 2
10057701  0      0.       0.     0.     2
10057801  0      0.2738   0.     0.     1
10057802  0      0.6253   0.     0.     2
10057901  0      0.568    0.     0.     2
*
****************************************
***** INLET ANN SLABS : VESSEL SIDE *****
****************************************
*
10018000  3   7   2    1    0.32604
10018100  0   1
10018101  2   0.34771  4    0.43271
10018201  2   2   5    6
10018301  0.0   6
10018401  563.0 7
10018501  001010000 0   1   0   0.59924  1
10018502  002010000 0   1   0   0.67512  2
10018503  003010000 0   1   0  1.91423  3
10018601  0      0      0      0   0.795292  1
10018602  0      0      0      0   0.895998  2
10018603  0      0      0      0   2.540506  3
10018701  0      0.     0.     0.           3
10018801  0      0.39437 0.    0.           3
10018901  0      0.16   0.     0.           3
*
****************************************
***** INLET   ANN   HEAT   SLABS   *****
****************************************
```

```
*
10016000  3 6 2 1 0.20313
10016100  0 1
10016101  2 0.22876 1 0.23293 2 0.24293
10016201  7 2 6 3 4 5
10016301  0.0 5
10016401  564.0  6
10016501  0      0        0        0  0.378022 1
10016502  0.     0        0        0  0.424597 2
10016503  0      0        0        0  1.203930 3
10016601  001010000  0    1    0    0.45209  1
10016602  002010000  0    1    0    0.50779  2
10016603  003010000  0    1    0    1.43982  3
10016701  0   0.        0.      0.   3
10016801  0   0.        0.      0.   3
10016901  0   0.016     0.      0.   3
*
**********************************************************************
*********  HEAT STRUCTURE MATERIAL  TABLE        **********************
**********************************************************************
*
****************************************
*****     BORON   NITRIDE          *****
****************************************
*
20100100  TBL/FCTN   1      1
*20100101  500.    4.611-3    1000. 4.417-3  1500.   4.25-3   2000. 4.083-3
*20100102  2500.   3.917-3    3000. 3.75-3   3500.   3.556-3
20100101  32.0    0.00255    200.0 0.00241   500.0   0.00216 1000. 0.00174
20100102  1500.   0.00133    2000. 9.09-4    2500.   4.91-4   3000. 7.40-5
20100103  4000.   7.40-5
20100151  32.     37.5       400.  37.5      800.    48.3     1200. 54.6
20100152  1600.   58.3       2000. 60.5      2400.   61.4     3400. 62.5
*
****************************************
******      316       LSS         ******
****************************************
*
20100200  TBL/FCTN   1      1
20100201  100.    2.153-3    800.   3.056-3  1600.   3.972-3 4000.0 3.972-3
20100251  32.0    61.3       400.   61.3      600.   64.6     800.   67.1
20100252  2200.   82.9
*
****************************************
*****        CONSTANTAN           ******
****************************************
*
20100300  TBL/FCTN   1      1
20100301  0.      3.889-3    3000.  3.889-3
20100351  212.    56.        572.   61.      932.    67.     1472. 73.
20100352  2192.   78.        2552.  84.      3000.   90.
*
****************************************
******        304  SS             ******
****************************************
*
20100400  TBL/FCTN   1      1
20100401  100.    2.444-3    400.   2.8056-3 600.    3.0278-3
20100402  1000.   3.5-3      1200.  3.75-3
20100451  100.    45.01      400.   45.01    600.    46.09   1000. 49.35
*
****************************************
```

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******          CARBON ST           *******
*****************************************
*
20100500  TBL/FCTN    1      1
20100501  212.   0.00889   572.  0.00750   752.   0.00694  1112. .00564
20100551  212.   54.28     754.   54.28
*
*****************************************
*****          TWO PHASE             *****
*****************************************
*
20100600  TBL/FCTN    1      1
20100601  212.   5.556-6   572.  8.333-6 4000.0  8.333-6
20100651  212.   1.        572.  64. 4000.0  64.0
*
*****************************************
*****          CU-BE                 *****
*****************************************
*
20100700  TBL/FCTN    1      1
20100701  68.    0.0375    572.   0.03444
20100751  212.   54.6      572.   54.6
*
************************************************************************
************          POWER   TABLE                   ********************
************************************************************************
*
20210000  POWER   402
20210001     0.1738    1.004580566
20210002     0.5217    1.004735710
20210003     0.8695    1.004476929
20210004     1.2173    9.286303711D-01
20210005     1.5651    7.126276855D-01
20210006     1.9130    5.963225098D-01
20210007     2.2608    5.836469727D-01
20210008     2.6086    6.504913330D-01
20210009     2.9564    8.946907959D-01
20210010     3.3043    9.959921875D-01
20210011     3.6521    1.003442261
20210012     3.9999    1.004166626
20210013     4.3477    1.004373535
20210014     4.6956    1.003338867
20210015     5.0434    9.586895752D-01
20210016     5.3912    7.824729004D-01
20210017     5.7390    6.089981689D-01
20210018     6.0869    4.775339966D-01
20210019     6.4347    4.018942871D-01
20210020     6.7825    3.401718140D-01
20210021     7.1303    2.599792480D-01
20210022     7.4782    2.098976746D-01
20210023     7.8260    2.045687561D-01
20210024     8.1738    2.036891785D-01
20210025     8.5216    2.028614197D-01
20210026     9.9129    2.022405701D-01
20210027    10.2608    2.021888428D-01
20210028    10.6086    2.021370850D-01
20210029    10.9564    1.930830994D-01
20210030    11.3042    1.509172974D-01
20210031    11.6521    1.276873169D-01
20210032    11.9999    1.247900391D-01
20210033    12.3477    1.245313416D-01
20210034    12.6955    1.238587646D-01
```

20210035	13.0434	1.239105072D-01
20210036	13.7390	1.234965973D-01
20210037	14.4347	1.233931274D-01
20210038	14.7825	1.228240356D-01
20210039	15.1303	1.164603577D-01
20210040	15.4781	1.035778046D-01
20210041	15.8260	9.167825317D-02
20210042	16.1738	8.583193970D-02
20210043	16.5216	8.474546814D-02
20210044	16.8694	8.671148682D-02
20210045	17.2173	1.177537842D-01
20210046	17.5651	1.532972107D-01
20210047	17.9129	1.591434937D-01
20210048	18.2607	1.605921326D-01
20210049	18.9564	1.604886780D-01
20210050	19.3042	1.562979736D-01
20210051	19.6520	1.128904724D-01
20210052	19.9999	6.363670349D-02
20210053	20.3477	5.520355225D-02
20210054	20.6955	5.473791504D-02
20210055	21.0433	5.473791504D-02
20210056	21.3912	5.442749786D-02
20210057	21.7390	5.401359558D-02
20210058	22.0868	5.411707306D-02
20210059	22.4346	5.401359558D-02
20210060	22.7825	5.391011810D-02
20210061	23.1303	5.385833318D-02
20210062	23.4781	5.427228546D-02
20210063	24.8694	5.401359558D-02
20210064	25.2172	5.380664063D-02
20210065	25.5651	5.370317841D-02
20210066	25.9129	5.422055054D-02
20210067	26.2607	5.308232880D-02
20210068	26.6085	4.252794647D-02
20210069	26.9564	2.809328079D-02
20210070	27.3042	2.385083008D-02
20210071	27.6520	2.343693161D-02
20210072	28.3477	2.333346176D-02
20210073	30.0868	2.359214783D-02
20210074	30.4346	2.322998810D-02
20210075	30.7824	2.317824936D-02
20210076	31.4781	2.354040909D-02
20210077	34.6085	2.369561768D-02
20210078	34.9563	2.390256882D-02
20210079	35.3042	2.441994095D-02
20210080	35.6520	2.592032242D-02
20210081	35.9998	2.736895752D-02
20210082	36.3476	2.923149490D-02
20210083	36.6955	3.078360748D-02
20210084	37.0433	3.274961853D-02
20210085	37.3911	3.445694733D-02
20210086	38.0868	3.787159729D-02
20210087	38.4346	3.963066864D-02
20210088	38.7824	4.149320221D-02
20210089	39.1302	4.314879608D-02
20210090	39.4781	4.563217163D-02
20210091	39.8259	4.713255310D-02
20210092	42.9563	4.785688019D-02
20210093	43.9998	4.754644775D-02
20210094	45.7389	4.744297028D-02
20210095	46.0867	4.723603058D-02
20210096	46.7824	4.697734070D-02

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20210097    48.1737    4.708081818D-02
20210098    64.5215    4.563217163D-02
20210099   300.0000    4.320053101D-02
*
****************************************************************************
************       NORMALIZED PUMP SPEED TABLE        ********************
****************************************************************************
*
20200100  REAC-T   402
20200101  -0.0     1.00000
20200102  0.0      1.00000
20200103  2.2      1.01235
20200104  7.0      1.00568
20200105 10.0      1.02384
20200106 12.5      1.01421
20200107 17.0      1.00803
20200108 30.0      1.00432
20200109 46.0      1.00327
20200110 50.0      1.00432
20200111 1000.     1.00432
*
****************************************************************************
***********   PUMP CHARACTERISTIC SURVE SETS          ********************
****************************************************************************
*
****************************************
*****    SINGLE PHASE CURVES      ********
****************************************
*
1101100   1        1
1101101   0.000  1.200   1.000   1.000
1101200   1        2
1101201   0.000 -0.350   0.300  -0.200   0.500   0.000   0.800   0.545
1101202   1.000  1.000
1101300   1        3
1101301  -1.000  1.500  -0.800   1.275  -0.600   1.375  -0.400   1.375
1101302  0.000   1.200
1101400   1        4
1101401  -1.000  1.500  -0.800   1.150  -0.600   0.950  -0.400   0.830
1101402  -0.200  0.775   0.000   0.725
1101500   1        5
1101501   0.000  0.975   0.500   1.350   1.000   1.95
1101600   1        6
1101601   0.0    0.725   0.200   0.725   0.400   0.800   0.600   1.025
1101602   1.000  1.950
1101700   1        7
1101701  -1.000  0.175  -0.500   0.650   0.000   0.975
1101800   1        8
1101801  -1.000  0.175  -0.750  -0.150  -0.550  -0.30  -0.275  -0.400
1101802   0.000 -0.350
1101900   2        1
1101901   0.000  0.540   0.200   0.590   0.400   0.650 0.600   0.770
1101902   0.800  0.950   0.900   0.980   0.950   0.960 1.000   0.870
1102000   2        2
1102001   0.000 -0.150   0.200   0.020   0.400   0.220 0.600   0.460
1102002   0.800  0.710   0.900   0.810   0.950   0.850 1.000   0.870
1102100   2        3
1102101   -1.000 0.620  -0.800   0.680  -0.600   0.530 -0.400 0.460
1102102   -0.200 0.490   0.000   0.540
1102200   2        4
1102201   -1.000 0.620   -0.800 0.530   -0.600 0.460 -0.400 0.420
1102202   -0.200 0.390    0.000  0.360
```

```
1102300  2       5
1102301  0.000  -0.630  0.200 -0.510  0.400 -0.390 0.600 -0.690
1102302  0.800  -0.200  0.900 -0.160  1.000 -0.130
1102400  2       6
1102401  0.000   0.360  0.200  0.320  0.400 0.270  0.600  0.180
1102402  0.800   0.050  1.000 -0.130
1102500  2       7
1102501  -1.000 -1.440 -0.800 -1.250 -0.600 -1.080  -0.400 -0.920
1102502  -0.200 -0.770  0.000 -0.630
1102600  2       8
1102601  -1.000 -1.440 -0.800 -1.120 -0.600 -0.790  -0.400 -0.520
1102602  -0.200 -0.310  0.000 -0.150
*
*************************************
***** TWO-PHASE MULTIPLIER TABLES ******
*************************************
*
1103000  0
1103001  0.000  0.000  0.100  0.000  0.150  0.050  0.240  0.800
1103002  0.300  0.960  0.400  0.980  0.600  0.970  0.800  0.900
1103003  0.900  0.800  0.960  0.500  1.000  0.000
1103100  0
1103101  0.000 -0.170  0.001 -0.170  0.006  0.000  0.100  0.000
1103102  0.150  0.050  0.240  0.560  0.800  0.560  0.960  0.450
1103103  1.000  0.000
*
*************************************
***** TWO-PHASE DIFFERENCE TABLES *****
*************************************
*
1104100  1      1
1104101  0.000  0.000  0.100  0.830  0.200  1.090  0.500  1.020
1104102  0.700  1.010  0.900  0.940  1.000  1.000
1104200  1      2
1104201  0.000  0.000  0.100 -0.040  0.200  0.000  0.300  0.100
1104202  0.400  0.210  0.800  0.670  0.900  0.800  1.000  1.000
1104300  1      3
1104301 -1.000 -1.160 -0.900 -1.240 -0.800 -1.170 -0.700 -2.360
1104302 -0.600 -2.790 -0.500 -2.910 -0.400 -2.670 -0.250 -1.690
1104303 -0.100 -0.500  0.000  0.000
1104400  1      4
1104401 -1.000 -1.160 -0.900 -0.780 -0.800 -0.500 -0.700 -0.310
1104402 -0.600 -0.170 -0.500 -0.080 -0.350  0.000 -0.200  0.050
1104403 -0.100  0.080  0.000  0.110
1104500  1      5
1104501  0.000  0.000  0.200 -0.034  0.400 -0.650  0.600 -0.930
1104502  0.800 -1.190  1.000 -1.470
1104600  1      6
1104601  0.000  0.110  0.100  0.130  0.250  0.150  0.400  0.130
1104602  0.500  0.070  0.600 -0.040  0.700 -0.230  0.800 -0.510
1104603  0.900 -0.910  1.000 -1.470
1104700  1      7
1104701 -1.000  0.000  0.000  0.000
1104800  1      8
1104801 -1.000  0.000  0.000  0.000
1104900  2      1
1104901  0.000  0.540  0.200  0.590  0.400  0.650  0.600  0.770
1104902  0.800  0.950  0.900  0.980  0.950  0.960  1.000  0.870
1105000  2      2
1105001  0.000 -0.150  0.200  0.020  0.400  0.220  0.600  0.460
1105002  0.800  0.710  0.900  0.810  0.950  0.850  1.000  0.870
1105100  2      3
```

```
1105101 -1.000  0.620 -0.800  0.680 -0.600  0.530 -0.400  0.460
1105102 -0.200  0.490  0.000  0.540
1105200  2      4
1105201 -1.000  0.620 -0.800  0.530 -0.600  0.460 -0.400  0.420
1105202 -0.200  0.390  0.000  0.360
1105300  2      5
1105301  0.000 -0.630  0.200 -0.510  0.400 -0.390  0.600 -0.290
1105302  0.800 -0.200  0.900 -0.160  1.000 -0.130
1105400  2      6
1105401  0.000  0.360  0.200  0.320  0.400  0.270  0.600  0.180
1105402  0.800  0.050  1.000 -0.130
1105500  2      7
1105501 -1.000 -1.440 -0.800 -1.250 -0.600 -1.080 -0.400 -0.920
1105502 -0.200 -0.770  0.000 -0.630
1105600  2      8
1105601 -1.000 -1.440 -0.800 -1.120 -0.600 -0.790 -0.400 -0.520
1105602 -0.200 -0.310  0.000 -0.150
*
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11. ABSTRACT (200 words or less)

This report presents the results of the RELAP5/MOD2 post-test assessment utilizing a semiscale large break loss-of-coolant experiment numbered S-06-3. Emphasis was placed on the capability of the code to calculate break flow rates during system blowdown stage, emergency core cooling system (ECCS) injection bypass during refill stage, quenching during reflood stage, and peak cladding temperature behavior throughout the whole experiment.

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